



# Course guide

## BIOCHEMISTRY

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**FACULTY OF CHEMISTRY**  
**COMPLUTENSE UNIVERSITY OF MADRID**  
**ACADEMIC YEAR 2022-2023**



## I.- IDENTIFICATION

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

## LECTURERS:

<b>Course Coordinator</b>	<b>Lecturer:</b> MANUEL GUZMÁN PASTOR <b>Department:</b> Biochemistry and Molecular Biology <b>Office:</b> 1 <sup>st</sup> Floor, Faculty of Biology, B building <b>e-mail:</b> <a href="mailto:mguzman@quim.ucm.es">mguzman@quim.ucm.es</a>

## Group A

<b>Lectures Seminars Tutorials</b>	<b>Lecturer:</b> ISMAEL GALVE ROPERH <b>Department:</b> Biochemistry and Molecular Biology <b>Office:</b> 1 <sup>st</sup> Floor, Faculty of Biology, B building <b>e-mail:</b> <a href="mailto:igr@quim.ucm.es">igr@quim.ucm.es</a>
<b>Lectures Seminars Tutorials</b>	<b>Lecturer:</b> MANUEL GUZMÁN PASTOR <b>Department:</b> Biochemistry and Molecular Biology <b>Office:</b> 1 <sup>st</sup> Floor, Faculty of Biology, B building <b>e-mail:</b> <a href="mailto:mguzman@quim.ucm.es">mguzman@quim.ucm.es</a>

## Group B

<b>Lectures Seminars Tutorials</b>	<b>Lecturer:</b> MARÍA BELÉN YÉLAMOS LÓPEZ <b>Department:</b> Biochemistry and Molecular Biology <b>Office:</b> L-20, 4 <sup>th</sup> Floor, QA building <b>e-mail:</b> <a href="mailto:mbyelamo@ucm.es">mbyelamo@ucm.es</a>
<b>Lectures Seminars Tutorials</b>	<b>Lecturer:</b> MARÍA TERESA VILLALBA DÍAZ <b>Department:</b> Biochemistry and Molecular Biology <b>Office:</b> L-20, 4 <sup>th</sup> Floor, QA building <b>e-mail:</b> <a href="mailto:mvillalb@ucm.es">mvillalb@ucm.es</a>

## Group C



Lectures Seminars Tutorials	<b>Lecturer:</b> CARLOS PASTOR VARGAS <b>Department:</b> Biochemistry and Molecular Biology <b>Office:</b> L-1, 4 <sup>th</sup> Floor, QA building <b>e-mail:</b> <a href="mailto:cpasto01@ucm.es">cpasto01@ucm.es</a>
Lectures Seminars Tutorials	<b>Lecturer:</b> MARÍA TERESA PORTOLÉS PÉREZ <b>Department:</b> Biochemistry and Molecular Biology <b>Office:</b> L-8, 4 <sup>th</sup> Floor, QA building <b>e-mail:</b> <a href="mailto:tportole@ucm.es">tportole@ucm.es</a>

### Group D

Lectures Seminars Tutorials	<b>Lecturer:</b> ANA SABORIDO MODIA <b>Department:</b> Biochemistry and Molecular Biology <b>Office:</b> 1 <sup>st</sup> Floor, Faculty of Biology, B building <b>e-mail:</b> <a href="mailto:asaborid@ucm.es">asaborid@ucm.es</a>
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### Group E

Lectures Seminars Tutorials	<b>Lecturer:</b> GUILLERMO VELASCO DÍEZ <b>Department:</b> Biochemistry and Molecular Biology <b>Office:</b> 1 <sup>st</sup> Floor, Faculty of Biology, B building <b>e-mail:</b> <a href="mailto:gvelasco@ucm.es">gvelasco@ucm.es</a>
Lectures Seminars Tutorials	<b>Lecturer:</b> BEGOÑA LAVÍN PLAZA <b>Department:</b> Biochemistry and Molecular Biology <b>Office:</b> L-6, 4 <sup>th</sup> Floor, QA building <b>e-mail:</b> <a href="mailto:blavin@ucm.es">blavin@ucm.es</a>

