CHEM-113: ORGANIC CHEMISTRY II

Also listed as: CHEM-113H

Effective Term
Fall 2026

BOT Approval Date
01/15/2026

Discipline
CHEM - Chemistry
Course Number
113

Course Title
Organic Chemistry II

Short Title
Organic Chemistry II

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

Units

Lecture Units
3.00

Lab Units
2.00

Total Units
5.00

Hours

Lecture Contact Hours
48-54
Out of Class Hours Lecture
96-108

Lab Contact Hours
96-108
Out of Class Hours Lab
0.00

Total Contact Hours
144 - 162

Total Out of Class Hours
96 - 108

Total Student Learning Hours
240 - 270

Is this an existing Extensive Lab?
Yes

Distance Education
Yes

Distance Education

Distance Education Type
Hybrid Only

Does the DE also apply to the Honors section?
Yes

What will be done in face-to-face meetings
The laboratory component of the course will be face-to-face. Students will perform hands-on qualitative and quantitative experiments that incorporate data analysis.

Honors component will meet synchronously (face-to-face or moderated through online technology such as Zoom)

Are you using publisher content?
No

Regular Substantive Interaction
Instructor-to-student, student-to-student, and student-to-content contact shall be distributed in a manner that will ensure regular substantive interaction (RSI) is maintained not only weekly but also for the duration of the course. Instructor interactions should be equivalent in time, quality and consistency to the engagement students would receive in a face-to-face course—for example, through announcements, discussion participation, personalized feedback, video messages, or other instructional communications. Instructors are expected to be responsive to student inquiries within a 24-72 hour time frame excluding holidays. RSI will be maintained through a variety of methods: • Orientation - Students must be oriented to the online and face-to-face portions at the start of the course. • Announcements - Announcements using the course management system must be posted at least weekly to keep students current on course events, due dates, materials, etc. • Discussion Forums - Content-related discussion forums within the designated CMS will include appropriate instructor participation and will be initiated and maintained, with timely feedback provided. Instructors are required to monitor the discussions and related activities to provide guidance and direction. Open-ended discussion boards may be used to further learning and interaction. • MSJC Communication – Instructor will use MSJC-administered communication tools (such as email or the designated CMS communication tools) to regularly communicate with and provide ease of access to students. • Timely Feedback - Timely feedback on student work will be provided by the instructor, which may include comments and/or rubrics, within the Grades area of the designated CMS. • Scheduled Meetings – Hybrid and synchronous courses will meet at regularly scheduled times. ADA Compliance - All course interactions and content must be designed with accessibility in mind and meet ADA requirements.

Honors / Non-honors
CHEM-113H
C-ID (Admin Only)

CB 00

CCC000610098

Course Title

Honors Organic Chemistry II

Approved Cal-GETC Area

AREA-5A

Approved Second Cal-GETC Area

AREA-5C

Approved Third Cal-GETC Area

Catalog Description

The course is the second of a two-semester sequence in organic chemistry. This course in organic chemistry includes a systematic study of the nomenclature, properties, preparation, reactions and uses in synthesis of conjugated systems, aromatics, alcohols, ethers, aldehydes, ketones, carboxylic acids, acid derivatives and amines, and a study of biological molecules.

Requisites

Prerequisite(s)

Prerequisite(s) (must be taken before)
CHEM-112 (with a grade of C or better).

Codes

TOP Code (CB 03)

1905.00 - Chemistry, General

CIP Code

40.0504 - Organic Chemistry.

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

Cal-GETC Areas

Approved Cal-GETC Area

AREA-5A

Approved Second Cal-GETC Area

AREA-5C

Learning Objectives

Learning Objectives

Learning Objective
1. Investigate the chemistry, structure, properties, and nomenclature containing the following functional group(s) using the IUPAC (International Union of Pure and Applied Chemistry) system of nomenclature: alcohol, ether, epoxide, thiol, sulfide, aldehyde, ketone, carboxylic acid or acid derivative, nitrile, amine, amide or other related compounds.
2. Analyze, evaluate and practice the mechanistic preparation and multi-step syntheses of compounds containing the following functional group(s): alcohol, ether, epoxide, thiol, sulfide, aldehyde, ketone, carboxylic acid or acid derivative, nitrile, amine, amide or other related compounds.
3. Investigate the reactivity of the following functional group(s): alcohol, ether, epoxide, thiol, sulfide, aldehyde, ketone, carboxylic acid or acid derivative, nitrile, amine, amide or other related compounds in addition to carbonyl alpha substitution and carbonyl condensation reactions.
4. Identify specific functional groups and determine the carbon backbone structure of known and/or unknown compounds using FT-IR, C-13 NMR, H-1 NMR, UV-VIS, and GCMS.

