CHEM-107: CHEMISTRY OF LIFE

Effective Term
Fall 2024

BOT Approval Date
12/14/2023

Discipline
CHEM - Chemistry
Course Number
107

Course Title
Chemistry of Life

Short Title
Chem of Life

Credit Status (CB 04)
D - Credit - Degree applicable

Units

Lecture Units
4.00

Lab Units
1.00

Total Units
5.00

Hours

Lecture Contact Hours
64-72
Out of Class Hours Lecture
128-144

Lab Contact Hours
48-54
Out of Class Hours Lab
0.00

Total Contact Hours
112 - 126

Total Out of Class Hours
128 - 144

Total Student Learning Hours
240 - 270

Is this an existing Extensive Lab?
Yes

Distance Education
No

Catalog Description
This course covers the basic principles of atoms, molecules, physical states, energy, solutions, acid/bases, chemical equations, structure and properties of major classes of organic molecules, biochemical molecules, and their functions in biological and abiotic systems.

Codes

TOP Code (CB 03)
1905.00 - Chemistry, General

CIP Code
40.0501 - Chemistry, General.

Student Accountability Model (SAM) Priority Code (CB 09)
E - Non-Occupational

Noncredit Category (CB 22)
Y - Credit Course

Repeatability Code
No

Grading Option
Letter grade OR P/NP

Minimum Qualifications

Minimum Qualifications	And/Or
Chemistry (Masters Required)	End

GE Information

Check GE Types Requested
AA/AS A - Natural and Physical Sciences

CSU Area(s)

Approved CSU Area
B1

Approved Second CSU Area
B3

IGETC Area(s)

Approved IGETC Area
5A

Approved Second IGETC Area
5C

Learning Objectives

Learning Objectives

Learning Objective
1. Explain the structure of the atom and its relation to the arrangement in the periodic table.
2. Compare and contrast the properties of ionic and covalent compounds in relationship to bonding patterns.
3. Distinguish different states of matter and the energy changes associated with changes of said states as it applies to biological systems.
4. Explain the properties of solutions, factors that affect solubility, and perform stoichiometric calculations including balancing chemical equations, determining limiting reactants, and interpreting dilution factors to determine solution concentration and its applications to biological systems.
5. Define pH and examine its relation to acids, bases, and buffers.
6. Identify and discuss the main functional groups in organic molecules and their properties in relation to biological systems.
7. Name organic molecules using the IUPAC system.
8. Diagram and explain the structure and functions of macromolecules that make up biological systems and review the pathways involved in metabolism.
9. Differentiate metric units used in measurements of volume, mass, and length.
10. Compare and contrast elements and compounds based on chemical and physical properties.
11. Compare and contrast exothermic and endothermic reactions.
12. Calculate and use molar concentrations in analyses of solutions and mixtures.
13. Interpret structures of various organic functional groups and compounds.
14. Analyze known and unknown biological molecules using qualitative analysis.
15. Evaluate and quantify calories of various foods using calorimetry techniques.
16. Utilize the appropriate chemical concepts to analyze real-world applications that are culturally relevant and accentuate diversity and inclusion.

Learning Outcome Information

Course Learning Outcomes

Learning Outcome
1. Given the IUPAC names for organic reactants, students will identify or draw the structural formulas and for the reaction, predict products, provide organic structures and their IUPAC names.
2. Students will identify defining characteristics and functionality of biomolecules and their applications to biological systems.
3. Students will be able to explain how to prepare and/or dilute solutions starting with solids and/or more concentration solutions.
4. Students will demonstrate proficiency on general, organic, and biochemistry topics from national American Chemical Society (ACS) General-Organic-Biochemistry condensed Exams by achieving a score that is one-half of one standard deviation below the national average (or higher) on the General-Organic-Biochemistry condensed Exam.
5. The student will utilize problem-solving strategies, take initiative, pursue knowledge, interests and experiences independently, and utilize reflection to clarify understanding and meaning.
6. Students will be able to refine understanding of chemical concepts by discussion and explanation with other students from different kinds of backgrounds, including different socioeconomic backgrounds, different cultures, different ethnic backgrounds, as well as at-risk students.

