COURSE GUIDE FOR (∞)

BIOINORGANIC CHEMISTRY

Academic Year 2020-2021

(Date last update: 08/07/2020)
(Date approved in Department Meeting: 17/07/2020)

MODULE	SUBJECT	COURSE	SEMESTER	CREDITS	TYPE
Optional	Bioinorganic Chemistry	Starting from 2nd yr	First (one Group) and Second (two Groups)	6	Optional

PROFESSOR	FULL CONTACT ADDRESS FOR TUTORIALS
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	TUTORING HOURS
	See Department website: http://inorganica.ugr.es/

BELONGS TO UNDERGRADUATE DEGREE PROGRAMME	OTHER DEGREES IN WHICH THE SUBJECT COULD BE TAUGHT
Pharmacy Degree	Chemistry and Biology Degrees

PREREQUISITES AND / OR RECOMMENDATIONS (if applicable)

Regarding the Pharmacy degree, it is highly recommended to have already passed the mandatory subjects: (i) Basic principles of Chemistry and (ii) Inorganic Chemistry. Despite this recommendation, it is required an adequate knowledge about:

- Coordination Chemistry
- Proteins structure and conformation
- Essential elements in biological systems

BRIEF DESCRIPTION OF CONTENTS

BLOCK 1: General knowledge.
BLOCK 2: Relevant Bioinorganic Chemistry in Biological Systems
BLOCK 3: Therapeutics and Toxicity

GENERAL AND SPECIFIC COMPETENCIES

A. General

CG1. To identify, design, synthesize, analyze, control and produce drugs and medicines, and other products as well as additional raw materials of health interest in human or veterinary use.

CG4. To design, prepare, deliver and dispense medications and other health products of interest.

CG11. To evaluate the toxic effects of substances, and design and perform the appropriate analysis to such evaluation.

B. Specific

CEM1.1 To identify, design, synthesize, analyze and produce pharmaceutical active ingredients, drugs and other products and materials of sanitary interest

CEM1.4 Estimating the risks associated to the use of chemicals and laboratory processes.

CEM1.9 Learning the origin, nature, design, obtention, analysis and quality controls of drugs and other sanitary products.

OBJECTIVES (EXPRESSED AS EXPECTED RESULTS OF EDUCATION)

- Knowing the role of metal ions in Biological systems, paying special attention to the study of the catalytic core of different metalloenzymes.
- Introducing the student into the knowledge of Medicinal Inorganic Chemistry, paying special attention to antitumoral therapeutics, and metal toxicity and chelation therapy.

DETAILED SYLLABUS

THEORETICAL SYLLABUS:

BLOCK 1: General knowledge.

Unit 1: INTRODUCTION AND GENERAL CONSIDERATIONS REGARDING THE PRESENCE OF METAL IONS IN BIOLOGICAL SYSTEMS.

- Origin of metal ions in Biological systems
- Chemical elements present in Biological systems
- Biological functions of inorganic elements

Unit 2: INTERACTIONS BETWEEN METAL IONS AND BIOLOGICAL LIGANDS.

- General aspects
- Chemical properties of metal ions
- Biological ligands
- Metal-protein interactions
- Stability of complexes and factors affecting it
- Chelate and Macrochelate effects

Unit 3: ELECTRONIC CONFIGURATIONS OF INTEREST IN BIOLOGICAL SYSTEMS.

- Vanadium
- Chromium
- Manganese
- Iron
- Cobalt
- Nickel
- Copper

Unit 4: METHODOLOGY AND EXPERIMENTAL TECHNIQUES USED IN BIOINORGANIC CHEMISTRY.

- Bioinorganic Chemistry Research
- Brief introduction to common characterization techniques used with biological model systems

BLOCK 2: Relevant Bioinorganic Chemistry in Biological Systems

Unit 5: BIOINORGANIC CHEMISTRY OF OXYGEN.

- General aspects
- Oxygen activation
- Oxidation in biology
- Transport and storage of dioxygen molecule

Unit 6: BIOINORGANIC CHEMISTRY OF IRON.