5. Analyze and illustrate the structures of biochemical macromolecules including carbohydrates, amino acids and proteins, lipids, and nucleic acids.
6. Classify biochemical macro-molecules and investigate the chemical reactivity in terms of structure/function relationships.
7. Investigate protein and ribonucleic acid enzymes associated with catalytic reactions of catabolism, anabolism, metabolism, synthesis, degradation, and energy in a biochemical system.
8. Practice lab safety and wear proper personal protective equipment (PPE), utilize Safety Data Sheets (SDS), observe chemical hazards and use proper chemical hygiene, and explain/demonstrate correct procedures for safe handling and disposal of hazardous waste.
9. Construct microscale glassware (microbell, picnometer, magnetic spin bar, evacuated capillary, microburette), and demonstrate specific precautions when using needles and sharps; assemble taper glassware apparatus and safely conduct experimental procedures.
10. Operate electrical equipment such as but not limited to melt temps, vortexes, and centrifuges according to manufacturer instructions, and extract accurate data from refractometers, polarimeters, and analytical balances to the correct level of instrument precision.
11. Operate, analyze, and interpret GC, FT-IR, UV-VIS, NMR, and GC/MS data and results both manually and with the use of software.
12. Accurately determine physical properties of known and unknown compounds in the laboratory, and in the field to the correct level of instrument precision.
13. Perform advanced evaporation, distillation, extraction, sublimation, crystallization/recrystallization, and various chromatography techniques including but not limited to thin layer chromatography, column chromatography, and gas chromatography.
14. Employ a variety of solubility and chemical tests, and identify functional groups associated with known and unknown compounds based on observations of results.
15. Produce single-step and multi-step synthesis reactions at the microscale, semi-microscale, and macroscale levels with advanced separation, purification techniques and characterization of known and/or unknown product(s) and/or reactant(s).
16. Execute strategies of qualitative analysis in the identification of wet and dry organic compounds and mixtures.
17. Maintain a proper laboratory notebook and organized computational files of analytical data/results.
18. Construct a clear/concise scientific laboratory report with experiential objectives, procedures, data/results, conclusions, and ACS formatted references for each experiment throughout the semester.
19. Interpret cyclic-planar geometry, conjugation, and Huckel's rule relative to identification of aromatic, non-aromatic, and anti-aromatic compounds, and evaluate aromatic ring activation/deactivation through interpretation of resonance and analyses of reactivity in the ortho, meta, and para sites of benzene and other aromatic compounds efficiently synthesized by mechanisms that add one, two, or more substituents by electrophilic aromatic substitution.
20. Investigate the historical and contemporary contributions organic chemists from underrepresented groups and articulate how their distinct perspectives or cultural backgrounds may have influenced their research focus or problem-solving approaches in the field.

Honors Objectives

Develop critical thinking, verbal expression, and written skills in the context of pursuing scientific investigation of theoretical frameworks to guide experimental design, data collection, and use of standards and controls, related to active participation in individual and/or collaborative research projects.

Demonstrate skills in scientific inquiry and application of modern laboratory and/or field techniques, which present intellectual challenges associated with evaluating the messiness of contemporary, real-world issues that can be studied using current chemistry methodologies.

Critque the theoretical underpinnings of research in chemistry using formal analytical techniques to develop provocative interpretations with a clear, concise direction, and compare/contrast various approaches toward scientific investigation to demonstrate that the complexities of science should also be addressed with creativity and diversity.

Appraise the implications, applicability, strengths and shortcomings of conducting and reporting peer-reviewed research.

Learning Outcome Information

Course Learning Outcomes

Learning Outcome
1. Students will synthesize organic functional groups to create new compounds.
2. Students will analyze reaction mechanisms to explain the steps of chemical synthesis.
3. Students will explain core concepts of biochemistry and their role in biological systems.

4. Students will apply knowledge of organic chemistry to solve problems similar to those on ACS Organic Chemistry Exams.
5. Students will apply problem-solving strategies to independently address chemical problems.
6. Students will use reflection to clarify understanding and deepen learning.

Content

Course Lecture Content

1. Ultraviolet spectroscopy (UV) and Conjugated Systems
    a. preparation of conjugated dienes
    b. structure and stability
    c. electrophilic addition reactions
    d. kinetics of addition reactions
    e. Diels Alder reactions
    f. uses of UV spectroscopy in structure determination
    g. HOMO-LUMO transitions
2. Benzene and Aromatic Compounds
    a. sources of benzene
    b. nomenclature
    c. resonance forms
    d. molecular orbital description
    e. Hückel 4n + 2 rule
    f. IR, UV, and NMR spectroscopy of aromatic compounds
    g. electrophilic aromatic substitution reactions
    h. halogenation reactions
    i. alkylation reactions
    j. acylation reactions
    k. Friedel-Crafts reactions
    l. nucleophilic aromatic substitution reactions
    m. oxidation and reduction reactions
    n. catalytic hydrogenation
    o. use in synthesis of other organic compounds
    p. substituent effects, inductive effects, and resonance effects in reactions
    q. IUPAC Nomenclature
3. Alcohols
    a. nomenclature
    b. sources
    c. physical and chemical properties
    d. hydrogen bonding in alcohols
    e. preparation from an alkene, alkyl halide, or ether
    f. preparation from a carbonyl compound
    g. preparation using a Grignard reagent
    h. preparation from a carboxylic acid or ester
    i. acidic and basic properties of alcohols
    j. dehydration reactions of alcohols
    k. oxidation reactions of alcohols
    l. use of protecting groups
    m. NMR, IR, and MS of alcohols
    n. thiols, and other related compounds
4. Ethers
    a. nomenclature
    b. structure and properties
    c. industrial preparation
    d. preparation using the Williamson ether synthesis process
    e. preparation using the oxymercuration/demercuration of alkenes