Program Learning Outcomes

Learning Outcome
"1. Demonstrate proficiency on chemistry topics from national American Chemical Society (ACS) exams. Achieve a score that is one-half of one standard deviation below the national average (or higher) on the General Chemistry or Organic Chemistry sequence exam versions, administered in CHEM 102 and CHEM 113 respectively."
"2. Demonstrate skill in standard laboratory techniques commonly acquired in the first two years of major's chemistry coursework."

Institutional Learning Outcomes

Critical Thinking: The student will analyze problems, gather and synthesize relevant information, evaluate ideas, information, and evaluate alternative points of view to create, innovate and implement effective solutions.
Information and Technology Literacy: The student will access, interpret, evaluate, and apply relevant information sources and digital media effectively, and in an ethical and legal manner.
Scientific Awareness: The student will apply the scientific method of inquiry to assess potential solutions for real-life challenges by employing science-based knowledge and methodologies in daily life.

Content

Course Lecture Content

1. Chemistry methods and measurement.
   a. Measurement in chemistry
   b. Metric units used in measurements of volume, mass, and length
   c. Significant figures and scientific notation
2. Matter and properties
3. Structure of the atom and periodic table.
   a. Periodic table
   b. Electron arrangement and periodic table
   c. Composition of atom
4. Structure and properties of ionic and covalent compounds.
   a. Naming compounds and writing their formulas
5. Calculations and chemical equations.
   a. Chemical formulas and chemical equations
   b. Balancing chemical equation
   c. Mole concept and atoms
   d. Stoichiometry calculations, including limiting reactant and percent yield calculations
6. Energy Rate and equilibrium.
   a. Energy, work and heat
   b. Exothermic and endothermic reactions.
   c. Kinetics Equilibrium
7. States of matter (gaseous, liquid and solid state)
8. Solutions
   a. Properties of solutions
   b. Solution Stoichiometry calculations
   c. Concentrations
9. Acids and Bases
10. pH
11. reactions between acids and bases
12. Buffers
13. Introduction to organic chemistry
    a. IUPAC naming of the organic compounds
14. Structures and reactivity of organic molecules
    a. Hydrocarbons: Alkanes, Alkenes, alkynes
    b. Oxygen and nitrogen containing organic molecules
    c. Alcohols, esters, aldehydes, ketones, carboxylic acids, amines
15. Macromolecules structure and function
    a. Carbohydrates
    b. Proteins (enzymes and proteins)
    c. Lipids
    d. Nucleic acids
16. Metabolism
    a. Carbohydrate metabolism (glycolysis, fermentation, kreb cycle)
    b. Fatty acid and amino acid metabolism
    c. Nucleic acid (Transcription, Replication, Translation)
17. Real-life applications of chemistry which are culturally relevant and accentuate diversity and inclusion.

Course Lab Content

1. Measurement and density
   a. Metric units used in measurements of volume, mass, and length.
2. Elements, compounds and mixtures
3. Simple chemical reactions
4. Balancing a chemical equation and Stoichiometry
5. Boyle's Law and Charles' law
6. Acid-base chemistry (molarity) and solution Stoichiometry
7. Acids, bases, pH, hydrolysis and buffers
8. Structure and properties of hydrocarbons
9. Synthesis of organic molecules in the laboratory (e.g aspirin)
10. Properties of organic molecules (Alcohols, Aldehydes and Ketones)
11. Organic functional group tests
12. Detection of fats, proteins, and carbohydrates in foods
13. Enzyme activity
14. Characterization of biological molecules
15. Digestion of biological molecules
16. Real-life applications of chemical laboratory theory and practice which are culturally relevant and accentuate diversity and inclusion.
17. Thermochemistry
    a. Exothermic and endothermic reactions.
    b. Calorimetry

Methods of Instruction

Method

Discussion

Integration

Discussions can be used help distinguish the components of the atom using the Modern, Bohr and Quantum Mechanical views of atomic structure. Discussions and case activities will be administered will draw upon primary scientific literature and relate basic chemical concepts to current global issues.