- General aspects
- Iron proteins involving the heme group
- Fe/S Proteins
- Fe-O-Fe systems
- Metabolism of iron

Unit 7: BIOINORGANIC CHEMISTRY OF COPPER.

- General aspects
- Copper proteins (type I, type II and type III)
- Oxydases
- Electron transport
- Superoxide dismutase (SOD)
- Hemocyanines
- Metabolism of copper

Unit 8: BIOINORGANIC CHEMISTRY OF COBALT.

- General aspects
- Vitamin B12
- Metabolism of cobalt

BLOCK 3: Therapeutics and Toxicity

Unit 9: ANTITUMORAL COMPLEXES.

- Cancer. Cause and treatments
- Structure-Activity Relationship (SAR). Empirical rules
- Antitumoral activity and reactivity vs DNA
- Coordination chemistry of platinum
- DNA structure. Functional groups in DNA
- Reactivity of Pt(II) compounds vs DNA
- Other antitumoral compounds

Unit 10: TOXICOLOGY OF SOME TRANSITION METALS IONS.

- General aspects
- Detoxification and self-defense mechanisms
- Rare pollutants

PRACTICAL SYLLABUS: LABORATORY PROJECTS

LABJOURNAL Nº 1 $(AdeH_2)[Cu(HEDTA)(H_2O)] \cdot 2H_2O$
LABJOURNAL Nº 2 $[Cu(MIDA)(AdeH)(H_2O)] \cdot H_2O$
LABJOURNAL Nº 3 $[Cu(NBzIDA)(AdeH)(H_2O)] \cdot H_2O$

Students will perform the synthesis, isolation and characterization of one of the complexes above referred according to the corresponding Labjournal assigned. Produce is described as follows:

Step 1: Theoretical knowledge to be applied in the Practicum will be explained by the teacher during theoretical classes.

Step 2: In the laboratory, every student will individually synthesize one complex (approximately two hours Lab) and then he/she will follow the experiment and finally isolate the compound.

Step 3: Characterization of the isolated compounds. All analytical data will be provided in the Labjournal. The analysis will be carried out during the theoretical classes with the assistance of the teacher.

BIBLIOGRAPHY

A) ESSENTIAL BIBLIOGRAPHY:

"QUIMICA BIOINORGÁNICA" J. S. Casas, V. Moreno, A. Sánchez, J. L. Sánchez, J. Sordo. Ed. Síntesis (2002).

"QUÍMICA BIOINORGÁNICA" Enrique Baran Ed. McGraw-Hill

"BIOINORGANIC CHEMISTRY: INORGANIC ELEMENTS IN THE CHEMISTRY OF LIFE" Wolfgang Kaim and Brigitte Schwederski. Ed. John Wiley and Sons.

"INTRODUCCION A LA QUIMICA BIOINORGANICA" M. Vallet, J. Faus, E. García-España y J. Moratal Ed. Síntesis (2003).

B) COMPLEMENTARY BIBLIOGRAPHY:

"PRINCIPLES OF BIOINORGANIC CHEMISTRY" Stephen J. Lippard and Jeremy M. Berg. Ed. University Science Books.

"BIOINORGANIC CHEMISTRY" Bertini; Gray; Lippard and Valentine. Ed. University Science Books.

"THE BIOLIGICAL CHEMISTRY OF THE ELEMENTS. THE INORGANIC CHEMISTRY OF LIFE" J.J.R. Frausto da Silva and R.J.P. Williams. Ed. Oxford University Press.

"METAL IONS AND BIOLOGICAL SYSTEMS" Astrid Sigel and Helmut Sigel. Ed. Marcell Dekker.

"HANDBOOK OF THE TOXICOLOGY OF METALS" Lars Friberg; Gunnar F. Nordberg and Velimir B. Vouk.Ed. Elsevier.

