Metals in Biology and Medicine

Code: 102520
ECTS Credits: 6

2025/2026

Degree	Type	Year
Chemistry	OT	4

Contact

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

To take this course, the "Fonaments de Química" and "Química dels elements" subjects must have previously been approved. It is highly recommended to have taken "Química de Coordinació i Organometàl·lica"

Objectives and Contextualisation

"Metalls en Biologia i Medicina" is a fourth-year subject in which the student must acquire a general view of the fu
The general objective of this subject is that, from the general knowledge

reaches a basic knowledge of how important is the presence of metals in living beings both from the point of view
The training objectives of the subject can be summarized in:
1) To know and understand the essentiality and toxicity of metals in biolo
2) To know the main types of metalloproteins and metal cofactors, their fu
3) To know the main drugs, both in therapy and diagnosis, that contain m
4) To learn to

experimentally
work with biological material

Competences

- Adapt to new situations.
- Communicate orally and in writing in one's own language.
- Develop synthesis and analyses studies in chemistry from previously established procedures.
- Evaluate the health risks and environmental and socioeconomic impact associated to chemical substances and the chemistry industry.
- Handle chemical products safely.
- Handle standard instruments and material in analytic and synthetic chemical laboratories.
- "Interpret data obtained by means of experimental measures, including the use of IT tools; identify their meaning and relate the data with appropriate chemistry, physics or biology theories."
- Learn autonomously.
- Manage, analyse and synthesise information.
- Manage the organisation and planning of tasks.
- Obtain information, including by digital means.
- Propose creative ideas and solutions.
- Reason in a critical manner
- Recognise and analyse chemical problems and propose suitable answers or studies to resolve them.
- Resolve problems and make decisions.
- Show an understanding of the basic concepts, principles, theories and facts of the different areas of chemistry.
- Show initiative and an enterprising spirit.
- Show sensitivity for environmental issues.
- Use IT to treat and present information.
- Use the English language properly in the field of chemistry.
- Work in a team and show concern for interpersonal relations at work.

Learning Outcomes

1. Adapt to new situations.
2. Communicate orally and in writing in one's own language.
3. Define the basic principles of drugs.
4. Describe the basic principles of biomineralisation processes and the most relevant biominerals.
5. Distinguish the different detoxification agents of living organisms contaminated by metals and their methods of action.
6. Distinguish the main types of metal cofactor and their functions in metalloprotein.
7. Distinguish the main types of metalloprotein and their functions in living organisms.
8. Identify the main drugs (for therapy and diagnosis) that contain metals, and understand their mechanisms.
9. Identify the maximum limits of presence of different metals in living organisms and in the environment.
10. Identify the risks involved in the handling of chemical compounds used in biological chemistry, and apply suitable protocols for the storage or elimination of the waste generated.
11. Learn autonomously.
12. Manage, analyse and synthesise information.
13. Manage the organisation and planning of tasks.
14. Obtain information, including by digital means.
15. Perform synthesis of compounds metals that can be considered models of active centres of metalloprotein and study their activity.
16. Properly interpret data obtained in the laboratory after computerised treatment and on the basis of the acquired knowledge.
17. Propose creative ideas and solutions.
18. Reason in a critical manner
19. Recognise and analyse situations of metal-biomolecule interaction by reading articles related with the problem.
20. Recognise the common chemical compounds found in the laboratory that require special safety measures.
21. Recognise the essentiality and toxicity of metals in biological systems.
22. Recognise the influence of metals on the structure and stability of metalloprotein.
23. Recognise the main metal storage and transport proteins, as well as their mechanisms.
24. Recognise the main oxygen storage and transport proteins, as well as their mechanisms.
25. Remember the most common English terms used in the world of bioorganic chemistry, and interpret an article in English in a reasonable time.
26. Resolve problems and make decisions.
27. Show initiative and an enterprising spirit.
28. Show sensitivity for environmental issues.
29. Study the action of certain metalloproteins in consideration of their characteristic substrates by means of common chemistry laboratory techniques.
30. Use IT to treat and present information.
31. Use standard instruments and materials to characterise the activity of certain metalloproteins in consideration of their characteristic substrates.
32. Work experimentally with biological material (inert, aseptic and/or controlled atmospheres).
33. Work in a team and show concern for interpersonal relations at work.

