



FACULTAD DE
CIENCIAS QUÍMICAS

BIOCHEMISTRY

COURSE GUIDE

BSc Chemistry

Academic Year 2023-2024



UNIVERSIDAD
COMPLUTENSE
MADRID



I.- IDENTIFICATION

COURSE NAME:	Biochemistry
CREDITS (ECTS):	9
CHARACTER:	Mandatory
SUBJECT/TOPIC:	Fundamental Complements of Chemistry
MODULE:	Fundamental
DEGREE:	Bachelor's degree in Chemistry
SEMESTER/TERM:	2nd (3rd Year)
DEPARTMENT:	Biochemistry and Molecular Biology

LECTURERS:

Course Coordinator	Lecturer: BEGOÑA LAVÍN PLAZA Department: Biochemistry and Molecular Biology Office: L-6, 4 th Floor, QA building e-mail: blavin@ucm.es

Group A

Lectures Seminars Tutorials	Lecturer: ISMAEL GALVE ROPERH Department: Biochemistry and Molecular Biology Office: 1 st Floor, Faculty of Biology, B building e-mail: igalvero@ucm.es
Lectures Seminars Tutorials	Lecturer: FRANCISCO JAVIER LACADENA GARCÍA-GALLO Department: Biochemistry and Molecular Biology Office: L-3, 4 th Floor, QA building e-mail: jlacaden@ucm.es

Group B

Lectures Seminars Tutorials	Lecturer: MARÍA BELÉN YÉLAMOS LÓPEZ Department: Biochemistry and Molecular Biology Office: L-20, 4 th Floor, QA building e-mail: mbyelamo@ucm.es
Lectures Seminars Tutorials	Lecturer: MARÍA TERESA VILLALBA DÍAZ Department: Biochemistry and Molecular Biology Office: L-20, 4 th Floor, QA building e-mail: mvillalb@ucm.es

Group C



Lectures Seminars Tutorials	Lecturer: CARLOS PASTOR VARGAS Department: Biochemistry and Molecular Biology Office: L-1, 4 th Floor, QA building e-mail: cpasto01@ucm.es
Lectures Seminars Tutorials	Lecturer: MARÍA TERESA PORTOLÉS PÉREZ Department: Biochemistry and Molecular Biology Office: L-8, 4 th Floor, QA building e-mail: tportole@ucm.es

Group D

Lectures Seminars Tutorials	Lecturer: ANA SABORIDO MODIA Department: Biochemistry and Molecular Biology Office: 1 st Floor, Faculty of Biology, B building e-mail: asaborid@ucm.es
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Group E

Lectures Seminars Tutorials	Lecturer: GUILLERMO VELASCO DÍEZ Department: Biochemistry and Molecular Biology Office: 1 st Floor, Faculty of Biology, B building e-mail: gvelasco@ucm.es
Lectures Seminars Tutorials	Lecturer: BEGOÑA LAVÍN PLAZA Department: Biochemistry and Molecular Biology Office: L-6, 4 th Floor, QA building e-mail: blavin@ucm.es

BBM Departmental Laboratory, QA Building, 4th Floor

Group	Semester	Lecturer	e-Mail	Office	Dept.
A	2 nd	To be determined	sglinares@ucm.es (Sara García Linares, Practicals Coordinator)	QA-3	BBM
B	2 nd	To be determined	sglinares@ucm.es (Sara García Linares, Practicals Coordinator)	QA-3	BBM
C	2 nd	To be determined	sglinares@ucm.es (Sara García Linares, Practicals Coordinator)	QA-3	BBM
D	2 nd	To be determined	sglinares@ucm.es (Sara García Linares, Practicals Coordinator)	QA-3	BBM
E	2 nd	To be determined	sglinares@ucm.es (Sara García Linares, Practicals Coordinator)	QA-3	BBM



II.- OBJECTIVES

■ GENERAL OBJECTIVE

To provide the student with a general knowledge of the structure and function of biological macromolecules –proteins and nucleic acids; and to provide him/her with insights into intermediate metabolism.

