NPTEL Inorganic chemistry of life – *Principles and perspectives,* July 2018

Assignment 0

Note : This is an introductory assignment. Your submission will be graded, but it will not count in your final score in the course. You are encouraged to try all the problems to the best of your knowledge. Its ok if you are not able to solve some problems. As course starts you will learn about concepts behind each question.

Q01. ***Answer the following questions in connection with the bioinorganic chemistry of alkali and alkaline earth ions.***

(a) Draw the structures of the two stereoisomers of Mg^{2+}-ATP complex.

(b) While the cryptand [2,2,1] is selective for sodium ion, it is the [2,2,2] that is selective for potassium ion. Substantiate with reasons?

(c) What are the binding moieties in metalloproteins of the alkali (M^{+}) & alkaline earth (M^{2+}) ions.

(d)When the Ca^{2+}-nuclease acts on a phosphate di-ester, write the chemical reaction showing the reactants and products clearly. What is(are) the main role(s) of Ca^{2+} in this enzyme?

Q02. Answer the following in connection with the biological inorganic chemistry of vanadium.

(a)List only biologically relevant (not other ones) oxidation states of vanadium.

(b)In a protein the vanadyl species is bound to the side chains of amino acids including histidine(s). Its EPR showed super-hyperfine coupling for vanadium nuclear splitting. Each such line is further split into 5 lines. Using this information, workout & identify the number of histidines bound to the vanadyl species in this protein.

(c)Given the two redox reactions,

(i) $VO^{2+} + 2H^{+} + e^{-} \rightarrow V^{3+} + H_2O$ $\quad E^{o} = 0.3$ V

(ii) $VO_2^{+} + 2H^{+} + e^{-} \rightarrow VO^{2+} + H_2O$ $\quad E^{o} = 1.0$ V

Answer the following. Identify the couple in (i) and also in (ii). Compare both and write which one of these redox couples is more favoured and why?

Q03. Answer the following in connection with the biological inorganic chemistry of manganese.

Write balanced reactions exhibited by superoxide dismutase (SOD) and catalase enzyme? What is the nuclearity of the reaction centre in each of these enzymes? How would you reconcile your answer in terms of the choice made by the nature for these enzymes.

Q04. The following questions are based on oxygen transport systems.

(a)Given that the O_2 stretching frequencies of free and bound to hemoglobin, hemerythrin and hemocyanin are ~1400, ~1150, ~850 and ~750 cm^{-1} respectively. Comment on the nature of O_2 binding to these proteins and substantiate your answer accordingly.

(b)By analysing the partial pressure of O_2 *vs.* percent of saturation curves, one can conclude that myoglobin is good for binding while hemoglobin is good for transport. Draw the curves with proper axis labelling and interpret the same in order to explain the conclusion.

(c)Highlight four major events with reasoning (in the proper sequence) involved in the reversible binding of O_2 (or transport of O_2) by haemoglobin.

Q05. Questions based on iron transport & storage systems.

(a)Draw the primary coordination sphere for iron in transferrin. What is the role of carbonate in the formation of such centre?

(b)What is the form in which iron is stored and what is the form in which iron is released? Explain with reasons?

(c)What is the nature of channels present in ferritin & what is the role of each of these channels in the functioning of the ferritin?