Method

Film/video Viewing and Discussion

Integration

Videos can be used to help predict electron configuration and orbital diagrams for various elements. A combination of publisher and instructor created materials can be used to reinforce unit conversion, periodic properties of the elements, and modern theories of chemical bonding

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Method

Lab Activities

Integration

Wet and dry chemical laboratory experiments will be used to derive the theoretical yield and percentage yield of a reaction. Students will be instructed in proper laboratory safety while performing standard laboratory techniques such as titration. The laboratory activities will provide a hands-on learning environment reinforcing key learning objectives such as the calculation of the percent yield for a reaction.

Method

Lecture

Integration

Use of presentation software (powerpoint, etc) and whiteboard will be used to demonstrate conversions from one system of units to another using dimensional analysis. Interactive activities can be used to facilitate content mastery related to key learning objectives including; (1) stoichiometry and reaction yields, (2) electron configuration and orbital structure and (3) the behavior of ideal gases including the principles of Charles' Law, Avogadro's Law, Boyles Law, and the ideal gas equation.

Method

Observation and Demonstration

Integration

Demonstrations of reactions and calculations can be used to calculate pressures, partial pressures, volumes, temperatures, and moles of gases using the principles of Charles' Law, Avogadro's Law, Boyles Law, and the ideal gas equation. Accessible tutorials and interactive web-based computer simulations can be used to facilitate content mastery related to key learning objectives including; stoichiometry and reaction yields, electron configuration and orbital structure and the behavior of ideal gases including the principles of Charles' Law, Avogadro's Law, Boyles Law, and the ideal gas equation.

Methods of Evaluation

Method

Exams/Tests

Integration

Lecture examinations (midterms and final exams)requiring critical analysis and synthesis of information presented in the lectures, tutorials, case studies, and the textbook will be conducted during laboratory face-to-face meetings. The exam will assess content knowledge associated with chemistry concepts.

Exam format can be multiple choice, short answer, or recognition and evaluation of figures, tables, and diagrams to access proficiency in defining terms, performing chemical calculations to the correct significant figures, in addition to interpretations of structure/function relationships associated with chemical compounds and biological molecules.

Midterm Exams and Lab Practicums should constitute no more than 35% to 50% of the course grade. Final Exams should constitute no more than 20-30% of the course grade. The department exam should be used for the final exam.

Method

Oral Presentation

Integration

Oral presentations may require students to conduct research associated with specific applications of chemistry or broad topics related to biochemical systems. Students may present their research as a 10 minute Power Point presentation or in the format of scientific literature.

Method

Homework

Integration

Homework assignments can be used to evaluate application of dimensional analysis and overall improvement of problem solving skills. Assigned homework will cover key course objectives such as unit conversion, molecular formulas, the quantum model of the atom, intermolecular forces, stoichiometry.

Please evaluate based on correctness. Homework assignments can be used to evaluate application of dimensional analysis and overall improvement of problem solving skills. Homework should constitute no more than 0 to 15% of the course grade.

Method
Class Participation

Integration
"Laboratory Exercises/Laboratory Performance"

Please evaluate based on correctness and completeness. Laboratory exercises assess how the students are learning practical application of chemistry concepts in a laboratory setting, and proper use of glassware, equipment, and chemical supplies throughout every lab. Also assessed during lab are derivations of theoretical and percentage yield of a reaction, calculated with accurate data and proper use of significant figures. Laboratory exercises can be used to evaluate safe and effective use of equipment, chemicals, and supplies while monitoring preparedness, organizational skills, and data analysis.

laboratory exercises assess how the students are learning the practical application of chemistry concepts in a laboratory setting, and proper use of glassware, equipment, and chemical supplies throughout every lab. Also assessed during lab are derivations of theoretical and percentage yield of a reaction, calculated with accurate data and proper use of significant figures. The laboratory exercises may be given directly to the instructor during the face-to-face laboratory meetings, or in some cases, they may be turned in electronically using the MSJC LMS. Laboratory exercises will be graded by the instructor and returned to the student within a reasonable timeframe. Written laboratory reports will be completed and turned into the instructor during laboratory face-to-face meetings that include an objective, procedure, data and results, data tables, discussion, conclusion, references, and when applicable, calculations, figures, and graphs. The laboratory reports will help students synthesize and apply knowledge related to enthalpy, bond energies, phase transitions and the quantum model of the atom.

Method
Quizzes

Integration
Please evaluate based on correctness. Quizzes evaluate student safety training, safe laboratory and chemical hygiene practices and student knowledge of personal protective equipment, injury prevention, chemical spills, and minor first aid.

