UNIVERSITY OF SWAZILAND

FINAL EXAMINATION 2006

TITLE OF PAPER : Bio-inorganic Chemistry

COURSE NUMBER : C517

TIME : Three Hours

INSTRUCTIONS : Answer all FOUR questions. Each question Carries 25 marks.

You are not supposed to open this paper until permission to do so has been granted by the Chief Invigilator

QUESTION 1

i) Discuss the classification of elements in bio- inorganic chemistry, clearly defining some parallels that occur for some of these classes. [15 marks]

ii) Describe the vertical elemental distribution profile that exists in most marine environments. [10 marks]

QUESTION 2

i) Discuss the importance of the chemistry of Cd^{2+} in terms of:
-Technological materials development [5 marks]
-Toxicity in humans [5 marks]

ii) Use the facts given below to explain the importance of cell conditioning in the homeostasis of zinc in MT. [9 marks]
MT = metallothionein
[NAD+/NADH]/[NADP+/NADPH] = 105
$E'_{0(NADP+/\ NADPH)}$ = - 394mV
$E'_{0(GSSG/GSH)}$ = -239mV

iii) Describe the types of copper coordination geometries that are found in copper proteins, citing their special characteristics. Give the name of one example in each case. [6 marks]

QUESTION 3

i) Naturally occurring chemicals reaction systems thrive on a series of selectivities. Discuss the details of the following selectivities.
Coordination geometry [4 marks]
Spin pairing stabilisation [4 marks]
Liganding atom [4 marks]
Kinetic control [4 marks]

ii) In connection with heavy metal toxicity, explain the acronym BAL, and why it is named thus. [4 marks]

iii) Give 5 examples of chelation therapeutic agents and the names of the toxicities they are suitable for. [5 marks]

QUESTION 4

i) Briefly describe the structure of zinc metallothionein (MT) as would be observed by NMR and X-ray crystallography. [5 marks]

ii) Explain the apparent redox activity associated with the zinc clusters of MT. [5 marks]

iii) The chelation of metal ions by polydentate ligands is important in drug design and heavy metal toxicity. Explain how the following analytical tools would contribute in an experiment aimed at investigating this fact.

Glass electrode potentiometry [5 marks]
Chemical speciation computer modeling [5 marks]
UV/Vis spectrophotometry (aqueous) [5 marks]