Course Change Request

Date Submitted: 06/30/26 12:50 pm

Viewing: CHEM 446 : Bioinorganic Chemistry

Last approved: 11/11/20 4:54 am

Last edit: 08/21/26 10:43 am

Changes proposed by: msikowit

Catalog Pages referencing this course

Chemistry (CHEM)

Chemistry, BA

In Workflow

1. **CHEM Chair**
2. **SC Curriculum Committee**
3. SC Assistant Dean
4. Assoc Provost-Undergraduate
5. Registrar-Courses
6. Banner

Approval Path

1. 06/30/26 1:52 pm Mikell Paige (mpaige3): Approved for CHEM Chair

History

1. Feb 14, 2019 by Megan Erb (msikowit)
2. Apr 2, 2019 by Tory Sarro (vsarro)
3. May 8, 2020 by Tory Sarro (vsarro)
4. Nov 11, 2020 by Tory Sarro (vsarro)

Select modification type:

Substantial

Are you completing this form on someone else's behalf?

No

Effective Term: Spring 2024

Subject Code:

CHEM - Chemistry **Course Number:** 446

Bundled Courses:

Is this course replacing another course? No

Equivalent Courses:

Catalog Title: Bioinorganic Chemistry

Banner Title: Bioinorganic Chemistry

Will section titles vary by semester? No

Credits: 3

Schedule Type: Lecture

Hours of Lecture or Seminar per week: 3

Repeatable: May be only taken once for credit, limited to 3 attempts (N3) **Max Allowable Credits:** 9

Default Grade Mode: Undergraduate Regular

Recommended Prerequisite(s):

Recommended Corequisite(s):

Required Prerequisite(s) / Corequisite(s) (Updates only):

Prerequisites: CHEM 463 or BIOL 483

Corequisite: CHEM 331 and CHEM 336

Registrar's Office Use Only - Required Prerequisite(s)/Corequisite(s):

And/Or	(	Course/Test Code	Min Grade/Score	Academic Level	)	Concurrency?
	(					
	(	CHEM 463	C	UG		
Or		CHEM 463	XS	UG		

And/Or	(	Course/Test Code	Min Grade/Score	Academic Level	)	Concurrency?
Or		BIOL 483	C	UG		
Or		BIOL 483	XS	UG	)	
And	(	CHEM 331	C	UG		
Or		CHEM 331	XS	UG	)	
And	(	CHEM 336	C	UG		
Or		CHEM 336	XS	UG	)	
					)	

Registration Restrictions (Updates only):

Registrar's Office Use Only - Registration Restrictions:

Field(s) of Study:

Class(es):

Level(s):

Degree(s):

School(s):

Catalog Description:

Application of inorganic coordination chemistry and physical methods in study of structure and function of metal ion sites in biomolecules. Inorganic topics include atomic and molecular structure, molecular symmetry and applications of symmetry, properties of transition metal ions, and modern bonding models such as ligand field theory. ~~Properties of transition metal ions, ligand field theory.~~ Bioinorganic topics ~~Topics~~ include ~~iron cytochromes, zinc and copper enzymes, cobalamins, iron sulfur proteins,~~ oxygen transport, iron storage, electron transfer, inorganic model compounds, metals in medicine, and toxicity of inorganic species.

Justification:

What: Updating co-requisites and catalog description to better fit the role of the course.

Why: CHEM 446 currently has prerequisites of both Biochemistry (CHEM 463 or BIOL 483) and Physical Chemistry (CHEM 331 (lecture) and CHEM 336 (lab)). Because of when the department offers these courses, chemistry majors (both traditional and transfer) have regularly been unable to complete the Physical Chemistry requirement (CHEM 331 and CHEM 336) before enrolling in CHEM 446. For the past 8 years, we have been manually permitting these students to take (CHEM 331 and CHEM 336) and CHEM 446 as co-requisites. We have seen no adverse effects on student performance as the content in CHEM 446 does not require proficiency in Physical Chemistry. This proposed change will remove the requirement of a permit enabling students to register for both Physical and Bioinorganic chemistry concurrently.

The catalog description has also been amended to more accurately reflect the content being taught in this course. The learning outcomes have been attached below as justification of the change to the catalogue description.

Does this course cover material which crosses into another department?	No

Learning Outcomes:

Module 1 (Weeks 1-2)

Regarding atomic structure, students will be able to

• Understand the origin of atomic spectra

• Use quantum numbers to define atomic orbitals and pictorially describe s, p, and d orbitals

• Write electron configurations for neutral atoms and ions

• Understand the relationship between Coulombic energy and Exchange energy as they relate to Hund's rule

• Calculating effective nuclear charge using Slater's rules

• Explain periodic trends such as electronegativity, ionization energy, electron affinity, atomic and ionic radii using quantitative and qualitative reasoning.