   f. reactions of ethers and acidic cleavage
   g. cyclic ethers and epoxides
   h. ring-opening reactions of epoxides
   i. crown ethers
   j. NMR, IR, and MS of ethers
   k. sulfides, and other related compounds
5. Aldehydes and Ketones
   a. overview of the carbonyl group
   b. nomenclature
   c. physical and chemical properties
   d. preparation of aldehydes from primary alcohols, alkenes, and esters
   e. preparation of ketones from secondary alcohols, alkenes, alkynes, and acid derivatives
   f. preparation of ketones using the Friedel-Crafts acylation method
   g. oxidation reactions of aldehydes and ketones
   h. Wolff-Kisner Reduction
   i. Wittig reaction
   j. nucleophilic addition reactions with water, HCN, Grignard reagents, hydrides, alcohols, and amines
   k. the Cannizzaro reaction
   l. NMR, IR, and MS of aldehydes and ketones
6. Carboxylic Acids
   a. nomenclature
   b. structure and physical properties
   c. dissociation and acidity
   d. substituent effects on acidity
   e. preparation of carboxylic acids by oxidation of a substituted alkylbenzene, alkene, primary alcohol, or aldehyde
   f. preparation of carboxylic acids from Grignard reagents
   g. reduction reactions of carboxylic acids
   h. IR, NMR, and MS of carboxylic acids
7. Carboxylic Acid Derivatives
   a. nomenclature of acid halides, acid anhydrides, amides, and esters
   b. nucleophilic acyl substitution reactions and relative reactivity of acid derivatives
   c. preparation of acid chlorides, acid anhydrydes, esters, and amides from carboxylic acids
   d. reactions of acid halides and conversion into acids, esters, amides, and alcohols
   e. preparation of acid anhydrydes
   f. reactions of acid anhydrydes and conversion into acids, esters, amides, and alcohols
   g. preparation of esters, fischer esterification
   h. reactions of esters and conversion into acids, amides, and alcohols
   i. preparation of amides
   j. reactions of amides
   k. chemistry of nitriles and other related compounds
   l. polyamides and polyesters
   m. IR, NMR, and MS of carboxylic acid derivatives
8. Carbonyl Alpha-Substitution Reactions
   a. tautomerism
   b. reaction mechanisms
   c. halogenation reactions of aldehydes and ketones
   d. Hell-Volhard-Zelinskii reaction
   e. the haloform reaction
   f. alkylation reactions
   g. malonic ester synthesis
   h. acetoacetic ester synthesis
   i. alkylation of nitriles
9. Carbonyl Condensation Reactions

   a. reaction mechanisms
   b. the aldol reaction
   c. dehydration reactions of aldol products
   d. the Claisen reaction
   e. the Michael reaction
   f. the enamine reaction
   g. use of carbonyl condensation reactions in synthesis
10. Aliphatic Amines
    a. nomenclature
    b. physical and chemical properties
    c. structure and bonding
    d. basicity of amines
    e. preparation, Gabriel Synthesis, Hofmann and Curtius Rearrangement
    f. alkylation and acylation reactions
    g. Hofmann elimination reactions
    h. IR, NMR, and MS of amines
11. Arylamines and Phenols
    a. preparation of arylamines
    b. electrophilic aromatic substitution reactions
    c. diazonium salts and their reactions
    d. physical and chemical properties of phenols
    e. preparation
    f. alcohol-like reactions of phenols
    g. formation of quinones
    h. IR, NMR, and MS of arylamines and phenols
12. Carbohydrates
    a. classification
    b. Fischer Projections
    c. D and L sugars
    d. cyclic configuration of monosaccharides
    e. reactions of monosaccharides
    f. Kiliani-Fischer Synthesis
    g. Wohl degradation
    h. stereochemistry of glucose
    i. disaccharides and polysaccharides
13. Amino Acids, Peptides, and Proteins
    a. structure of amino acids
    b. synthesis of amino acids
    c. isoelectric points
    d. peptides
    e. classifications of proteins
    f. protein structure
    g. Edman degradation
    h. Merrifield solid-phase technique
    i. enzymes
14. Lipids
    a. waxes, fats, and oils
    b. soaps
    c. phospholipids
    d. prostaglandins
    e. terpenes
    f. steroids
15. Heterocycles and Nucleic Acids
    a. five-membered heterocyclic compounds
    b. structure and reactions of pyridine

   c. fused-ring heterocycles
   d. nucleotides
   e. heterocyclic amine bases in RNA and DNA
   f. structure of DNA
   g. role of RNA and DNA in heredity
   h. DNA sequencing
16. Effect of organic chemistry on society
   a. Explore contributions of organic chemists from underrepresented groups in relation to the topics listed above.

Course Lab Content

This lab course builds on and expands the skills developed in first-semester organic chemistry, with students working independently to complete experiments specific to the second semester. While the lab content of Organic Chemistry 112 and 113 overlaps, this course places a greater emphasis multi-step synthesis, exploring named organic reactions (such as the Diels-Alder reaction and Aldol reaction), and higher level techniques such as anhydrous air-sensitive reactions.

1. Safety
   a. General Laboratory Safety
   b. Personal Protective Equipment
   c. SDS and Chemical Hygiene
   d. Handling and Disposal of Hazardous Waste
   e. Glassware and Sharps
   f. Accident Safety
2. Equipment
   a. Standard Taper Glassware
   b. Support Apparatus
   c. Electrical Equipment such as but not limited to:
      hot plates
      melt temps
      centrifuges
      vortexes
      ovens
   d. Refractometers
   e. Polarimeters
   f. Analytical balances
   g. Compressed Gas Cylinders
3. Instrumentation and Associated Software
   a. GC (Gas Chromatography)
   b. FT-IR (Fourier Transform Infrared Spectroscopy)
   c. NMR (Nuclear Magnetic Resonance Spectroscopy)
   d. UV-VIS (Ultraviolet-Visible Spectroscopy)
   e. GCMS (Gas Chromatography Mass Spectrometry)
4. Techniques - Advanced
   a. Determination of Physical Properties
   b. Distillation
   c. Extraction
   d. Sublimation
   e. Crystallization
   f. Chromatography
5. Single- and Multi-Step Synthesis with advanced purification techniques and product analyses
   a. Microscale
   b. Semi-microscale
   c. Macroscale