"HANDBOOK OF NUCLEOBASES COMPLEXES" J. R. Lusty, P. Wearden, V. Moreno . CRC Press (vol. II)

RECOMMENDED LINKS

http://www.hindawi.com/journals/bca/
(Bioinorganic Chemistry and Applications, open access journal)

http://investigacion.ugr.es/ugrinvestiga/static/Buscador/*/grupos/ficha/FQM283

http://biomec.ugr.es/datos_inicio/

TEACHING METHODOLOGY

- Expositive classes where the teacher will promote the active participation of students with questions, comments, etc.
- The content explained during the expositive classes will be presented in PPT slides which will be delivered to students by the online platform PRADO.
- Both the expositive classes and the practicum will be face-to-face or online (Scenario A) or exclusively online (Scenario B), with the online version being synchronous or asynchronous streaming classes, according to the UGR rules.
- Practical classes in which the student will be introduced into the synthesis and characterization of complexes.

EVALUATION (EVALUATION INSTRUMENTS, EVALUATION CRITERIA AND PERCENTAGE ON THE FINAL QUALIFICATION).

ORDINARY CALL

The evaluation will be based on different items in which students must demonstrate the skills acquired.

- One exam during the scheduled classes, unless an alternative date is agreed with the students.
- One final exam at the end of the Course.
- Practicum. Overcoming the practicum is MANDATORY to pass the subject. To achieve this goal, students must: (1) synthesize, (2) isolate and (3) characterize the assigned product.

Overcoming of any of the tests will not be achieved without a uniform and balanced understanding of all matter.

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

- Theory: 70% of the grade of the subject. It will consider all theoretical exams performed. Correction rules will be always explained before the exam.
- Performance at practical classes, attendance and labjournal: 20% of the grade of the subject.
- Class attendance and programmed activities: 10% of the grade of the subject.

EXTRAORDINARY CALL

It will follow the same criteria as the ordinary call. One exam of theoretical contents will be carried out that counts for 70% of the final grade, keeping the 20% practicum and 10% attendance/activities obtained during the Course, thus reaching the 100% qualification. If the student does not want to keep the qualifications obtained during the Course, he/she should explicitly ask the teacher, thus accepting that the exam that carried out in the extraordinary call would count for 100% of the final grade.

DESCRIPTION OF THE EVIDENCE THAT WILL BE PART OF THE FINAL UNIQUE EVALUATION ESTABLISHED IN THE "REGULATIONS OF EVALUATION AND GRADING OF THE STUDENTS OF THE UNIVERSITY OF GRANADA"

- Those students who, for any reason, cannot attend regularly to the classes, and therefore cannot follow the continuous assessment plan, they can ask for a final single evaluation process. This request must be addressed to the Head of the Department within the first two weeks of the subject. This evaluation will consist in a single written or oral exam, which will evaluate the knowledge on the subject, with its qualification being considered as the final grade of the subject. In this Final Unique evaluation one exam of theoretical contents will be carried out, counting for 100% of the final grade.
- In this case, evaluation will be carried out face-to-face (Scenario A) or online through the online platform PRADO EXAMEN or GoogleMeet (Scenario B)

ADDITIONAL INFORMATION

Latest advances in the Bionorganic Chemistry research field will be shared with students, including those results presented in relevant Bioinorganic Chemistry Conferences, such as the European Biological Inorganic Chemistry Conference (EUROBIC) or the National Bioinorganic Chemistry Meetings organized by AEBIN. It should be noted that the teachers were Chairs of this Conference held in Granada in Septiembre de 2012 (www.eurobic11.com).

SCENARIO A (ON-CAMPUS AND REMOTE TEACHING AND LEARNING COMBINED)

TUTORIALS

TIMETABLE (According to Official Academic Organization Plan)	**TOOLS FOR TUTORIALS** (Indicate which digital tools will be used for tutorials)
Available at: http://inorganica.ugr.es/	Email, PRADO Platform and GoogleMeet video conference

