CHEM 12CL: ORGANIC CHEMISTRY LABORATORY

Foothill College Course Outline of Record

Heading	Value
Effective Term:	Summer 2025
Units:	2
Hours:	6 laboratory per week (72 total per quarter)
Prerequisite:	CHEM 12BL.
Corequisite:	Completion of or concurrent enrollment in CHEM 12C.
Advisory:	Not open to students with credit in CHEM 13CH.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Non-GE
Transferable:	CSU/UC
Grade Type:	Letter Grade Only
Repeatability:	Not Repeatable

Student Learning Outcomes

- Interpret experimental data through application of theoretical models
- Safely handle Organic Chemicals
- Gain skill with common synthetic chemistry techniques

Description

Laboratory course to accompany CHEM 12C. Intended to strengthen student's skill in application of laboratory techniques, and to encourage independent work. Emphasis is on chemical reactions relevant to CHEM 12C, multi-step syntheses, and identification of unknowns.

Course Objectives

The student will be able to:

1. Safely handle and dispose of hazardous organic chemicals
2. Acquire skill in laboratory techniques common to experimental organic chemistry
3. Acquire and interpret spectroscopic data, including NMR, IR, and GC-MS
4. Provide a rationale for each step in an experimental design
5. Analyze data to discern the validity of a hypothesis
6. Communicate clearly using the language of organic chemistry
7. Work constructively and collaboratively in groups

Course Content

See Lab Content, below.

Lab Content

1. Safely handle and dispose of hazardous organic chemicals
    a. Research the Material Safety Data Sheets of chemicals
    b. Categorize chemicals according to their compatibility
2. Develop skill in laboratory techniques common to experimental organic chemistry. Representative projects may include the following or equivalent alternatives addressing similar outcomes:
    a. Aldol condensation-dehydration of unknown aldehydes and ketones
        i. Preparation, recrystallization and MP of ketone and aldehyde derivatives for unknown identification
        ii. Characterization of aldol products via NMR and MP
    b. Ester synthesis via reaction between unknown alcohol and acetic anhydride
    c. Evaluation of the Keq for Fischer esterification of unknown alcohols
        i. Determination of relative response factors in GC
        ii. NMR analysis of mixtures
    d. Amine synthesis via selective reduction of 3-nitroacetophenone
    e. Multi-step synthesis of bromoaniline from aniline; evaluation of regioselectivity
    f. Quantitative kinetics via NMR: evaluating substituent effects on the nucleophilic substitution of substituted benzyl chlorides
    g. Thermodynamic vs. kinetic control in the alkylation of chlorobenzene
    h. Combined spectroscopic identification of an unknown (MS, 1H NMR, IR)
3. Acquire and interpret spectroscopic data, including NMR, IR, and GC-MS
    a. Routine acquisition of 1H NMR and IR spectra following isolation of organic products
    b. Analysis of 1H NMR data. Applications may include but are not limited to:
        i. Acquisition of 13C NMR of organic unknowns
        ii. Utilizing 1H NMR spectra to determine equilibrium constants between acetate esters and their associated alcohols
        iii. Analyze GC-MS data of a general organic unknown to confirm its identity
4. Provide a rationale for each step in an experimental design
    a. Independent strategic planning of experimental procedures
    b. Evaluate procedural steps to identify consequences of errors and to propose alternative approaches
5. Analyze data to discern the validity of a hypothesis
    a. Determine the regioselectivity of a reaction through NMR analysis
    b. Formulate a strategy to deduce the identity of an unknown organic compound based on its properties and chemical reactivity alone
6. Communicate clearly using the language of organic chemistry
    a. Maintain complete and accurate records of experimental data and observations
    b. Prepare written laboratory reports
    c. Research and present chemical safety and handling precautions (SDS reports)

Special Facilities and/or Equipment

1. Chemistry laboratory with adequate chemicals and equipment for conducting the prescribed course.
2. Each student is issued a laboratory bench locker containing specialized glassware and equipment for both mini- and micro-scale organic synthesis.

3. Instrumentation maintained for shared routine use includes analytic balances, melting point apparatus, polarimeters, gas chromatographs, UV-Visible spectrophotometers, FTIR spectrophotometers, 1H/13C 60MHz FT-NMR 1H/Multinuclear 60 MHz FT-NMR, and a gas chromatograph-mass spectrometer (GC-MS).

Method(s) of Evaluation

Methods of Evaluation may include but are not limited to the following:

Critical evaluation of procedural steps in prelab exercises and/or quizzes
Demonstrating skill in safe handling of organic chemicals
Recording data and observations
Writing laboratory reports/ post lab summaries
Written short- answer examinations

Method(s) of Instruction

Methods of Instruction may include but are not limited to the following:

Students will prepare, isolate, purify, and characterize organic compounds

Students will formulate hypotheses and critically evaluate the experiment designed to test it
Students will work with partner(s) to analyze experimental data
Students will draw conclusions based on first-hand experience
Students will discover the connection between experiment and real-world applications
Students will actively participate in instructor-led discussion of experimental design

Representative Text(s) and Other Materials

Mohrig, Jerry, David Alberg, Gretchen Hofmeister, Paul Schatz, and Christina Noring Hammond. Laboratory Techniques in Organic Chemistry: Supporting Inquiry-driven Experiments. 2014.

Although this text is more than 5 years old, it is still in print and is a seminal text that describes laboratory methodology and techniques rather than providing prescriptive activities and is still therefore up to date.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

1. Students will conduct a preliminary analysis of experimental procedures with the application of prior knowledge.
2. Students will evaluate and reflect on experimental results and summarize their findings in a post-lab report.
3. Students will draw their own conclusions based on first-hand observations and discuss them verbally and in writing.

Discipline(s)

Chemistry