6. Qualitative Analysis of Unknowns
   - advanced separation techniques, physical properties, chemical tests, analytical data, troubleshooting
      a. 2-component liquid mixture
      b. 2-component solid mixture
      c. Liquid/solid mixture
7. Laboratory Notebook and Computational Data Files
      a. Derivation of clear/concise experimental Objectives
      b. Retention, understanding and interpretation of mechanisms
      c. Streamlining and organization of preparation and procedures
      d. Tabular formatting of chemical hazards, data, observations, and results
      e. Problem solving and troubleshooting
      f. Data analyses including calculations of theoretical and percent yields
      g. Critical evaluation and discussion of experimentally derived conclusions in comparison to current literature
      h. Proper formatting of references according to American Chemical Society (ACS)
      i. Analyses of spectral data in comparison to current literature

Honors Content

General topics covered in the honors component are identical to those in the regular section; however, honors students are specifically introduced to research design and implementation associated with more sophisticated technology and instrumentation. Students will participate in activities to develop original thinking and creativity beyond regular course expectations. Topics reflect current issues in chemistry, including but not limited to a systematic study of nomenclature, physical and chemical properties, preparation, reactions, extraction, isolation, synthesis, and characterization of organic and biochemical molecules and their interactions with humans and their environments.

Students will demonstrate skills in investigation and application of research corresponding to contemporary real-world issues associated with the science of chemistry.

Methods of Instruction

Method

Activity

Integration

Group assignments, projects, and homework will be used to evaluate, analyze, compare and contrast various mechanisms of syntheses, explain the chemical behavior of reactive species that drive a reaction forward, characterize physical, chemical, and analytical data/results, and develop intuitive understanding of spectroscopic data in real time.

DE Adaptations for MOI

The method could be done in an online/asynchronous way through the use of the CMS in a variety of ways depending on the specific activity.

The assignments and modules section of the CMS can be used to disseminate the assignments and instructions, the discussion board can be used to allow students to work together, and evaluation and feedback from the instructor can happen through the assignments section or the discussion board of the CMS. All materials will be provided in accessible formats. The instructor will provide timely feedback.

Method

Lab Activities

Integration

Laboratory experimentation will provide a hands on opportunity to unite lecture material with real-world chemistry at the microscale, semi-microscale, and macroscale levels using updated protocols and equipment in a controlled laboratory environment, and in the field to convey active learning. Students will (1) collect scientific data while performing lab experiments, (2) format and write lab reports using scientific methods including an organized presentation of data and results, and (3) demonstrate application of knowledge through post-laboratory analysis. All laboratory activities will focus on laboratory skills, experimental techniques, proper use of equipment, safe lab practices and chemical hygiene, waste disposal, and quality of data/results.

DE Adaptations for MOI

N/A- Lab portion will be in-person.

Method

Lecture

Integration

Lecture will utilize whiteboard, power point, spectroscopy, molecular models, demonstrations, and multimedia in an interactive discussion-based, problem solving forum to prepare students for active participation in experimental procedures in the lab. Lecture material will be used to convey concepts of organic chemistry such as identifying and naming compounds, how to synthesize new compounds, and how to isolate and characterize molecules with various functional groups.

DE Adaptations for MOI

Lecture can be given in online asynchronous fashions such as accessible pre-recorded lectures with follow along note-taking. All materials will be provided in accessible formats. The instructor will provide timely feedback.

Method

In-class Exercises

Integration

Laboratory model kits and molecular modeling software programs will be used to create three-dimensional representations of organic molecules and demonstrate how reactions occur.

DE Adaptations for MOI

N/A-This portion is for the in-person lab.

Method

Role Playing/Simulation

Integration

Computer simulations and other multi-media will be used to demonstrate proper laboratory techniques such as how to perform attenuated total reflectance (ATR) FT-IR. Additionally simulation and multi-media resources will be utilized to observe virtual mechanisms during multi-step syntheses reactions.

DE Adaptations for MOI

Students can access accessible material online/at home. All materials will be provided in accessible formats. The instructor will provide timely feedback.

Method

Discussion

Integration

Explore and discuss how the field of organic chemistry has been shaped by chemists from diverse backgrounds and how organic chemistry has affected different communities.

Discussion topics can be varied but examples may include:
-The work of Percy Julian, an African American chemist who developed large-scale syntheses of medicinally important compounds such as steroids from soybeans, making treatments more accessible and affordable.
-Marie Maynard Daly, the first African American woman to earn a Ph.D. in chemistry in the United States, whose work on nucleic acids connects directly to the organic chemistry of amides, peptides, and nucleotide bases.
-Rosalind Franklin’s X-ray crystallography studies of DNA structure serve as another case where students connect organic chemistry concepts—such as aromaticity, hydrogen bonding, and stereochemistry—to groundbreaking research conducted by a woman who was historically underrecognized for her contributions.

-Discussions of how Indigenous and global medicinal traditions relied on natural products that were eventually isolated and synthesized in modern laboratories such as various alkaloids.
-The chemistry of dyes such as indigo and cochineal allows students to apply concepts of conjugated systems, resonance, and electrophilic substitution while recognizing their importance in cultural identity and trade. Similarly, the chemistry of alcohols, aldehydes, and carboxylic acids is examined in the context of fermentation practices that have been central to many civilizations throughout history.
-Uneven social impacts of organic chemistry discoveries. The synthesis of life-saving pharmaceuticals such as antiretroviral drugs for HIV/AIDS connects to topics of stereochemistry and chirality, but also to the inequities in drug distribution, as marginalized populations often faced limited access to these treatments.
-Environmental justice issues are explored through the lens of organic pollutants such as DDT, PCBs, and PFAS, whose persistence and toxicity can be explained through aromatic stability, substitution reactions, and halogenated organics, but whose health burdens fall disproportionately on low-income and Indigenous communities.
-The chemistry of synthetic polymers such as nylon and polyethylene is taught alongside polymerization mechanisms, but students also consider the environmental and social consequences of plastic waste, especially in vulnerable populations.