MEASURES TAKEN TO ADAPT TEACHING METHODOLOGY
• The percentage of face-to-face and online classes will depend on the number of students enrolled in the Course and the security measures dictated by the corresponding health authorities. If possible, teaching will be preferentially developed face-to-face, keeping at least a 1.5 m distance among students. Theoretical classes with a high number of students will be splitted, with alternative groups that would receive teaching half face-to-face and half online. All students will receive the same number of face-to-face and virtual practicum sessions per week. • The number of students will never overcome the maximum capacity of the given rooms/labs according to new COVID restrictions. • Currently, the recommended online platforms at the University of Granada are Prado, Consigna UGR, Google Meet and Google Drive by means of the official account @go.ugr and also the official @correo.ugr.es email account. If any additional platform is required, instructions will be given to students. • Teaching materials regarding online teaching will be given to students by any the aforementioned platforms. • Practicum will be face-to-face in small groups to guaranty the mandatory social distance and other safety rules in the laboratory. Theoretical explanations regarding the practicum might be given online through explicative videos provided by the virtual platform PRADO.
MEASURES TAKEN TO ADAPT EVALUATION (Instruments, criteria and percentage of final overall mark)
Ordinary Call
• The evaluation will be carried out according to the criteria indicated in the corresponding general section, keeping the same percentage no matter the student attendance is on-site or on-line. • The exams will be face-to-face provided the number of students enrolled allows it according to the safety regulations indicated by the authorities. If this is not possible, the evaluation will be online and will be carried out using the PRADO EXAMEN platform and / or the Google Meet video conference service.
Extraordinary Call
• The evaluation will be carried out according to the corresponding general section with face-to-face exams provided the number of enrolled students allows it according to the safety regulations indicated by the authorities. If this is not possible, the evaluation will be carried out virtually by using the PRADO EXAMEN platform and / or the Google Meet video conferencing service.
Single final Call
• The evaluation will be carried out according to the corresponding general section with face-to-face exams provided the number of enrolled students allows it according to the safety regulations indicated by the authorities. If this is not possible, the evaluation will be carried out virtually by using the PRADO EXAMEN platform and / or the Google Meet video conferencing service, according to UGR rules.
SCENARIO B (ON-CAMPUS ACTIVITY SUSPENDED)
TUTORIALS

TIMETABLE (According to Official Academic Organization Plan)	**TOOLS FOR TUTORIALS** (Indicate which digital tools will be used for tutorials)

Available at: http://inorganica.ugr.es/	Email, PRADO Platform and GoogleMeet video conference

MEASURES TAKEN TO ADAPT TEACHING METHODOLOGY

- All theoretical classes, seminars and practicum will be virtual. They will be carried out via the Google Meet platform or any other online platform officially recommended by the University of Granada. Synchronous sessions will be preferred, although certain personal circumstances, such as sickness of the teacher or any close relative, work/life balance, etc., might encourage an asynchronous scenario which would be complemented by monitoring and specific students' follow-up activities.
- Currently, the recommended online platforms at the University of Granada are Prado, Consigna UGR, Google Meet and Google Drive by means of the official account @go.ugr and also the official @correo.ugr.es email account. If any additional platform is required, instructions will be given to students.
- Teaching materials regarding online teaching will be given to students by any the aforementioned platforms.

MEASURES TAKEN TO ADAPT EVALUATION (Instruments, criteria and percentage of final overall mark)

Ordinary Call

- The exams will be carried out by using the PRADO EXAMEN platform and / or the GoogleMeet video conference service.
- According to the UGR rules and regarding Articles 9.1 and 9.2 about continuous online evaluation assessment, the percentages of evaluation will be divided as follows:
  - One on-line theoretical written exam (divided in two parts) via the platform PRADO EXAMEN. Qualification will count for 60% of the final grade.
  - One on-line written exam about the practicum; 20% of the final grade.
  - Activities, self-evaluation and attendance to online classes: 20% of the final grade.

Extraordinary Call

- The evaluation criteria will follow that indicated in the corresponding general section.
- The exams will be carried out using the PRADO EXAMEN platform and / or the GoogleMeet video conference service.

Single final Assessment

- The evaluation criteria will follow that indicated in the corresponding general section.
- The exams will be carried out using the PRADO EXAMEN platform and / or the GoogleMeet video conference service.