

CHUKA



UNIVERSITY

## UNIVERSITY EXAMINATIONS

### THIRD YEAR EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE

**CHEM 314: BIOINORGANIC CHEMISTRY**

**STREAMS: BSC (Y3S1)**

**TIME: 2 HOURS**

**DAY/DATE: WEDNESDAY 24/3/2021**

**2.30 PM – 4.30 PM**

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#### INSTRUCTIONS:

- Answer question ONE (Compulsory) and any other Two questions.
- Do not write on the paper.

#### QUESTION ONE (30 MARKS)

- (a) Mention the main fields studied in Bioinorganic Chemistry. [2 Marks]
- (b).(i) Essential elements are universally required for growth and survival of an organism, hence the body requires the necessary amount of such elements. Illustrating with an aid of a sketch, discuss the possible levels of dietary intakes of a given essential element. [4 Marks]
- (ii) Define the term essential element and enumerate the necessary biochemical criteria an element must exhibit to be regarded as essential. [4 Marks]
- (iii) By giving two suitable examples in each case, distinguish between trace, ultra-trace and bulk elements. [3 Marks]
- (c). (i) What is a ligand? Name an example. [2.5 Marks]
- (ii) List down the factors that affect the hardness and softness of acids and bases. [2 Marks]
- (iii) Discuss the characteristics of a hard and soft acid and a hard and soft base. Give one example of each case. [4 Marks]

- (iv) Why is classification of acids and bases into two categories such as useful qualitative concept? [2 Marks]
- (d).(i) Briefly explain what is meant by the term chelate effect. How is this effect utilized by nature? [3 Marks]
- (ii) Name and draw structures of any three clinically used chelating agents. In each case state their uses. [3.5 Marks]

**QUESTION TWO (20 MARKS)**

- a). What are siderophores? What are their sources and functions? [4 Marks]
- b). (i) Briefly describe how microbes get and release enough iron from their environment despite the fact that they are too tiny. [2 Marks]
- (ii) Show how developing embryos in eggs of certain birds are protected against attacks by microbes. [2 Marks]
- c). Iron and copper are found in metalloproteins, hemerythrin and hemocyanin which are responsible for oxygen transport and storage in marine invertebrates such as sipunculid worms and in mollusks and anthropoids.
- (i) Identify the metalloproteins associated with the above functions. [2 Marks]
- (ii) Describe the structure of the two metalloproteins for the oxygenated and deoxygenated forms. [2 Marks]
- (iii) Sketch the structures of the active site of the two metalloproteins for the oxygenated and deoxygenated forms. [2 Marks]
- (iv). State the colours of the oxygenated and deoxygenated forms of the two metalloproteins and give the oxidation states of the metal centres in the metalloproteins. [2 Marks]
- (d) (i). Discuss the various types of ionophores and how the function.
- (ii) Distinguish between channel former and ion carrier ionophores.
- (iii) Briefly discuss the electronic and structural changes that occur in heme during the conversion of deoxyhemoglobin to oxyhemoglobin. [2 Marks]

**QUESTION THREE (20 MARKS)**

(a).(i) Distinguish between active and passive transport of ions across a cell membrane.[2 Marks]

(ii) Briefly discuss the origin and propagation of a nerve impulse in the light of the existence of sodium-potassium concentration gradient across the cell membrane. [4 Marks]

(b) (i) Briefly explain the main differences between chlorophyll molecule and a porphyrin ring. [4 Marks]

(ii) Explain why magnesium is the metal of choice found in a chlorophyll molecule.[4 Marks]

(c). Cytochromes are metalloproteinase that are vital in the mitochondrial electron transfer chain and are also essential in plant chloroplasts for photosynthesis.

(i) Briefly describe what cytochromes are. [3 Marks]

(ii) Briefly describe why cytochrome c has no potential oxygen binding capacity. [3 Marks]

**QUESTION FOUR (20 MARKS)**

a).(i). Explain what you understand by the term models compounds. [2 Marks]

(ii) What are picket fence porphyrins? [2 Marks]

(iii) What features of picket fence porphyrins make them good models for O<sub>2</sub> binding to myoglobin or hemoglobin? [3 Marks]

(iv) Explain how the efficiency of a model porphyrin compound is measured after its synthesis in the laboratory. [2 Marks]

b).(i) What are respiratory pigments? Give four examples of respiratory Pigments. [2 Marks]

(ii) Outline the similarities and differences between haem units in deoxygenated myoglobin and cytochrome C. [3 Marks]

(c) (i) Briefly describe the structure of vitamin B<sup>12</sup> [Diagram not required. [3 Marks]

(ii) What is the main function of vitamin B12 in life and what does its deficiency in the body lead to? [1.5 Marks]

(iii) Name three types of reactions that are mediated by Vitamin B12. [1.5 Marks]

**QUESTION FIVE (20 MARKS)**

- a). By giving one example each case, distinguish between diagnostic and therapeutic drugs. [3 Marks]
- b) Platinum based are commonly used for treatment of various types of cancer.
- (i) Name and draw the structure of one platinum based drug that is effective in the treatment of genitourinary, testicular and ovarian cancer. Show its mode of action and its major drawbacks. [6 Marks]
- (ii) Enumerate the features that a prospective platinum based anticancer drugs should possess to exhibit significant antitumor activity. [4 Marks]
- c) What are gold based drugs used for? Name one example of a more recent gold drugs and why it is more stable than its predecessors. [3 Marks]
- d) Boron neutron capture therapy (BNCT) is a therapeutic technique that finds use in cancer treatment. Briefly discuss how this technique works. [4 Marks]

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