Module 2 (Weeks 3-4)

Regarding basic bonding theories, students will be able to

• Draw and interpret Lewis structures and VSEPR geometries

• Understand exceptions to the octet rule

• Choose the best resonance structure using formal charge

• Understand the impact of lone pair and bonded pair repulsions on VSEPR geometries

• Be able to explain experimental data and predict trends in bond angles and lengths resulting from electronegativity and atomic size effects

• Predict molecular polarity

Module 3 (Week 5)

Regarding symmetry, students will be able to

• Give examples of symmetry present in everyday objects

• Define, depict, and identify the 5 principle symmetry elements and operations

• Understand the concept of a point group as a collection of items with like symmetry elements

• Assign point groups for shapes and molecules without the aid of outside resources

• Know the relationship between symmetry and chirality and be able to identify chiral molecules based upon their symmetry elements

Module 4 (Week 7)

Regarding molecular orbitals, students will be able to

• Understand the foundation of molecular orbital theory as resulting from the linear combination of atomic orbitals.

• Describe and depict the molecular orbitals formed from s, p, and d orbitals

• Describe the 3 requirements for formation of molecular orbitals and bonding

• Draw and depict the full MO diagram for homonuclear and heteronuclear diatomic molecules

• Use orbital potential energies to predict MO interactions for heteronuclear diatomic molecules

• Predict the magnetic properties of molecules using molecular orbital electron configurations

Module 5 (Week 8)

Regarding Acid-Base and Donor-Acceptor Chemistry, students will be able to

• Define and give examples for 4 primary acid-base concepts: Arrhenius, Bronsted-Lowry, Solvent-System, and Lewis

• Describe Lewis acid-base chemistry and be able to predict the type of reaction based upon relative energies using frontier orbitals

• Understand hydrogen bonding from the context of donor-acceptor chemistry and molecular orbital theory.

• Use hard-soft acid-base theory (HSAB) to predicting solubilities and cation-anion interactions

• List and identify examples of Pearson's hard and soft bases and acids

• Be able to connect and explain hard-hard and soft-soft interactions in the context of frontier orbital relationships

Module 6 (Weeks 9-10)

Regarding coordination chemistry, students will be able to

• Define the terms coordination sphere, ligand, coordination complex, chelate

• Identify and draw common mono- and poly-dentate ligands

• Name coordination compounds using modern inorganic nomenclature

• Be able to calculate the charge on the metal in a coordination complex

• Understand and be able to correctly use the isomer names cis, trans, mer, and fac

• Identify geometric isomers vs. optical isomers

• Identify examples of 4 different structural isomers: ionization, linkage, coordination, and hydrate

• Describe the experimental method of measuring magnetic properties of complexes

• Determine the magnetic susceptibility of a complex by calculating the spin-only magnetic moment

• Predict the appropriate electronic structure of a complex (high spin vs. low spin) by comparing theoretical spin-only moments with experimental data.

• Briefly define and understand valence bond and crystal field theory

• Provide a detailed explanation for coordination complex electronic structure using Ligand Field Theory

• Predict the d-orbital splitting in a coordination complex of octahedral, square planar, and tetrahedral geometries.

• Write electron configurations for high and low spin complexes and describe these arrangements from the perspective of ligand field stabilization, exchange energy and coulombic energy.

• Identify a ligands position in the spectrochemical series and predict the resulting impact on d-orbital splitting in a coordinated metal

• Describe the sigma and pi bonding in transition metal complexes, including metal-to-ligand pi bonding and pi back-bonding

Module 7 (Weeks 12-15)

Regarding bioinorganic chemistry, students will

• Know how to access an interpret protein crystal structures from the Protein Data Bank

• Be able to identify the common inorganic elements found in biological systems and explain at least one specific example

• Understand the roles of iron in biology, especially in oxygen transport

• Understand the role of manganese in photosynthesis

• Be able to explain the difference between inner and outer sphere mechanisms in enzymes

• Recognize the various reactive oxygen species, explain their electronics, and the related enzymes

• Learn about the various inorganic compounds and elements used in medicine

Will this course be scheduled as a cross-level cross listed section?

Attach Syllabus

CHEM 446 Fall 2024 Syllabus and Schedule.pdf

Additional Attachments

~~CHEM446.pdf~~

Specialized Course Categories:

Have you reached out to the Libraries to determine whether there are adequate resources to support your course? If not, please email Meg Meiman, Associate University Librarian for Learning, Research, and Engagement at mmeiman2@gmu.edu.

Additional Comments:

Reviewer Comments

Key: 2255