Content

….Introduction: Chemical elements of biological relevance: the frontier between essentiality and toxicity. Origin and abundance of different metals on Earth: relationship between abundance in the oceans and living beings. Metals of biological and pharmacological interest.

….Metallic elements in Medicine: Metallic therapeutical drugs: supplements, antimicrobial and antiarthritic agents. Li and the control of bipolar disorders. Diseases associated to the excess and/or defect of metals. Toxic metals. Anticancer therapeutic agents. Examples and mechanisms of action of cis-Pt and new

generation Pt(II) drugs. Other anticancer agents containing metals. Imaging and diagnostic agents. ^{99m}Tc as a radiodiagnosis agent. Radiotherapy. Contrast agents for Magnetic Resonance Imaging (MRI): the case of Gd(III).

….Metal ions and proteins. Bonding, stability and folding: The metallic cofactor. Amino acids as ligands of metal ions. Metalloproteins: folding, stability and classification. Role of the metal and the peptide chain. Tetrapyrrolic cofactors and nucleic acids. Elements of the *s*- and *p*-blocks

….Transport and storage of metal ions in living systems: Bioavailability of metal ions. General properties of transport systems: channels, transporters and pumps. Metallochaperons. The case of Fe. Metallic storage mechanisms: the case of ferritin and metallothioneins.

….Special cofactors and metal clusters: Structural characteristics, functionality and abundance. Fe-S cofactors and other electronic transfer cofactors: cytochromes and blue copper proteins. Nitrogenase. Zinc cofactors. Hemo cofactors: transport and storage of oxygen- Other oxygen transporters. Corrins and chlorophylls. Protection against free radicals.

….Biominerals and biomineralization: Types of biominerals and their function: the case of Ca, Si, oxides and sulfides of Fe. General principles of biomineralization. Growth of biominerals.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory Practices	12	0.48	1, 11, 2, 27, 29, 12, 13, 10, 16, 28, 14, 17, 18, 15, 20, 19, 25, 26, 33, 32, 31, 30
Theory classes	36	1.44	1, 11, 2, 3, 27, 4, 5, 6, 7, 29, 12, 13, 9, 8, 28, 14, 17, 18, 15, 19, 22, 23, 24, 21, 25, 26, 33, 30
Type: Supervised			
Semminars	2	0.08	1, 11, 2, 27, 12, 13, 16, 28, 14, 17, 18, 19, 25, 26, 33, 30
Type: Autonomous			
Individual work	84	3.36	1, 11, 2, 3, 27, 4, 5, 6, 7, 29, 12, 13, 9, 8, 10, 16, 28, 14, 17, 18, 15, 20, 19, 22, 23, 24, 21, 25, 26, 33, 32, 31, 30

Classes of theory - Lectures: Students will acquire the knowledge of the subject by personally attending the class
student consulting the bibliography that the teacher will indicate and parti
fundamentally unidirectional transmission of knowledge of the teacher to

Also, each student will prepare a topic of his/her choice from a list of proposed topics, which will be exposed in cl

Classes of problems and Seminars: The knowledge acquired in theory classes and in personal study, will be app
the participation of students is important. Thus, in these sessions, the sol

develop critical thinking and logical reasoning, in order to increase stude

Practical classes: Laboratory practices will be carried out (3 sessions of 4 h each) related to the topics of the subj
products and chemical reagents and biological material as well as the us
and will be supervised by the teacher who will evaluate the students cons

Information on "satisfaction surveys": The teacher will allocate approximately 15 minutes of any of the classes at

