UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Bioinorganic Chemistry

2425-1-F5401Q023

Aims

The aim of the course is to illustrate properties, structures, reactivity, biological functions and methods of characterization of compounds of bioinorganic relevance.

Contents

Introduction to bioinorganic chemistry

Physical and spectroscopic methods for the characterization and study of bioinorganic systems
Fundamentals of electron transfer theory (Marcus theory and quantum tunneling);
Structure and function of metal proteins for electron transfer
Electron transport: the case of cytochrome c oxidase
Photosynthesis and PSII
Detoxification and activation of O2
Role of metals in diseases: the case of copper in neurodegenerative diseases
Activation and catalysis of small molecules (CO2, CH4, CO, H2)
Heme and non-heme metallo proteins for the activation of recalcitrant substrates

Detailed program

Sure, here is the translation:

Introduction

1. Chemical elements of the periodic table in living systems
2. Concept of essential elements
3. Metalloenzymes, metallomics, metal homeostasis/dyshomeostasis
4. Biogeochemical cycles of major elements involved in the chemistry of living organisms, role of metalloproteins in cellular processes, modulation of thermodynamic and kinetic properties of metals by proteins.

Properties of biologically relevant inorganic compounds (cofactors, metalloproteins, metal-nucleic acid complexes).
Structural and catalytic roles of metal ions in living systems

1. Biochemistry review: structure of proteins, membranes, and major cofactors
2. Membrane proteins and their structure
3. Stereoelectronic properties of metal cofactors
4. Biomimetic compounds

Techniques for studying bioinorganic chemistry: XRD crystallography and cryoEM, spectroscopies, cyclic voltammetry, and quantum and computational chemistry approaches

Electron transfer in metalloproteins

1. Marcus theory and quantum tunneling
2. Electron transfer proteins and characterization of cofactors (Fe-S clusters, heme groups, and Cu centers)
3. Trends in ET rate constants with varying distances between redox centers

Electron transport: the case of cytochrome-c oxidase (cco, complex IV)

1. Cellular metabolism review: major pathways in eukaryotic organisms, cellular respiration, and electron transport chain
2. Structure of the cco protein complex and structure of metal cofactors
3. Mechanism of oxygen reduction and proton translocation

Activation of molecular oxygen and ROS detoxification

1. Introduction to the biogeochemical cycle of oxygen and the Great Oxidation Event
2. ROS in living systems
3. Metalloenzymes involved in ROS detoxification processes (SOD, SOR, and catalase and their mechanisms of action)

Transition metal dyshomeostasis: the case of copper in Alzheimer's disease

1. Introduction to Alzheimer's disease (AD)
2. Etiological hypotheses in AD (amyloid cascade, oxidative stress, metal dyshomeostasis)
3. Copper-amyloid peptide interaction and catalysis of oxygen reduction to hydroxyl radicals
4. Propagation of OH radicals and oxidative stress

Activation of small molecules (1) – protons and H?

1. Hydrogenases and their classification (FeFe, NiFe, and Fe-only H?ase)
2. FeFe and NiFe hydrogenases: function, structure, and catalytic mechanism

Activation of small molecules (2) – CO?

1. Chemical and biological activation of CO?
2. Acetogenic organisms and the Wood-Ljungdahl pathway

3. Metalloenzymes involved in CO? activation in acetogens: CODH, CODH-ACS complex, and FDH

Activation of small molecules (3) – CH?

1. Introduction to archaebacteria - methanogenic and methanotrophic microorganisms
2. Metabolic pathway of CO? reduction to CH? in methanogens
3. Structure and mechanism of Methyl Coenzyme M reductase (MCR)
4. Metabolic pathway of CH? oxidation in methanotrophs
5. Structure and mechanism of methane monooxygenase (MMO)

Heme and non-heme metalloproteins for the activation of recalcitrant substrates

1. Laccase
2. Lignin peroxidase

Prerequisites

Basic knowledge of biochemistry (proteins, DNA and RNA, metabolic pathways, etc.) and of the chemical-physical properties of metal ions and coordination compounds

Teaching form

21 two-hour lectures, in person, Delivered Didactics

Textbook and teaching resource

I. Bertini, H.B. Gray, E.I. Stiefel, E.S. valentine "Biological Inorganic Chemistry: Structure and Reactivity" University Science Books, Sausalito, California

Course slides and scientific papers

Semester

First year LM - Second Semester

Assessment method

Oral examination

Office hours

Write to luca.bertini@unimib.it

Sustainable Development Goals

LIFE ON LAND