DE Adaptations for MOI

Discussions can be done through the discussion board in the CMS. All materials will be provided in accessible formats. The instructor will both facilitate and participate the discussions. The instructor will provide timely feedback.

Additional Methods of Instruction for Honors

Independent study with instructor consultation.

Honors students are required to meet regularly with the instructor (twice monthly), either alone or with other honors students to discuss honors projects, analyze additional readings, update presentations, or address issues pertinent to the student's progress and course experience. The purpose of early discussions will be to outline project details from the initial steps throughout completion of the project. Chemistry staff IAs may be invited to attend these discussions for collaboration on equipment and supplies.

Methods of Evaluation

Method

Exams/Tests

Integration

Lecture midterm exams as well as a final exam will be utilized to monitor student progress throughout the course, and modify teaching practices to better serve student learning and engagement.

The exams will assesses the students' comprehensive understanding of the identification, physical properties, chemical reactivity, and synthesis, of organic compounds containing various functional groups in addition to structure/function relationships of biochemical molecules.

DE Adaptations for MOE

N/A- Testing will be done in-person and proctored.

Method

Group Projects

Integration

Student's work will be assessed in small groups of 3 or 4 as they undertake intellectually challenging syntheses reactions and utilize spectral data to acquire or identify products using brainstorming by leveraging multiple resources and engaging in collaborative efforts.

DE Adaptations for MOE

Can be done through discussion boards or group-based assignments through the CMS. All materials will be provided in accessible formats.

Method
Homework

Integration
Homework will be used to assess student familiarity of physical properties, chemical reactivity and synthesis of new compounds containing various functional groups.

DE Adaptations for MOE
Student can complete and turn in homework through the online CMS. All materials will be provided in accessible formats.

Method
Final Performance

Integration
Practicums and Exams are conducted to assess student knowledge of safe practices, policies, and chemical hygiene in addition to student learning and practical application of the course material. Students will evaluate experimental data, calculate and analyze results such as expected and unexpected percent yields and percent errors, troubleshoot problems, and propose alternative procedures, techniques, and/or equipment to describe and explain potential improvements.

DE Adaptations for MOE
N/A- will be done in-person.

Method
Class Performance

Integration
Pre-laboratory assignments and laboratory reports will be assessed to determine student engagement and performance in evaluation and interpretation of laboratory exercises in which synthesis, purification, and characterization of new compounds, and identification of unknown compounds will be conveyed in an organized format, including an objective, table of physical properties/hazards, chemical reaction, protocol, data/results, calculations, discussion and conclusions, references, and appendix written clear and concise with appropriate scientific language, and acknowledgment of literature values.

DE Adaptations for MOE
Students can complete this outside of the lab/classroom and submit through the course CMS. All materials will be provided in accessible formats.

Method
Class Participation

Integration
Students will discuss the contribution of a diverse range of chemists and how their gender, background, and ethnicity might have influenced their research as well as the effect of the research on various communities. Discussions can take on various forms from in-person group discussions to discussion boards on the CMS.

DE Adaptations for MOE
Discussions can be held on the discussion board of the CMS. All materials will be provided in accessible formats.

Evaluation of Honors assignments
Research projects and proposals are assessed according to the organization and development of the scientific method, the number and kind of references consulted, the depth of the analysis of theoretical framework for the investigation being proposed, and the diversity of different points of view on the topic investigated.

Written and oral presentations are assessed for clarity, organization, critical thinking, and the summary of results presented.

Honors students are expected to question prevailing ideas and formulate original interpretations after completing research, and present their logic in written and/or oral format to the class at large.

Research papers will be assessed according to the quality of the hypothesis, execution of the research, ability to synthesize information from data and results, number and pertinence of references, accuracy of content, insight and originality of the work, and whether directions for ACS style guide formatting were followed.

Applied activities, such as field reports, will be assessed based on accuracy of content, insight and originality of the work. All work and papers ascribing the activity will be discussed at a professor/student meeting.

Presentations will be assessed for clarity, accuracy of content, organization, and the summary of results presented.

If any assignments are rewitten or clarified, then the evaluation should be reviewed and adjusted accordingly if necessary.

Assignments

Assignment Type

Other

In-class and/or outside of class

In-class
Outside of class

Formative or Summative

Summative

Assignment

Typical homework, groupwork, and exam questions are given for each section of the course content and are intended to indicate the level of difficulty for problems and test questions for the second semester organic chemistry level. Most of these questions involve analyses of structures, mechanisms, spectral data, etc; however, the representation of homework, groupwork, and exam questions below does not fully reflect assignments.

Students will receive feedback on errors made in the assignments. Students will be assessed based on the accuracy of their answers.

Example (pictures removed):

Part 14 Problem Set
1. Draw the product from reaction of each of the following substances with (1) Br2, FeBr3 and (2) CH3COCl, AlCl3.

2. The following molecular model of a dimethyl-substituted biphenyl represents the lowest-energy conformation of the molecule. Why are the two benzene rings tilted at a 63° angle to each other rather than being in the same plane so that their p orbitals overlap? Why doesn’t complete rotation around the single bond joining the two rings occur?

3. Using resonance structures, show why anisole (methoxybenzne) is an ortho/para director.

4. How would you synthesize the following compound starting from benzene? More than one step is needed.

5. The carbocation electrophile in a Friedel–Crafts reaction can be generated by an alternate means than reaction of an alkyl chloride with AlCl3. For example, reaction of benzene with 2-methylpropene in the presence of H3PO4 yields tert-butylbenzene. Propose a mechanism for this reaction.

How assignment will be adapted in online format

Can be assigned and accessed through the modules in their CMS. Students may complete the assignments then upload them to the CMS as a pdf for example.

Students will receive feedback on errors made in the assignments through the CMS. Students will be assessed based on the accuracy of their answers and recorded to the gradebook of the CMS.