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Laboratory Module	20%	4	0.16	1, 3, 27, 4, 5, 6, 7, 29, 12, 13, 9, 8, 28, 17, 18, 15, 19, 22, 23, 24, 21, 25, 26
Written exercices	80%	12	0.48	1, 11, 2, 27, 29, 12, 13, 10, 16, 28, 14, 17, 18, 15, 20, 19, 25, 26, 33, 32, 31, 30

The skills of this subject may be assessed:

A) continuously through two modules that include written tests and practice reports and/or written assignments, which will be assigned a specific weight in the final grade, or

B) through single assessment

It is necessary to obtain a grade ≥5.0 in the overall evaluation to pass the s
NON-ASSESSABLE: A student receives the grade of NOT ASSESSABL

A) CONTINUOUS EVALUATION

1. Written tests (80%)

They will consist of two compulsory partial exams. In order to consider a
To pass the subject by partials, you must have a minimum grade of 5.0 p

obtained in the presentation of the theme prepared for each student. For students who do not pass one or both c

and of the marks obtained in the two partial tests (remaining 30%).

These exams will consist mainly of short theoretical questions and some

1.a) First partial exam

There will be a first partial exam, which will collect approximately 50% of

during the

first
part of thecourse.

The result of this operation will determine the final grade of the first partial.

1.b) Second partial exam

The second test of evaluation of the subject will be done once the theore

obtained in this second partial will be increased with a 10% of the average mark obtained in the controls carried

1.c) Recovery exam

It will be done after the two partials and will include all the course materia
In order to attend this final exam (recovery activity), the student must have been previously evaluated in the conti

to a minimum of 2/3 of the final grade.

2. Laboratory module (20%)
Students will deliver reports on the practices carried out, and their skills i

B) UNIQUE ASSESSMENT

Students who have chosen the single assessment modality will have to take a final test which will consist of an e

consist mainly of short theoretical questions and some practical exercises or cases to solve.

Afterwards the student will have to deliver a Word file and a Power Point presentation corresponding to the prepa

of the course for the oral presentations of students. Likewise, she/he will hand in the reports of the laboratory pra

The student's grade will be the weighted average of two ofthe three previous activities, where the theory exam wi

adding to the previous mark the 10% obtained in the preparation of the free-choice theme.

If the final grade does not reach 5, the student has another opportunity to pass the subject through the recovery e

corresponding to the theory and the problems. The practice part is not recoverable.

Bibliography

Basic bibliography:

- *Biological Inorganic Chemistry, A New Introduction to Molecular Structure and Function*, R.R. Crichton, Elsevier, 2019
- *Concepts and Models in Bioinorganic Chemistry*, H.-B. Kraatz, N. Metzler-Nolte, Wiley-VCH, 2006
- *Biological Inorganic Chemistry, Structure & Reactivity*, I. Bertini, H.B. Gray, E.I. Stiefel, J.S. Valentine, University Science Books, California 2007
- *Bioinorganic Medicinal Chemistry*, E. Alessio, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany 2011
- *Metals in Medicine*, James C. Dabrowiak, John Wiley & Sons Ltd, 2nd Edition, 2017

- *Química Bioinorgánica*, J.S. Casas, V. Moreno, A. Sánchez, J.L. Sánchez, J. Sordo, Editorial Síntesis, Madrid 2002
- *Introducción a la Química Bioinorgánica*, M. Vallet, J. Faus, E. García-España, J. Moratal, Editorial Síntesis, Madrid 2003

Software

To take this course it is necessary to have access to Microsoft Office (Power Point and Word) as well as to Zoom (in case the classes must have virtual format)

Groups and Languages

Please note that this information is provisional until 30 November 2025. You can check it through this link. To consult the language you will need to enter the CODE of the subject.

Name	Group	Language	Semester	Turn
(PLAB) Practical laboratories	1	English	second semester	afternoon
(SEM) Seminars	1	English	second semester	morning-mixed
(TE) Theory	1	English	second semester	morning-mixed