Quizzes will be administered during the laboratory face-to-face meetings to evaluate student safety training, safe laboratory and chemical hygiene practices and student knowledge of personal protective equipment, injury prevention, chemical spills, and minor first aid.

Assignments

Assignment Type
Reading

In-class and/or outside of class
Outside of class

Formative or Summative
Formative

Assignment
Discussion Prompt:

Collaborative problem solving is a key component of scientific practice. You will read the following excerpt from the lecture textbook. After reading the assigned textbook excerpt, you will research and select a problem or example from the lecture textbook or another scholarly resource that best covers a chemical concept presented in the assigned reading.

Assignment Type
Writing

In-class and/or outside of class

In-class
Outside of class

Formative or Summative

Summative

Assignment

Summative Writing Activity: Quiz

Complete the following quiz:

Balance the following equations:
C16H34 + O2 --> CO2 + H2O (Candle burning)
C8H18 + O2 --> CO2 + H2O (Gas burning)
HCl + Zn --> H2 + ZnCl2 (Single displacement)

Assignment Type

Writing

In-class and/or outside of class

In-class

Formative or Summative

Summative

Assignment

Summative Writing Activity: Exams

The following are example questions used in summative exams.

Please complete the following questions. Show all work clearly for each question.

A)Calculate the pH if H3O+ concertation is 0.1 M
B)What is the molar concentration of an acetic acid (CH3COOH) solution that has a pH = 7.0?

Name the compounds:
A)CaCl2
B)NO2
C)FeO3
D)NaI

Determine the molarity of a solution made by dissolving 20.0 g NaOH in sufficient water to yield 482 cm3 solution.

Classify each of the monomers below. What macromolecule will each give rise to? Identify the functional groups in each monomer. Determine if each monomer is saturated or unsaturated.
i) CH3(CH2)7CH=CH(CH2)7COOH
ii)CH3-CHNH2-COOH
iii)C6H12O6

Assignment Type

Writing

In-class and/or outside of class

In-class

Formative or Summative
Formative

Assignment
Formative Writing Activity: In-Class Problem Solving

As part of this activity, you will work collaboratively on a problem presented in-class. Please write your response or proposed solution to the problem on a separate sheet of paper. Afterwards you will be asked to share your responses with the class and the instructor at the end of the problem solving session.

Below is an example problem that can be used during an in-class problem solving session:

Calculate the molar mass of the given compound:

1) Ammonium Nitrate

Assignment Type
Writing

In-class and/or outside of class
Outside of class

Formative or Summative
Formative

Assignment
Formative Writing Assignment: Homework

You will complete homework problems created by the instructor and assigned from the lecture and laboratory textbook. Sample homework problems are provided below.

Homework Problem Set: Nomenclature

Name the compounds:
A)$CaCl_2$
B)NO_2
C)FeO_3
D)NaI

Assignment Type
Writing

In-class and/or outside of class
Outside of class

Formative or Summative
Formative

Assignment
DEI Assignment: Student Discussion Forum

Students will be able to refine their understanding of chemical concepts by discussion and explanation with other students from various backgrounds, including different socioeconomic backgrounds, different cultures, different ethnic backgrounds, as well as at-risk students.

Class Discussion Forum Prompt

Discussing chemical concepts with your peers is a key way to improve your understanding and comprehension of chemical concepts. Your peers in the course have a diverse range of perspectives that inform how they approach and solve problems. To this end, you will select a chemical concept presented from any of the assigned lecture modules and propose a real life example of that chemical concept or principle. Please draw connections between your lived experiences and the chemical concepts and principles we have observed in both lecture and laboratory. Also, provide a reply to at least two of your peers' posts.

Assignment Type
Reading

In-class and/or outside of class
Outside of class

Formative or Summative
Formative

Assignment
CHEM 107 Laboratory Focused Formative Reading Assignment

Students will read laboratory protocols and procedures for identifying and characterizing carbohydrates and proteins and apply those laboratory protocols to identify and classify samples of carbohydrates and proteins.

