VNIVERSITAT DE VALÈNCIA

Course Guide
36468 Bioinorganic Chemistry

COURSE DATA

Data Subject	
Code	36468
Name	Bioinorganic Chemistry
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
1110 - Degree in Chemistry	Faculty of Chemistry	4	First term

Subject-matter

Degree	Subject-matter	Character
1110 - Degree in Chemistry	16 - Inorganic Chemistry Applied	Optional

Coordination

Name	Department
JIMENEZ GARCIA, HERMAS RAFAEL	320 - Inorganic Chemistry

SUMMARY

Bioinorganic Chemistry (6 credits) is included in the applied inorganic chemistry subject area and is given in the seventh four-month term of the Degree in Chemistry. The main aim is to introduce students to the complex and interesting world of inorganic biochemistry. After analysing the concepts of biocoordination, students study the functions performed in living organisms by inorganic compounds and metalloproteins – as well as the physicochemical aspects that regulate them. This implies understanding the role of the essential elements and the various action mechanisms of proteins and enzymes in relation to their structural characteristics.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

It is important to understand the basic concepts of coordination chemistry included in the syllabuses of Inorganic Chemistry II and III.

OUTCOMES

1110 - Degree in Chemistry

- Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.
- Interpret the variation of the characteristic properties of chemical elements according to the periodic table.
- Demonstrate knowledge of the characteristics and behaviour of the different states of matter and the theories used to describe them.
- Demonstrate knowledge of the principles of quantum mechanics and their application to the description of the structure and properties of atoms and molecules.
- Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications.
- Relate the macroscopic properties and the properties of individual atoms and molecules, including macromolecules (natural and synthetic), polymers, colloids and other materials.
- Show knowledge of the structure and reactivity of the main classes of biomolecules and the chemistry of the main biological processes.
- Handle chemicals safely.
- Carry out standard experimental procedures involved in synthetic and analytical work, in relation to organic and inorganic systems.
- Relate chemistry with other disciplines.
- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

- Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community.

LEARNING OUTCOMES

The previous section includes the competences contained in the document VERIFICA. This subject addresses part of the learning results of the matter Applied Inorganic Chemistry that allow to acquire specific knowledge of chemistry, cognitive skills and general skills recommended by the EUROPEAN CHEMISTRY THEMATIC NETWORK (ECTN) for the Chemistry Eurobachelor® Label. The following table lists the learning outcomes acquired in the subject Bioinorganic Chemistry related to the competences of the degree in Chemistry.

SPECIFIC KNOWLEDGE OF CHEMISTRY	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Bioinorganic Chemistry that contemplate the learning outcomes EUROBACHELOR®
The principal techniques of structural investigations, including spectroscopy	Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications..(CE7). Show knowledge of the structure and reactivity of the main classes of biomolecules and the chemistry of the main biological processes..(CE12). Handle the instrumentation used in the different areas of chemistry.(CE19). Demonstrate knowledge of the principles, procedures and techniques for the determination, separation, identification and characterisation of chemical compounds.(CE8)
The structure and reactivity of important classes o biomolecules and the chemistry of important biological processes	Show knowledge of the structure and reactivity of the main classes of biomolecules and the chemistry of the main biological processes..(CE12). Relate chemistry with other disciplines.(CE26).

COMPETENCES AND COGNITIVE SKILLS	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Bioinorganic Chemistry that contemplate the learning outcomes EUROBACHELOR®
Competences for the evaluation, interpretation and synthesis of information and chemical data.	Evaluate, interpret and synthesise chemical data and information..(CE16). Interpret data from observations and measurements in the laboratory in terms of their significance and the theories that underpin them..(CE20).

GENERAL COMPETENCES	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Bioinorganic Chemistry that contemplate the learning outcomes EUROBACHELOR®
Competences in information management, in relation to primary and secondary sources, including information retrieval through on-line searches.	Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate..(CG6). Have basic skills in the use of information and communication technology and properly manage the information obtained.(CT2).
Ability to analyse materials and synthesize concepts.	Develop capacity for analysis, synthesis and critical thinking.. (CG1). Show inductive and deductive reasoning ability..(CG2). Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration..(CB3).

Skills related to information technology such as word processing, spreadsheet, recording and storage of data, internet use related to the subjects.	Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate..(CG6). Have basic skills in the use of information and communication technology and properly manage the information obtained.(CT2).
Interpersonal skills to interact with other people and get involved in team work.	Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7). Demonstrate the ability to adapt to new situations..(CG9).
Competences in oral and written communication, in one of the main European languages, in addition to the language of the country of origin.	Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7). Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community. (CT1). Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences..(CB4). Have basic skills in the use of information and communication technology and properly manage the information obtained.(CT2).

