Approved by: ……..

Dean

Date.....

SOFIA UNIVERSITY "ST. KLIMENT OHRIDSKI"

Faculty: .....Chemistry and Pharmacy…….....

Subject area: *(code and name)*

C	H	L	3	8	2	4	1	3

.....**Pharmacy**.....

Master Program: *(code and name)*

C	H	L	3	8	2	4	1	3

.....**Pharmacy**.....

S Y L L A B U S

Course:

E	0	3	4

(code and name) ***Bioinorganic Chemistry***

Lecturers: Assoc. Prof. Anife Ahmedova and Prof. Mariana Miteva

Academic work	Type	Acad. hours
In-class work	Lectures	30
	Seminars	
	Practical classes (teaching assistance)	30
Total in-class work		**60**
Out-of-class work	Topical writing / Course paper	
	Presentation	15
	Scientific essay	
	Course project	
	Field trip	
	Independent literature research	25
	Student teaching	
Total out-of-class work		**40**
TOTAL ACADEMIC WORK		**100**
ECTS credits in-class work		2.4
ECTS credits out-of-class work		1.6
TOTAL ECTS CREDITS		**4**

№	Grade components[1]	% of the grade
1.	Workshops {search of information and group discussions of presentations and topical writings)	40%
2.	Final exam	60%

Outline of the course:

The modern bioinorganic chemistry deals with the biological processes involving metalloenzymes and metalloproteins, focusing on the main structural and functional characteristics related to the presence of metal ion(s) in their active site. This involves deeper understanding of the properties of metal ions to form coordination compounds and the corresponding characteristics of their structure and reactivity that are directly connected with the biological activity. The main consequences from failures in the metal ions homeostasis will be outlined as well as the methods for their treatment through appropriate chelating agents. Another crucial subject of the bioinorganic chemistry is the application of metal complexes in medicine for diagnostics and therapy of wide range of diseases. Metal based pharmaceuticals are amongst the most widely used in the chemotherapy of cancer and arthritis. The unique properties of the metal complexes and the knowledge of the structure-reactivity-biological activity relationship hold out the opportunity for inteligent design of metallopharmaceuticals with target properties and activity. That is why the subjects in the present teaching course will evolve from the fundamental coordination chemistry knowledge to the direct pharmaceutical applications of metal complexes. Moreover, the usage of metal complexes of radioactive elements is a quickly developing modern field of the radio-pharmaceuticals that will be presented to the students, too.

Preliminary requirements:

General knowledge on Inorganic, Analytical, Organic chemistry and Biochemistry is required.

Key competences acquired:

The students will broaden their basic knowledge of Inorganic chemistry and biochemistry by learning about the biological role and importance of biometals for the life processes. This will be achieved through acquirements of fundamental theories of coordination chemistry that is needed for better understanding of the specificity of the proeprties and reactivity of the metal complexes and of the metalloenzymes and metalloproteins. Moreover, the students will become acquainted with the well-known applications of metal complexes in different fields of the modern medicine.

[1] Depending on the course specificity and on the requirements of the teacher, other types of activity can be added or the unnecessary ones can be removed.

Lessons plan

№	Topic:	Acad. hours
	Lectures	
1	Main subjects and problems of the bioinorganic chemistry. Bioelements, biometals and bioligands. Biologicals function of biometals. Interaction with bioligands.	3
2	Overview of the structure theories and properties of coordination compounds. Stability and reactivity of metal complexes and their importance for some biochemical processes.	3
3	Metal assimilation by the living organisms. Transport, storage and homeostasis of metal ions.	2
4	Biological significance and role of metalloproteins and metalloenzymes in the functions of living organisms.	2
5	Examples of metalloproteins: iron-containing proteins, oxygen transporters – structure, function and model systems.	4
6	Types of metalloenzymes. Zinc containing metalloenzymes for catalyses of hydrolytic and redox processes. Importance of the metal ion and the structure of the active site.	3
7	Types of copper containing metalloenzymes for catalyses of redox processes. Importance of the metal ion and the structure of the active site.	3
8	Metalloenzymes for activation of small molecules – oxygen activation, nitrogen fixation, nitrogenases.	2
9	Biomedical application of coordination compounds for diagnostics and therapy - basic principles, examples and perspectives.	4
10	Metal complexes for treatment of cancer, arthritis, diabetes, and failures in the essential metal ions homeostasis.	4
	Seminars/Practical exercises	
1	Coordination chemistry – basic definitions and nomenclature. Structure theories and properties of coordination compounds. Thermodynamic stability. Chelate and macrocyclic effects.	4
2	Types, mechanisms and characteristics of the chemical reactions of coordination compounds (addition, substitution, oxidation and reduction). Kinetic stability. Role of the ligands and metal ion type for the mechanisms and the reactivity of the complexes.	4
3	Structure-properties-reactivity relationship of the coordination compounds.	3
4	Overview of the most frequently used spectroscopic and physical methods for structural and reactivity studies on biocoordiantion compounds.	5
5	Small metal complexes with enzyme activity – modeling and synthesis of coordination compounds with target properties and reactivity for potential pharmaceutical application.	4
6	Biomineralisation.	2
7	Metal based pharmaceutical agents: advantages, shortcomings and	4

	perspectives. Chelatotherapy – basic principles of detoxication and/or regulation of failures in metal ions homeostasis.	
8	Metal complexes as radiopharmaceuticals – structure. Properties and applications. Methods for radio-labeling. Integrated chemo- and radio-therapy.	4

Topics Covered on the Final Exam

№	Topic
1	Main subjects and problems of the bioinorganic chemistry. Bioelements, biometals and bioligands. Biologicals function of biometals. Interaction with bioligands.
2	Coordination chemistry – historical remarks and basic definitions. Structure theories and properties of coordination compounds. Thermodynamic stability. Chelate and macrocyclic effects.
3	Types, mechanisms and characteristics of the chemical reactions of coordination compounds (addition, substitution, oxidation and reduction). Kinetic stability. Role of the ligands and metal ion type for the mechanisms and the reactivity of the complexes.
4.	Biological significance of coordination compounds and their role for the functions of living organisms. Metalloproteins and metalloenzymes.
5.	Examples of metalloproteins: iron-containing proteins, oxygen transporters – structure, function and model systems.
6.	Types of metalloenzymes. Metalloenzymes for catalyses of hydrolytic and redox processes.
7.	Modeling enzyme systems through purposive synthesis of metal complexes with target properties and reactivity for potential pharmaceutical application.
8.	Biomineralization.
9.	Biomedical application of coordination compounds - advantages, shortcomings and perspectives.
10.	Metal complexes for treatment of cancer, arthritis, diabetes and failures in the essential metal ions homeostasis. Chelatotherapy.
11	Radiopharmaceuticals for diagnostics and therapy – structure, properties and applications.

Bibliography

Main sources:

1. Robert R. Crichton “Biological Inorganic Chemistry”, Elsevier, 2008
2. N. Farrel, “Uses of Inorganic Chemistry in Medicine”, RSC Cornwall, 1999
3. J.A. Lawrance “Introduction to Coordination Chemistry” John Wiley & Sons Ltd., 2010

Additional sources:

1. M. J. Kendrick, M. T. May, M. J. Plishka, K. D. Robinson, "Metals in Biological Systems" - Ellis Horwood, New York, 1992
2. R.M. Roat-Malone, Bioinorganic chemistry, John Wiley & Sons Inc., 2002

Date:

Author:

Assoc. Prof. Anife Ahmedova