



# MACHAKOS UNIVERSITY

University Examinations 2021/2022

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR SUPPLEMENTARY/ SPECIAL EXAMINATION FOR  
BACHELOR OF BACHELOR SCIENCE IN ANALYTICAL CHEMISTRY  
SAN 302: BIOINORGANIC CHEMISTRY

DATE: 17/03/2022

TIME: 2:00-4:00 PM

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**INSTRUCTIONS:**

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

## SECTION A

### QUESTION ONE (30 MARKS)

- a) Match the terms on the left with their meanings on the right. (5 marks)

Term	Meaning
Active center	
Charge-transfer complex	
Cofactor	
Holoenzyme	
Ionophore	

- b) Explain ANY THREE ways on how biochemists benefit/ profits from nature (3 marks)
- c) Describe the naturally occurring porphyrins (3 marks)
- d) Differentiate between hard and soft acid-bases giving two examples of ligands for each. (4 marks)
- e) 'Oxygen transportation is not catalytic but a stoichiometric function', explain this statement. (6 marks)
- f) Name the coordination geometries for the following coordination numbers: (4 marks)
- Coordination number 4
  - Coordination number 6
- g) Draw an energy level diagram showing all possible electronic transitions and indicate the allowed transitions. (5 marks)

## SECTION B

### QUESTION TWO (20 MARKS)

- a) Identify the **four main** techniques that can be used to characterize bioinorganic systems (4 marks)
- b) State five advantages of infrared spectroscopy (5 marks)

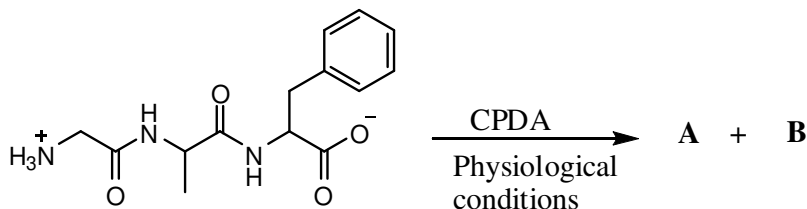
- c) In bioinorganic systems, the substrate interacts with protein residues inside the active cavity and/or with the metal ion in order to be activated. Briefly explain (by use of equations where necessary) the possible bond breaking and/or bond formation processes. (8 marks)
- d) Explain why zinc is a good Lewis acid in complexes with lower coordination numbers. (3 marks)

### QUESTION THREE (20 MARKS)

- a) Describe the key events of iron metabolism, clearly stating the role of the iron proteins involved under the following physiological processes:
- Transport in the bloodstream into bone marrow and cells (3 marks)
  - Storage of excess iron in the body and loss of iron (4 marks)
- b) Differentiate between myoglobin and hemoglobin (2 marks)
- c) Iron plays a key role in oxygen uptake, transport and storage. Draw the metalloporphyrin structure that is involved in oxygen transportation. (2 marks)
- d) 'Oxygen transportation is not catalytic but a stoichiometric function', explain this statement. (6 marks)
- e) Thermodynamic aspect is one of the key principles of coordination chemistry related to bioinorganic chemistry. State and briefly explain **any three** aspects of this principle. (6 marks)

### QUESTION FOUR (20 MARKS)

- a) In the tissues of vertebrates, one of the respiratory by products is carbon dioxide. Identify the enzymes involved and describe how this toxic waste is excreted from the vertebrate's body. (10 marks)
- b) The reaction below is catalyzed by carboxypeptidase A (CPDA). Identify the products **A** and **B** formed. (4 marks)



- c) Describe a general mechanism for the above hydrolysis reaction (6 marks)

**QUESTION FIVE (20 MARKS)**

- a) Name three ways in which nitrogen gas in the atmosphere gets converted to nitrates in the soil. (3 marks)
- b) The reduction of nitrogen molecule requires large amount of energy due to the thermodynamic stability of the molecules. Identify the source of this energy in the biological nitrogen fixation. (1 mark)
- c) Nitrogenase is the enzyme that catalyzes the nitrogen fixation; the reduction of nitrogen ( $N_2$ ) to ammonia ( $NH_3$ ). The reaction proceeds via a one-electron/one-proton addition step. Schematically illustrate how the reaction proceeds from the enzyme to release of ammonia. (6 marks)
- d) Name four metals that are involved in biological electron transfer processes of biological systems. (2 marks)
- e) Explain four differences between iron-containing proteins and copper-containing proteins, in their physiological appearance and function. (8 marks)