On completing this course in bioorganic chemistry students will have acquired the following skills and abilities:

An understanding of the parallelism between the relative abundance of the elements in living things and their abundance in the seawater – including an understanding of the principles underlying biological selection of the elements by living organisms.

An understanding the role of substrate transport and storage metalloproteins and their biological relevance, structure, and action mechanism.

An understanding the role of electron transfer metalloproteins and their structures and action mechanisms. Become aware of the importance of sustainable water management (SDG6).

An understanding of the main biological mechanisms of defence and detoxification.

An understanding the role of metalloenzymes in biological processes.

An awareness of how to use knowledge of the action mechanisms of metal ions in living organisms as a source of inspiration for the preparation of molecules with pharmacological applications: therapeutic uses and diagnosis, with the aim of ensuring healthy lives and promote well-being for all at all ages (SDG3).

DESCRIPTION OF CONTENTS

1. Chemical elements of life

1.1. The essential chemical elements. Abundance and essentiality. Essenciality and toxicity. Absorption, transport and storage. Essential elements: metals and not metals.
1.2. Toxicity of some metallic ions.
1.3. Biocoordinación. The proteins as ligands. Types of metaloproteíns. Biochemical function of the metalloproteíns. Study of the metalloproteíns. Inorganic probes. Model compounds.
1.4. Structural characterization of the metalloproteíns.

2. Bioinorganic Chemistry of iron

2.1. Introduction. Chemistry of the iron of biological importance. Porphyrines of iron. Clusters iron - sulphur. Proteins of iron.
2.2. Proteins hemo. Hemoglobin and mioglobin. Catalases and peroxidases. Cytochrome P-450.
2.3. Cytochrome c. Nitrite reductasa desasimilatoria (cytochrome cd1).
2.4. Iron-sulfur Proteins. Centers 1Fe-0S. Centers 2Fe-2S. Centers 3Fe-4S. Centers 4Fe-4S. Other centers Fe-S.
2.5. Biological functions of the Fe-S proteins.
2.6. Not hemo Proteins without prostetics groups. 2.6.1. Dinuclear Centers. 2.6.2. Active mononuclear Centers.
2.7. Captation, transport and storage of iron. 2.7.1.-Siderophores. 2.7.2.-Transferrin. 2.7.3.-Ferritin.
2.8. Metabolism of the iron in humans.
2.9. Synthetic models for the transport of dioxygen.

3. Biouinorganic chemistry of copper

3.1. Introduction. Chemistry of Cu(II) of biological importance. Classification of proteins of copper.
3.2. Centers of copper of type 1: blue Proteins of electronic transference: biological function, structure and chemical properties.
3.3. Centers of Copper of type 2. 3.3.1.-Superoxide dismutase Cu-Zn. 3.3.2.-Other enzymes of copper of type 2. Not blue Oxidases.
3.4. Centers of copper of type 3. 3.4.1.-Hemocyanin: an alternative for the transport of dioxygen. 3.4.2.-Tirosinasa.
3.5. Multicentral Proteins of copper. 3.5.1.-Nitrite reductase. 3.5.2.-blue Oxidases of copper.

4. Bioinorganic chemistruy of zinc

4.1. Introduction. Importance and biological functions of zinc.
4.2. Study of the carbonic anhydrase.
4.3. Study of the carboxypeptidase.
4.4. Study of the alkaline phosfatase.
4.5. Study of the alcohol deshydrogenase.
4.6. The Zn(II) with structural function and genetic regulation: fingers and clusters of zinc.
4.7. Model Compounds of hydrolitic enzymes of zinc.

5. Bioinorgànic chemistry of alkaline and alkaline earths

5.1. Introduction. Chemistry of coordination of alkaline and alkaline earths ions of biological importance. Antibiotics as ligands. Synthetic Ligands. Crowns ethers and criptands.
5.2. Processes of transport across membrane. 5.2.1.-Sodium potassium bomb. 5.2.2.-Transport across membrane by means of ionóforos mobile. 5.2.3.-Processes of transport across channels or pores. 5.3. Calcium. Proteins of calcium: classification and chemical characteristics. 5.4. Intracelular Proteins of calcium. Calmodulines. Troponin C and the muscular contraction. Extracelular Proteins of calcium. 5.5. Magnesium in biology. Enzymes of magnesium. 5.6. Magnesium and polynucleotides.

6. Bioinorgànic chemistry of molybdenum and tunsgten

6.1. Introduction. Biological importance of the molybdenum. Classification of proteins of molybdenum.
6.2. Structure of the active center of molybdenum enzymes. 6.3. Tungsten enzymes.