Assignment Type
Other

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

Formative or Summative
Formative

Assignment
Watch the 23 videos in the "OCHEM Part 14 Rxns of Aromatics" playlist and take hand-written notes on the lecture. Your notes must be neat and complete; everything that is written by the instructor must also be written by you. The attached work along and work along key is optional.

How assignment will be adapted in online format
Students would access the video either through the CMS or an external video source (such as youtube) linked in the modules section. Students may submit their notes through the assignments area of the CMS. Students will be evaluated on the completeness of their notes and any feedback/grading would happen through the assignments section of the CMS.

Assignment Type
Writing

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

Formative or Summative
Summative

Assignment
Start learning how to write an experimental section for a lab report.

From the video below, watch the times 0:00-2:34, 5:12-7:45, 19:58-21:50

the organic chemistry lab report & scientific writingLinks to an external site.

In addition, read #3 Experimental (to see an example of an experimental procedure and how to write out spectroscopy data (we will note include coupling constants)).

4: Formal Lab Reports

Since this is may be your first time doing an experimental section, re-type the picture below, and fill in any blanks (for your submission change the color of any text you added to red so I can grade it more easily). Pay close attention to how to write an experimental, you will be doing one from scratch next week!

Experimental Section
Meso-1,2-Dibromo-1,2-Diphenylethane1
To a dry 10 mL round bottom flask equipped with a magnetic spin bar and air condenser, E-stilbene (____ mg, _____mmol) is added followed by glacial acetic acid (____ mL). The mixture is heated in a sand bath to ___-___ °C with stirring until the solid dissolves (~5 min). The air condenser is removed and to the warm solution, in the hood, pyridinium bromide perbromide (___mg, ___ mmol) is added followed by glacial acetic acid (___ mL). The air condenser is reattached, and the mixture is heated in the sand bath at a temperature of ___-___ °C with stirring for an additional 5-6 minutes.
The reaction mixture is removed from the heat source and allowed to cool to approximately 40-50 °C. Water (___ mL) is added with swirling and then the reaction mixture is placed into an ice bath for _-_ minutes. A crystalline solid is collected by vacuum filtration

using a Hirsch funnel. The crude product is washed with cold water (3x 2mL) followed by washing with acetone (_x _mL). The product is allowed to dry on filter paper yielding a white solid (___ mg, ___ mmol, _____% yield): mp ____-____°C (lit.2 mp___-___°C); 1H NMR (80MHz, CDCl3): δ ____ (__, __), ____ (__,__); FTIR (neat) cm-1: _____(__), ____ (___).
Chemical Tests:
Ignition: A small amount of sample is burned using a Bunsen burner. The presence of soot indicates a positive test.
Beilstein: A copper wire is flattened. A small amount of sample is placed on the flattened copper wire and burned. A fleeting blue-green flame indicates a positive test.
Silver Nitrate: To a conical vial, 0.5 mL of a 2 % ethanolic AgNO3 solution is added followed by ~10 mg of the unknown. A precipitate indicates a positive test. Heat is added if necessary.
References
1. In here goes the for the Lab Manual.
2. In here goes the literate value of the product (find one yourself)

Supplementary Information:
Paste a picture of your spectra here (IR and NMR). Include a structure of the compound the spectra represents. For IR spectra identify all peaks which represent functional groups. For NMR label all protons and match them the peaks in the NMR

For examples of very well written experimental sections see the Organic SynthesesLinks to an external site. journal (click on the pdf of any article, this journal is amazing as they actually run the experiments to make sure they work before they publish anything! (reproducibility is a growing problem in modern science...))

For examples of chemistry publications check out this open access journal: ACS Omega Links to an external site.(Total Synthesis Example)Links to an external site.

The SI (supplementary information) is generally a separate document that contains any data that didn't make it in the paper. This is usually spectroscopy data such as IR and NMR. We will include our spectroscopy data. On your IR and NMRs draw the structure that is represented by the spectra and label any peaks (for IR ID which are our functional groups and for NMR match the peaks to the hydrogens they represent).

Screenshot of how to format references:

image.png

Example of how to mark-up spectra and format them in your experimental:

image.png

1HNMR (80MHz, CDCl3): δ 3.75 (q, 2H), 2.60 (s, 1H), 1.25 (t, 3H)

FTIR (neat) cm-1: 3250, 2950

How assignment will be adapted in online format
Since this is for the lab portion it would be not need to be adapted for online.

Assignment Type
Reading

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

Formative or Summative
Formative

Assignment
Check out C&EN's talented 12 for 2024 (2025 still underway): Talented 12Links to an external site.

Examine the diverse group of scientists and pick 1 person and discuss their contributions and what you think of them (can also look at previous years if you'd like). Be sure to examine and discuss how their background and life experiences have contributed to their work.

"Details matter. Just ask the Talented 12 class of 2024. To tackle big global problems, this group of early-career researchers is digging into the details of nuclear fuel storage, battery electrolytes, nucleic acid function, and microplastics in the human body. And that's just a sampling of the standout science you can read about in the profiles that follow.

C&EN's readers submitted nearly 450 nominations for this year's class. Picking just 12 to highlight from hundreds of nominees is always tough. But it reminds us how chemists are using their knowledge of the central science to change our world for the better. We think you'll be impressed with what the members of this year's class are doing, and we look forward to seeing where they'll lead chemistry in the future."

How assignment will be adapted in online format

Can be done in an online discussion board. Students will be evaluated based on the quality of their contribution to the discussion.