■ SPECIFIC OBJECTIVES

- To learn the different levels of protein and nucleic acid organization, as well as their functions.
- To decipher and understand the different metabolic pathways and processes that occur in cells.

III.- PREVIOUS KNOWLEDGE AND RECOMENDATIONS

■ PREVIOUS KNOWLEDGE: -

■ RECOMENDATIONS: -

IV.- CONTENTS

■ BRIEF DESCRIPTION

Protein structural levels. Relationship between structure and function of proteins. Cooperativity. Allosteric regulation. Enzymes. Enzyme kinetics. Regulation of enzyme activity. Nucleic acid structure. Molecular basis of genetic information: replication, transcription, translation. Intermediate metabolism and bioenergetics. Carbohydrate metabolism. Tricarboxylic acid cycle. Mitochondrial electron transport chain. Oxidative phosphorylation. Lipid metabolism. Nitrogen metabolism.

Lab practical contents:

To measure the concentration of a protein. To calculate kinetic parameters of an enzymatic system. To learn how to characterize proteins and DNA.

Oral presentation contents:

To prepare and present a 10-minute oral presentation of a topic related to the content explained during the theoretical lectures -as proposed by the lecturers.

■ SYLLABUS:

Protein structure

1. Protein structure: Properties of amino acids and peptides.
2. Structural levels of organization, protein bonds and forces that stabilize protein structure.



Protein function

3. Relationship between protein structure and function. Transport and storage of proteins. Cooperativity. Allosterism. Immunoglobulins.
4. Enzymes: specificity, active site, cofactors and coenzymes. Kinetics of enzymatic reactions. Enzyme inhibition. Regulation of the enzyme activity.

Molecular basis of genetic information

5. Nucleic acids: Structure and types. Physico-chemical properties. Relationship between structure and function.
6. DNA Replication. Transcription.
7. Translation of genetic information: protein biosynthesis.

Intermediate metabolism

8. General concepts of metabolism and bioenergetics.
9. Carbohydrate metabolism. Glycolysis. Aerobic and anaerobic metabolism of pyruvate. Krebs cycle.
10. Mitochondrial electron transport chain. Oxidative phosphorylation.
11. Gluconeogenesis. Glycogen metabolism. Hormonal regulation.
12. Lipid metabolism. Lipoproteins. Fatty acid β -oxidation. Ketogenesis.
13. Fatty acid synthesis. Cholesterol metabolism.
14. Nitrogen metabolism. Amino acid metabolism. Transamination and deamination of amino acids. Amino acids as precursor of other molecules. Metabolism of nucleotides.

V.- COMPETENCES

■ GENERAL:

CG1-MF1	To recognize the chemical processes of daily life.
CG2-MF1	To link Chemistry with other disciplines.
CG3-MF1	To continue studies in multidisciplinary fields.
CG5-MF1	To demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the field of Chemistry.
CG6-MF1	To analyse and solve qualitative and quantitative problems.
CG7-MF1	To recognize and analyse new problems and plan strategies to solve them.



CG8-MF1	To consult and use scientific information in an efficient manner.
CG9-MF1	To demonstrate knowledge of laboratory material and practical abilities.
CG10-MF1	To manipulate chemical material in a safe manner.
CG10-MF2	To recognize and acknowledge the risks of the use of chemical hazards and laboratory procedures.
CG11-MF1	To handle standard chemical instruments.
CG11-MF2	To develop the ability to follow protocols to characterize chemical reagents.
CG12-MF1	To interpret data obtained from observations and measurements taken in the laboratory.
CG13-MF1	To recognize and implement Good Laboratory Practices (GLP).