7. Bioinorganic chemistry of cobalt and nickel

7.1. Introduction.
7.2. Bioinorganic chemistry of cobalt. 7.2.1.-Cobalamines, Vitamin B12 and coenzime B12. 7.2.2.-Proteins B12.
7.3. Biochemistry of nickel of biological interest. 7.3.1.-Urease. 7.3.2.-Hydrogenases.

8. Bioinorganic chemistry of vanadium, chrome and manganese

8.1. Introduction.
8.2. Vanadium. 8.2.1.-The vanadium in the tunicades. 8.2.2.-Amavadine. 8.2.3.-Haloperoxidases of vanadium.
8.3. Chrome.
8.4. Manganese. 8.4.1.-Biological Importance of manganese. 8.5. Enzymes of manganese.

9. Fixation of dinitrogen

9.1. Introduction. 9.1.1.- Chemical Fixation of N2. 9.1.2.-Biological fixation of N2.
9.2. Structure and properties of the nitrogenase. Mechanism of nitrogenase

10. Metal ions in medicine

10.1. Introduction. Chelatotherapy.
10.2. Anticancer drugs. Arthritic drugs.
10.3. Anti-infective agents. Antimicrobial Agents. Antivirals.
10.4. Radiopharmaceuticals. MRI contrast agents. Drugs with antiulcer activity. Neurological agents

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	51,00	100
Tutorials	9,00	100
Development of individual work	12,00	0
Study and independent work	60,00	0
Preparation of evaluation activities	18,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The subject is organised to ensure that the student independently learns around three main axes:

Classroom presentations. In these classes the lecturer will provide a general overview of the topic with special emphasis on key concepts or concepts of particular complexity. The lecturer will indicate the most relevant information sources for personal study. The lecturer will motivate the student to participate in the various discussions that will arise during the course.

Seminars are provided between four and six one-hour sessions. This seminars will look for a specific application of the knowledge students have acquired in the theory lessons. Students should have prepared previously proposed topics. The presentation of the work will be carried out by students, on an individual or group basis.

Tutorials. Students will attend in groups with sessions lasting one hour. In these sessions, the lecturer will guide the student on the elements to be learned and the evaluation. Students will receive a list of questions and issues that will help in the study of each of the aspects covered in the theoretical lessons.

Tutorials will be also used to resolve doubts that may have arisen in classes and provide guidance on working methods for the resolution of questions.

EVALUATION

The knowledge acquired will be assessed through an examination in the periods established by the faculty, and the exam result will make the largest contribution to the final mark (70 %). The examination will consist of questions on basic knowledge and relationships that may require consideration of aspects of the subject that appear in various subjects. Students who are not successful may resit the exam.

Class attendance will be evaluated positively, as well as student participation in associated activities, including:

• Completion of the exercises.

• Attendance and participation in clear and reasoned discussions.

• Development and presentation of work.

The final mark will be the exam (70 % of the total) plus the marks obtained in other activities (30 % of the total), with the established weightings for each. To pass the course the student must achieve a minimum score of 5 in each of the sections of the assessment.

RESITS

Students who resit the exam will be tested on the course content covered in the lectures, tutorials, and seminars, so that the lecturer can assess whether the student has acquired the necessary skills and knowledge.

REFERENCES

Basic

- - Kraatz, H. B.;Metzler-Nolte, N. ; Concepts and Models in Bioinorganic Chemistry, Wiley-VCH, Weinheim, 2006, ISBN: 3527313052
- - Vallet,M.; Faus,J.; García-España,E.; Moratal,J. "Introducción a la Química Bioinorgánica", Síntesis, Madrid, 2003, ISBN: 84-9756-073-6
- - Casas,J. S.; Moreno,V.; Sánchez,A.; Sánchez,J. L.; Sordo,J.; "Química Bioinorgánica", Síntesis, Madrid, 2002, ISBN 84-9756-027-2

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- - Cowan, J. A. "Inorganic Biochemistry: An Introduction", Wiley-VCH, New York, 1997, ISBN: 0-471-18895-6.
- - Lippard,S. J.; Berg,J. M.; "Principles of Bioinorganic Chemistry", W. H. Freeman & Co., Mill Valley, California, 1994, ISBN: 0-935702-73-3.

Additional

- - Bertini,I.; Gray,H.B.; Stiefel, E.I.; Valentine,J.S.; "Biological Inorganic Chemistry: Structure and Reactivity ", University Science Books , Sausalito, California, 2007, ISBN: 9781891389436.
- - Fraústo da Silva, J. J. R.; Williams,R. J. P.; "The Biological Chemistry of the Elements. The Inorganic Chemistry of Life", Oxford University Press, Oxford, 1991. ISBN: 0198555989
- - Stryer,L.; Biochemistry, 4ª Ed., W. Freeman and Company, New York, 1995, ISBN: 0716720094.