Honors Assignments

Assignment

Students must successfully complete regular course requirements and supplemental honors assignments including but not limited to: participation in honors class discussions twice each month, meeting with their instructor twice each month, review of pertinent literature, design, implementation and/or evaluation of research, visits to field sites or other project requirements as approved by the instructor. In order to receive honors credit, students shall complete exercise 4 and one of the following enrichment exercises 1 through 3:

Required or Optional

Required

Assignment

1. Propose and develop a plan for carrying out an empirical research project dealing with a current issue in chemistry. Produce a formal research proposal using ACS style guide in a format acceptable for publication in a contemporary journal of chemistry with a minimum of five typed pages in 12-point font, single spaced with a minimum of five references. Students do not have to complete the research but the proposal must be detailed enough to allow for someone to actually carry out the work.

Potential examples:
-Develop new methods to remove pollutants from the environment such as the presence of polyfluoroalkyl substances ("forever chemicals").
-Develop new green syntheses of various organic compounds that are often derived from petroleum.
-Analyzing the synthesis of pharmaceutical compounds and developing pathways to form derivatives and test their efficacy.

Required or Optional

Required

Honors Core Values

Academic Rigor and Research

Justify how the assignment reflects the Academic Rigor and Research Core Value

In order for students to write a formal research proposal students must first have a strong understanding of the underlying science achieved through academic rigor. By proposing a research project they are achieving the research core value.

Assignment

2. Produce an analysis of and/or comparison of chemistry-related research, or the application of chemical research. These projects may include a critical analysis of "fictional" (superheroes, science fiction, etc.) works based on applied and theoretical research. These projects necessitate investigation into the temporal and environmental settings for the research, the theoretical perspective of the researchers, and the professional histories of the authors. If the project is a comparison of research, at least two major works must

be compared. The completed project should be a minimum of five typed pages in 12-point font, single spaced with a minimum of five references.

Examples:
-Trace how each theory of chemical bonding developed, including contributions from Pauling, Mulliken, and others. Analyze their differing assumptions about electron distribution and bonding. Include how their temporal and environmental setting may have led them to their conclusions.
-Compare early 20th-century petrochemical synthesis (e.g., Friedel–Crafts alkylation) with modern biocatalytic or solvent-free reactions. Include discussions of how one may or may not have needed to precede the other.
-Analyze how the fictional “web fluid” in Spider-Man compares to real scientific efforts to create high-strength, biodegradable polymers and protein-based fibers (like spider silk or synthetic polypeptides).

Required or Optional

Required

Honors Core Values

Academic Rigor and Research

Justify how the assignment reflects the Academic Rigor and Research Core Value

Students look through research and analyze it critically. This requires a strong foundation of the underlying science achieved through academic rigor.

Assignment

3. Research and write field or laboratory reports using formal scientific reporting techniques, based on an actual research project agreed upon by the student and instructor. Field and laboratory reports shall include pertinent data, results and conclusions with a minimum of three typed pages in 12-point font, single spaced with a minimum of five references. This report design should also include photographic, multimedia, and/or other supporting materials.

Example Project: With guidance from the instructor, the student visits a local water reservoir such as Diamond Lake multiple times throughout the semester and records various measurements such as dissolved oxygen, conductivity, temperature, pH, and water depth at the same GPS coordinates each visit. The student may also collect samples of fresh water and perform laboratory analyses for various nutrient pollutants.

Required or Optional

Required

Honors Core Values

Engagement

Justify how the assignment reflects the Engagement Core Value

Students engage with science hands on through experimentation and documenting that research.

Assignment

4. Construct a formal oral presentation, based on the written component of the honors project. Oral presentations may be completed in one or more of a variety of formats including power point (minimum of 12 slides including Introductory/Title and Reference slides), poster (including Abstract, Introduction and Background, Protocol, Data and Results, and Discussion and Conclusions), video, multimedia, or other platforms of illustration to the class or other group (15-20 minutes in length), or in conjunction with honors students from other classes. Oral presentations must be accompanied by a formal written, list of literature cited references in ACS format (minimum of 5 sources).

Required or Optional

Required

Honors Core Values

Engagement

Justify how the assignment reflects the Engagement Core Value

Students engage with their instructor, their peers, and possibly the larger scientific community as they share their work.

Course Materials

Textbooks

Mayo, Pike, and Forbes (2023). Microscale Organic Laboratory, 7th ed. John Wiley and Sons. ISBN: 978-1-119-11052-1

Klein, D. , Starkey, L (2025). Organic Chemistry, 5th ed. John Wiley and Sons. ISBN:978-1394189373

Class Size Information

Class Size

24

Class Size Category

J - Specialty lab

Diversity and Inclusion

Course Design and Materials: Course will incorporate diverse perspectives, authors, and examples that reflect a variety of cultures, identities, and lived experiences. Instructional materials will be reviewed regularly to ensure representation, inclusivity, and alignment with equity-minded practices across disciplines.

Inclusive Learning Environment: Instructors will establish classroom norms and policies that promote respect, civil discourse, and belonging in both online and face-to-face classes. Clear expectations for communication and engagement will support a learning space where all students feel valued and heard.

Accessible Instruction: Course content will be delivered using accessible design. Materials will follow accessibility guidelines within the CMS, including captioned media, readable document formats, and multiple means of engagement to support diverse learning.

Equitable Teaching Practices: Instructors will use transparent and grading criteria, varied assessment methods, and timely feedback to promote fairness and student success. Opportunities for revision, reflection, and multiple demonstrations of learning may be incorporated when appropriate to the discipline.

Culturally Responsive Pedagogies: Instructional strategies will encourage critical thinking about diverse perspectives and systems of power relevant to the course content. Faculty will foster opportunities for students to connect course material to real-world contexts.

Ongoing Reflection and Improvement: Faculty will engage in continuous professional development related to IDEAA principles and reflect on course practices using metacognition to identify opportunities for increased equity, inclusion, and accessibility.