■ **SPECIFIC:**

CE17-MFCQ1	To learn the different factors involved in the specific structure and function of biological macromolecules (proteins and nucleic acids), and how function is determined by structure.
CE18-MFCQ1	To explain the bases of enzymology, the kinetic and thermodynamic factors that regulate enzyme catalytic action, as well as cooperative and inhibitory processes.
CE20- MFCQ1	To explain the basis of metabolism, metabolic pathways, and their regulation. To develop an integrated view from a cellular and tissular perspective.
CE21-MFCQ1	To describe basic mechanisms involved in replication, transcription, and protein biosynthesis.
CE22-MFCQ1	To learn and perform the very basic experimental methods used in Biochemistry.

■ **CROSS-DISCIPLINARY KNOWLEDGE:**

CT1-MF1	To elaborate and write scientific and technical reports.
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CT2-MF1	To develops skills for teamwork.
CT3-MF1	To develop and apply critical and self-critical thinking.
CT5-MF1	To use biochemistry information and bibliography.
CT6-MF1	To identify the importance of biochemistry in the industrial, environmental and social settings.
CT7-MF1	To learn the use of different informatic resources used in Biochemistry.
CT11-MF1	To develop independent learning.
CT12-MF2	To develop environment-care sensitivity.

VI. – LEARNING OUTCOMES

At the end of this module, the student will be able to:

- Describe the structures of biological macromolecules (proteins and nucleic acids), which factors determine macromolecule structure, and how function is closely related to structure.
- Explain the basis of enzymology, the kinetic and thermodynamic factors that regulate enzyme catalytic action, as well as cooperative and inhibitory processes.
- Describe basic mechanisms involved in replication, transcription, and protein biosynthesis.
- Explain the basis of metabolism, metabolic pathways, and their regulation. To develop an integrated view from a cellular and tissular perspective.
- Learn and perform the very basic experimental methods used in Biochemistry.
- Interpret data obtained from observations and measurements taken in the laboratory.
- Recognize and implement Good Laboratory Practices (GLP).

VII. – WORKING HOURS DISTRIBUTED BY ACTIVITIES

Activity	Attendance (hours)	Self-study (hours)	Credits (hours)
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Lectures	45	80	5
Seminars	14	11	1
Tutorials / Guided work	3	12	0.6
Laboratory practicals	21	15	1.5
Exam and report preparation	3	21	0.9
Total	86	139	9 (225)

VIII.- METODOLOGY

This module will follow a hybrid methodology by using both, cooperative and self-study learning approaches. Face-to-face classes in this module will be divided into **lectures, seminars, tutorials/ guided work, and laboratory practicals.**

During the lectures, the contents of each module will be explained to the student by the lecturer. Theoretical and experimental concepts will be explained to the student in order to provide a global and comprehensive view of the module. Blackboard and PowerPoint presentations will be used. At the end of a lesson, and as a way to integrate the recent knowledge acquired, an interconnection with other lessons of this module and other modules of the Degree will be discussed. Moreover, students will be provided with appropriate learning material through the Virtual Campus, videos and/or photocopies.

Seminars will have the objective of applying the knowledge learned to specific questions and/or exercises. Students will receive, in advance, the questions and/or exercises to work on them. Part of them will be discussed and solved in the class by the lecturer, and other part will be resolved and presented by the student.

Oral presentations (10 minutes) will have the objective of developing skills CG2-MF1, CG8-MF1, CT2-MF1, CT3-MF1, CT6-MF1, among others. Working groups will be designed, and different topics related to the recent knowledge acquired will be provided to the students at the beginning of the module. Students will conduct the defense of the assigned topic by the last week of the face-to-face lessons.

Tutorials/guided activities: Different face-to-face tutorial sessions will be organized. In these sessions, students will have the opportunity to ask questions, seek for advice, and learn how to solve the proposed exercises.

Laboratory practicals: The laboratory practicals will be directly linked to the theoretical contents, which will provide a reinforcement of the knowledge learned during the lectures and seminars. The laboratory sessions will be performed in the second semester. Students will receive an instruction booklet that will help them to perform the proposed experiments in a successful and safe manner. Simultaneously to the experimental work, students will prepare a laboratory notebook where they will describe all the details, calculations and data obtained during the practicals. At the end of the laboratory sessions, students will deliver the laboratory notebook to the lecturers for evaluation.