Instructions

Carbohydrates are a key class of compound with a range of chemical tests to identify and characterize carbohydrates. You will review the iodine test, fermentation tests, and Seliwanoff's test for carbohydrates and then apply what you have learned from the readings to identify and characterize an unknown carbohydrate sample provided in laboratory.

Course Materials

Textbooks
Smith, J. S. (2022). General, Organic, and Biological Chemistry 5/E McGraw Hill. ISBN: 9781260732023

Other Resources
Applegate, C., Neely, M.B., Sakuta, M. (2016). Laboratory Manual for General, Organic, and Biological Chemistry 1/E Prentice Hall. ISBN: 9780073511252

Class Size Information

Class Size
24

Class Size Category
J - Specialty lab

Diversity and Inclusion

Explain how diversity and inclusion(e.g., gender, culture/race, sexuality, etc.) is infused into the course.
The course revisions operate with a foundational intention of Diversity and inclusion. While vastly underrepresented in the field; women, BIPOC, LGBTQ+, and disabled scientists have made contributions in chemistry, these scientists and their accomplishments will be highlighted within the lecture content and as the focus of an assignment.

Describe how assignments, instruction, evaluation, course content, and interactions are contextualized for diverse learners promoting an equitable course.

To support diverse learners, more emphasis has been placed on the process of learning and establishing a growth mindset, as well as the role of individual differences in the learning process. This will encourage students to have an increased self-awareness, awareness of others and to engage as individuals and value students as whole people in the learning process. Assignments show a variety of approaches to the course content utilizing a variety of sources, including written texts, popular and scientific articles, accessible videos, and websites while scaffolding approaches to help them understand the critical reading and thinking process. A variety of different types of assignments are used throughout the course and students are given many opportunities to choose the topic of focus for the assignments. The course content, objectives, methods of instruction, methods of evaluation, and assignments, allow students to interact with their instructor, and each other, while learning about real world issues, to build critical thinking skills in community and through personal interaction, in-class and out of class practice to apply skills, and to receive feedback both informally in discussions and other formative types of low stake assignments and formally through summative assessments.

Interactions

Explain how the course will incorporate student-to-student interaction.

Students will engage in a variety of collaborative activities such as break-out rooms, discussion boards, or small group assignments so that students will have frequent opportunities to engage in peer-to-peer discussions designed to foster community and encourage students to experience variant interpretations of the content under analysis. Students will successfully perform laboratory experiments in small groups, where cooperation and collaboration will be required to successful perform and analyze the results of the lab experiment.

Explain how the course will incorporate instructor-to-student interaction.

The instructor will lead lectures in class or online either synchronously or asynchronously. Discussions will be conducted in person during class or through CMS discussion forums, or through breakout rooms in a video-conferencing platform. The instructor will lead and guide students through laboratory exercises and in-person lecture activities. The instructor will provide feedback to students in the CMS gradebook with regards to responses to formative assignments such as discussions and presentations, as well as provide feedback on summative assignments such as reports, projects, and exams. The instructor will communicate with students in class as well as through canvas announcements, email, discussion boards, and in office hours. Frequent instructor feedback and instructor-to-student interaction contributes to student mastery of laboratory techniques and their mastery of the course lecture concepts.

Explain how the course will incorporate student-to-content interaction.

To learn critical thinking concepts and explore chemical processes, the instructor will provide a variety of media for learning. Students will reference accessible and ADA compliant materials such as assigned readings (textbooks, lab manuals/exercises, articles, websites), written lecture materials or transcripts of lectures, illustrative images, charts and graphs, video or audio lectures, narrated PowerPoint presentations, embedded or linked multimedia content (such as films, YouTube videos, lab simulations, podcasts, etc.), and student created content, through presentations and discussions.

Explain how the course will incorporate student-to-self interaction (metacognitive).

Through discussions, presentations, and assignments, students will pose questions about science as well as how they approach their assignments and analysis. Through readings, lectures, activities, and discussions, students will explore connections between the course content and personal experiences, to demonstrate how science can be a vehicle for analyzing current societal and community concerns. The analytical and critical thinking skills students use in this course while analyzing scientific information have broad applications beyond the classroom. Many assignments in this course allow students to choose their own topic and to reflect on why they chose the topic, how they relate to the topic, and how they may use the newfound information to impact their lives, the lives around them, and the environment.

Key: 870