

Approval: 4th Senate Meeting

Course Name	: Bioinorganic chemistry
Course Number	: CY-644
Credit	: 3-0-0-3
Prerequisites	: CY101 or equivalent and basic knowledge in coordination chemistry
Students intended for	: B. Tech. & Ph.d.
Elective or Compulsory	: Elective
Semester	: Odd/Even

Preamble: We all are aware about the complexity of biological processes. The metal ions as important inorganic species play crucial role in regulating various biological processes. The aim of the course is to clarify the role of inorganic species particularly metal ions in biological processes including their function in human body. This course will teach the basic principles of analytical techniques and discuss their application in inorganic biomolecules and will elucidate the recent developments of the medicinal uses of metals. If offered in future, a minor in the area of 'chemistry-biology interface', this course can be considered as one among the courses needed to specialize in this area.

Course Outline: Fundamentals of coordination chemistry; Introduction to bioinorganic chemistry; Role of alkali and alkaline earth metal ions; Essential and trace metals; fundamentals of Na-K Pump; Ionophores and crown ethers; Their active structure/site and function in: (a) Metal ion transport and storage - Ferritin, Transferrin, metallothionein etc; (b) Electron Transfer - cytochromes, Fe-S Proteins, copper protein etc. (c) Oxygen activation - cytochrome P450, cytochrome c oxidase. (d) Oxygen transport and storage - hemoglobin, myoglobin, hemerythrin, hemocyanin, their coordination geometry and electronic structure, co-operability effect, Hill coefficient and Bohr Effect; characterization of O₂ bound species by spectroscopic methods; Peroxidase, alcohol dehydrogenase, carbonic anhydrase, nitrogenase, vitamin B12 coenzyme; The significance of metal-based compounds for medicinal use (cis-platin, radiopharmaceuticals etc); recent developments in the medical field based on inorganic or bioinorganic principles; Metals used in diagnosis; Gd-based MRI and X-ray contrast agents; Bioassay, EPR spectroscopy, Single crystal X-ray diffraction, Electrochemistry with cyclic voltammetry, UV-Vis Absorption Spectroscopy, Fluorescence emission spectroscopy and Fluorescence excited state life time measurements; Toxic effects of Pb, Cd, Hg and Cr with specific examples; The essential role of metal ions in photosynthesis and other processes in plant and fungal systems. Identify the bioinorganic molecules responsible for energy harvesting and electron transfer in biological systems.

Modules:

Introduction – Fundamentals of coordination chemistry; Introduction to bioinorganic chemistry; Role of alkali and alkaline earth metal ions; Essential and trace metals; fundamentals of Na-K Pump; Ionophores and crown ethers. (7 h)

The role of metal ions in biological functions – Their active structure/site and function in: (a) Metal ion transport and storage - Ferritin, Transferrin, metallothionein etc; (b) Electron Transfer - cytochromes, Fe-S Proteins, copper protein etc. (c) Oxygen activation - cytochrome P450,

cytochrome c oxidase. (d) Oxygen transport and storage - hemoglobin, myoglobin, hemerythrin, hemocyanin, their coordination geometry and electronic structure, co-operativity effect, Hill coefficient and Bohr Effect; characterization of O₂ bound species by spectroscopic methods. (12 h)
Other enzymes - Peroxidase, alcohol dehydrogenase, carbonic anhydrase, nitrogenase, vitamin B12 coenzyme. (2 h)

The use of metals in medicinal chemistry- The significance of metal-based compounds for medicinal use (cis-platin, radiopharmaceuticals etc); recent developments in the medical field based on inorganic or bioinorganic principles; Metals used in diagnosis; Gd-based MRI and X-ray contrast agents. (8 h)

Some related basic tools and techniques - Bioassay, EPR spectroscopy, Single crystal X-ray diffraction, Electrochemistry with cyclic voltammetry, UV-Vis Absorption Spectroscopy, Fluorescence emission spectroscopy and Fluorescence excited state life time measurements. (5 h)

Toxicity of metals-Toxic effects of Pb, Cd, Hg and Cr with specific examples. (2 h)

Metal Ions in Plant-Based Systems: The essential role of metal ions in photosynthesis and other processes in plant and fungal systems. Identify the bioinorganic molecules responsible for energy harvesting and electron transfer in biological systems. (4 h)

Text & Reference Books:

Text book:

1. Principles of Bioinorganic Chemistry by Stephen J. Lippard and Jeremy M. Berg.

Reference books:

1. Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life by Wolfgang Kaim and Brigitte Schwederski
2. Biological Inorganic Chemistry Edited by Ivano Bertini, University of Florence Harry B. Gray, California Institute of Technology, Edward I. Stiefel, Princeton University, Joan Selverstone Valentine, UCLA
3. Bioinorganic Chemistry by Wolfgang Kaim and Brigitte Schwederski
4. Bioinorganic Chemistry by Asim K. Das
5. Inorganic Chemistry by D. F. Shriver, P. W. Atkins, C. H. Langford, Oxford Univ. Press, 1990.
6. Inorganic Chemistry, Principles of Structure and Reactivity, J. E. Huheey, E. A. Keiter, R. L. Keiter, Pearson Education, 2004.