### BBM Departmental Laboratory, QA Building, 4<sup>th</sup> Floor

Group	Semester	Lecturer	e-Mail	Office	Dept.
A	2 <sup>nd</sup>	To be determined	<a href="mailto:sglinares@ucm.es">sglinares@ucm.es</a> (Sara García Linares, Practicals Coordinator)	QA-3	BBM
B	2 <sup>nd</sup>	To be determined	<a href="mailto:sglinares@ucm.es">sglinares@ucm.es</a> (Sara García Linares, Practicals Coordinator)	QA-3	BBM
C	2 <sup>nd</sup>	To be determined	<a href="mailto:sglinares@ucm.es">sglinares@ucm.es</a> (Sara García Linares, Practicals Coordinator)	QA-3	BBM
D	2 <sup>nd</sup>	To be determined	<a href="mailto:sglinares@ucm.es">sglinares@ucm.es</a> (Sara García Linares, Practicals Coordinator)	QA-3	BBM
E	2 <sup>nd</sup>	To be determined	<a href="mailto:sglinares@ucm.es">sglinares@ucm.es</a> (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  $\beta$ -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:**

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



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

■ **SPECIFIC:**

<b>CE17-MFCQ1</b>	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.
<b>CE18-MFCQ1</b>	To explain the bases of enzymology, the kinetic and thermodynamic factors that regulate enzyme catalytic action, as well as cooperative and inhibitory processes.
<b>CE20- MFCQ1</b>	To explain the basis of metabolism, metabolic pathways, and their regulation. To develop an integrated view from a cellular and tissular perspective.
<b>CE21-MFCQ1</b>	To describe basic mechanisms involved in replication, transcription, and protein biosynthesis.
<b>CE22-MFCQ1</b>	To learn and perform the very basic experimental methods used in Biochemistry.

■ **CROSS-DISCIPLINARY KNOWLEDGE:**

<b>CT1-MF1</b>	To elaborate and write scientific and technical reports.
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<b>CT2-MF1</b>	To develop skills for teamwork.
<b>CT3-MF1</b>	To develop and apply critical and self-critical thinking.
<b>CT5-MF1</b>	To use biochemistry information and bibliography.
<b>CT6-MF1</b>	To identify the importance of biochemistry in the industrial, environmental and social settings.
<b>CT7-MF1</b>	To learn the use of different informatic resources used in Biochemistry.
<b>CT11-MF1</b>	To develop independent learning.
<b>CT12-MF2</b>	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
<b>Total</b>	<b>86</b>	<b>139</b>	<b>9 (225)</b>

## 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"*, 7<sup>th</sup> 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"*, 4<sup>th</sup> edition, Ed. Pearson Education, 2013.
- Nelson D.L., Cox M.M. *"Lehninger. Principles of Biochemistry"*, 7<sup>th</sup> edition Ed. Omega, 2018.
- Müller-Esterl, W.: *"Biochemistry"*, 1<sup>a</sup> edition, Ed. Reverté, 2008.
- Voet, D.; Voet, J.G. & Pratt, C.W.: *"Principles of Biochemistry"*, 4<sup>th</sup> edition, Ed. Panamericana, 2016.
- Salway, J.G.: *"Metabolism at a glance"*, 4<sup>th</sup> 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"*, 2<sup>nd</sup> edition, Ed. Acribia, Zaragoza, 1982.

## 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.



*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 may 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 <sup>st</sup> week	2 <sup>nd</sup> week
	Seminars	2	1		
2. Function of proteins	Lectures	8	1	3 <sup>rd</sup> week	5 <sup>th</sup> week
	Seminars	3	1		
3. Molecular bases of genetic information	Lectures	9	1	5 <sup>th</sup> week	8 <sup>th</sup> week
	Seminars	3	1		
4. Carbohydrate metabolism	Lectures	11	1	8 <sup>th</sup> week	11 <sup>th</sup> week
	Seminars	3	1		
5. Lipid metabolism	Lectures	7	1	11 <sup>th</sup> week	13 <sup>th</sup> week
	Seminars	2	1		
6. Nitrogen metabolism	Lectures	4	1	13 <sup>th</sup> week	14 <sup>th</sup> 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
<b>Laboratory</b>	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%
<b>Exams</b>	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%
<b>F: Face-to-face; SS: Self-study; E: Evaluation</b>								