IX.- BIBLIOGRAPHY

■ BASIC:

At the beginning of the module, the recommended bibliography will be detailed, explaining the most relevant details of each of them.

- Stryer, L., Berg, J.M. & Tymoczko, J.L.: *"Biochemistry with clinical applications"*, 7th edition, Ed. Reverté, 2013.
- Tymoczko, J.L., Berg, J.M. y Stryer L.: *"Biochemistry"* Ed. Reverté, 2014.
- Mathews, C.K., Van Holde, K.E., Appling, D.R. & Anthony-Cahill, S.J.: *"Biochemistry"*, 4th edition, Ed. Pearson Education, 2013.
- Nelson D.L., Cox M.M. *"Lehninger. Principles of Biochemistry"*, 7th edition Ed. Omega, 2018.
- Müller-Esterl, W.: *"Biochemistry"*, 1^a edition, Ed. Reverté, 2008.
- Voet, D.; Voet, J.G. & Pratt, C.W.: *"Principles of Biochemistry"*, 4th edition, Ed. Panamericana, 2016.
- Salway, J.G.: *"Metabolism at a glance"*, 4th edition. Willey Blackwell, 2017.

■ COMPLEMENTARY:

- Lodish, H. et al: *"Molecular and Cell Biology"*, 7th ed., Panamericana, 2016.
- García-Segura, J.M. et al: *"Técnicas instrumentales de análisis en Bioquímica"*, Ed. Síntesis, 1996.
- Segel, I.H.: *"Cálculos de Bioquímica: Cómo resolver problemas matemáticos de Bioquímica General"*, 2nd edition, Ed. Acribia, Zaragoza, 1982.
- Appling, D.R., Anthony-Cahill, S.J. y Mathews, C.K.: *"Biochemistry: Concepts & Connections"*, 2e Global Edition, 2019.

X.- EVALUATION

For the final evaluation of the module, it is mandatory to participate in all the proposed activities. It is mandatory to attend all practical sessions and to participate in at least 70% of the face-to-face lectures.

Marking of the proposed activities (mid-term exam, laboratory, seminars) will be communicated to the student with sufficient time prior to the final exam. For the mid-term exam, marking will be communicated within a maximum period of 20 days. Either way, the mid-term marking will always be communicated at least 7 days prior to the final exam.

The final mark will be calculated according to the following percentages:

■ ORAL AND WRITTEN EXAM:

70%

The evaluation of the acquired competences in the theoretical part will be carried out by a final exam. A mid-term exam will be also offered for the first part of the course (Lessons 1-7). This part of the course will be cleared if the mark of the mid-term exam



is equal or higher than 5.0. To pass the final exam it will be mandatory to obtain a minimum mark of 4.0 in each of the two parts of the course (first part: Lessons 1-7; second part, Lessons 8-14).

Evaluated competences: CG1-MF1, CG2-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CG12-MF1, CE17-MFCQ1, CE18-MFCQ1, CE20-MFCQ1, CE21-MFCQ1, CT1-MF1, CT3-MF1, CT5-MF1, CT11-MF1.

■ **PERSONAL WORK, GUIDED ACTIVITIES, AND ATTENDANCE AND PARTICIPATION IN THE LECTURES** **10 %**

For evaluating the student's learning process, ability of exercise/problem resolution will be assessed. Students must participate in all activities proposed by the lecturer. Attendance and participation in all activities will be positively considered for the final mark. The continuous failure in attendance may be penalized.

Evaluated competences: CG2-MF1, CG3-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CG12-MF1, CG13-MF1, CE17-MFCQ1, CE18-MFCQ1, CE20-MFCQ1, CE21-MFCQ1, CE22-MFCQ1, CT1-MF1, CT2-MF1, CT3-MF1, CT5-MF1, CT6-MF1, CT7-MF1, CT11-MF1, CT12-MF2.