Explain how diversity and inclusion(e.g., gender, culture/race, sexuality, etc.) is infused into the course.

Different aspects of Diversity, Equity, and Inclusion (DEI) are intentionally infused throughout the organic chemistry course. Students not only learn reactions, mechanisms, and molecular structures, but also investigate how the field has been shaped by chemists from diverse backgrounds and how organic chemistry has affected different communities.

Examples of chemists from diverse backgrounds that students may learn about include the work of Percy Julian, an African American chemist who developed large-scale syntheses of medicinally important compounds such as steroids from soybeans, making treatments more accessible and affordable. They may also learn about Marie Maynard Daly, the first African American woman to earn a Ph.D. in chemistry in the United States, whose work on nucleic acids connects directly to the organic chemistry of amides, peptides, and nucleotide bases. Rosalind Franklin's X-ray crystallography studies of DNA structure serve as another case where students connect organic chemistry concepts—such as aromaticity, hydrogen bonding, and stereochemistry—to groundbreaking research conducted by a woman who was historically underrecognized for her contributions.
Examples of how organic chemistry has affected different communities may include students grappling with the uneven social impacts of organic chemistry discoveries. The synthesis of life-saving pharmaceuticals such as antiretroviral drugs for HIV/AIDS connects to topics of stereochemistry and chirality, but also to the inequities in drug distribution, as marginalized populations often faced limited access to these treatments. Environmental justice issues may be explored through the lens of organic pollutants such as DDT, PCBs, and PFAS, whose persistence and toxicity can be explained through aromatic stability, substitution reactions, and halogenated organics, but whose health burdens fall disproportionately on low-income and Indigenous communities. The chemistry

of synthetic polymers such as nylon and polyethylene is taught alongside polymerization mechanisms, but students may also consider the environmental and social consequences of plastic waste, especially in vulnerable populations.

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

Multiple forms of assignments and evaluations are intentionally built into the course to give students varied opportunities to demonstrate their learning and to recognize that knowledge and ability are expressed in different ways. In-person microscale organic chemistry labs emphasize hands-on skills, experimental design, and observation, allowing students to engage directly with the processes of organic chemistry. Written lab reports then extend this experience by requiring students to analyze data, articulate mechanisms, and communicate their findings in a scientific format, blending technical knowledge with critical thinking and communication skills. Traditional exams provide a more structured way for students to demonstrate mastery of foundational concepts, reaction mechanisms, and problem-solving strategies under timed conditions, ensuring that core competencies are met. At the same time, the course goes beyond conventional methods of assessment by integrating assignments that explore the historical, cultural, and societal impacts of organic chemistry. These components invite students to connect molecular concepts to broader human contexts, such as the role of organic compounds in medicine, agriculture, and environmental sustainability, or the contributions of chemists from diverse backgrounds whose work has shaped the field. This range of evaluation methods not only accommodates different learning strengths—whether practical, analytical, or contextual—but also affirms that organic chemistry can be understood and valued through multiple lenses. By blending laboratory practice, technical communication, traditional assessment, and societal inquiry, students gain a more comprehensive and inclusive understanding of both the subject matter and their own abilities as learners.

Interactions

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

In the in-person organic chemistry labs, students actively engage with one another by discussing their progress, sharing strategies, and collaborating to troubleshoot challenges that arise during experiments. These interactions not only strengthen their practical skills but also foster a supportive learning environment where peers learn from one another's approaches and perspectives.

Beyond the laboratory, students participate in online discussions that extend the scope of organic chemistry into broader social and cultural contexts. These conversations address the contributions of underrepresented groups to the field, the ways organic chemistry impacts different communities, and how advances in areas such as pharmaceuticals, materials, and sustainability have improved quality of life. Together, these experiences highlight both the technical and human dimensions of the subject, encouraging students to view chemistry as a collaborative and socially relevant discipline.

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

During in-person lab periods, students will work closely with the instructor, who will demonstrate and assist with hands-on organic chemistry techniques and the use of laboratory instrumentation. This direct interaction provides students with guidance in developing their experimental skills and ensures they feel supported as they practice complex procedures.
In addition to lab work, the instructor will lead students through the core content of organic chemistry in online lectures. These sessions will introduce foundational concepts, reaction mechanisms, and problem-solving strategies, giving students the knowledge they need to connect theory with practice.

The instructor will also facilitate and participate in online or in-person discussions that place organic chemistry in a broader context. These conversations explore the historical development of the field as well as its impact on modern society, helping students recognize how organic chemistry continues to shape the world and influence everyday life.

The instructor will provide timely feedback to students throughout the course.

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

Students will engage with the content in multiple formats designed to build both technical skills and conceptual understanding. In the in-person lab, they will carry out modern organic chemistry experiments and work directly with instrumentation that reflects current practices in the field, giving them hands-on experience with the tools and techniques used by professional chemists.

Online lecture periods will focus on developing a strong foundation in the principles and mechanisms of organic chemistry, while discussions will encourage students to apply this knowledge to broader historical and contemporary contexts. By connecting core concepts to real-world issues and developments, students will see how organic chemistry extends beyond the classroom and continues to shape science, technology, and society.

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

The course emphasizes student-to-self metacognitive interactions by encouraging learners to reflect on their growth and progress across different settings. In the in-person lab, students build confidence and skill by repeating organic chemistry techniques and drawing on prior experience to refine their approach. Online lectures and assessments provide opportunities for students to evaluate their understanding, identify areas for improvement, and apply strategies to strengthen their performance.

Online discussions extend this reflection further by prompting students to consider how organic chemistry connects to their own lives and experiences. By examining both the personal and societal impacts of the subject, students are encouraged to think critically about how their learning shapes them and how they can use this awareness to guide their development as scientists and problem-solvers.

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