■ **LABORATORY PRACTICAL SESSIONS** **20%**

The ability of the student to carry out the laboratory sessions and the quality of the laboratory notebook will be assessed. All knowledge learned during the laboratory sessions will be assessed in the exam.

Evaluated competences: CG6-MF1, CG7-MF1, CG9-MF1, CG10-MF1, CG10-MF2, CG11-MF1, CG11-MF2, CG12-MF1, CG13-MF1, CE22-MFCQ1, CT1-MF1, CT2-MF1, CT3-MF1, CT5-MF1.



ACTIVITIES SCHEDULED

UNIT	ACTIVITY	HOURS	GROUPS	START	END
1. Structure of proteins	Lectures	6	1	1 st week	2 nd week
	Seminars	2	1		
2. Function of proteins	Lectures	8	1	3 rd week	5 th week
	Seminars	3	1		
3. Molecular bases of genetic information	Lectures	9	1	5 th week	8 th week
	Seminars	3	1		
4. Carbohydrate metabolism	Lectures	11	1	8 th week	11 th week
	Seminars	3	1		
5. Lipid metabolism	Lectures	7	1	11 th week	13 th week
	Seminars	2	1		
6. Nitrogen metabolism	Lectures	4	1	13 th week	14 th week
	Seminars	1	1		
	Tutorials	3	1		



SUMMARY OF ACTIVITIES

Teaching activity	Associated competences	Lecturer activity	Student activity	Assessment procedure	F	SS	Total	E
Lectures	CG1-MF1, CG2-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CG12-MF1, CE17-MFCQ1, CE18-MFCQ1, CE20-MFCQ1, CE21-MFCQ1, CT1-MF1, CT3-MF1, CT5-MF1, CT6-MF1, CT7-MF1, CT11-MF1, CT12-MF2	Presentation of theoretical concepts. Approach with questions.	Take notes. Formulation and resolution of questions.	Assessment of the answers given to the questions proposed related to the theoretical content	45	80	125	10%
Seminars	CG1-MF1, CG2-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CE17-MFCQ1, CE18-MFCQ1, CE20-MFCQ1, CE21-MFCQ1, CT1-MF1, CT2-MF1, CT3-MF1, CT5-MF1, CT6-MF1, CT7-MF1, CT11-MF1, CT12-MF2	Application of the theory for the resolution of the exercises and problems.	Take notes. Resolution of exercises and questions. Formulation of questions and doubts.	Assessment of the answers (approach and result) given for the resolution of practical exercises.	14	11	25	
Tutorials	CG1-MF1, CG2-MF1, CG3-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CG9-MF1, CG12-MF1, CG13-MF1, CE17-MFCQ1, CE18-MFCQ1, CE20-MFCQ1, CE21-MFCQ1, CT1-MF1, CT2-MF1, CT3-MF1, CT5-MF1, CT6-MF1, CT7-MF1, CT11-MF1, CT12-MF2	Direction and supervision of the study and activities of the student. Raise questions.	Resolution of the proposed exercises.	Assessment of the group work and oral presentations.	3	12	15	



Teaching activity	Associated competences	Lecturer activity	Student activity	Assessment process	F	SS	Total	E
Laboratory	CG6-MF1, CG7-MF1, CG9-MF1, CG10-MF1, CG10-MF2, CG11-MF1, CG11-MF2, CG12-MF1, CG13-MF1, CE22-MFCQ1, CT1-MF1, CT2-MF1, CT3-MF1, CT5-MF1	Explanation and supervision of the experimental procedures.	Perform and analyse all proposed experiments.	Continuous assessment of the attitude and ability of the student in the laboratory, and exam.	21	15	36	20%
Exams	CG1-MF1, CG2-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CE17-MFCQ1, CE18-MFCQ1, CE20-MFCQ1, CE21-MFCQ1, CT1-MF1, CT3-MF1, CT5-MF1	Exam design, surveillance and exam marking. Evaluation of the student.	Exam preparation and examination.	Exam marking.	3	21	24	70%

F: Face-to-face; SS: Self-study; E: Evaluation

