Course Information
Division: Science
Course Number: CHM 236 (SUN# CHM 2236)
Title: General Organic Chemistry II
Credits: 4
Developed by: Phil McBride, Ph.D.
Lecture/Lab Ratio: 3 Lecture/3 Lab
Transfer Status: ASU NAU UA

CHM 234 (3) & CHM 238 (1)
CHM 238 --and--
CHM 238L
CHEM 243B --and--
CHEM 241B

Activity Course: No
CIP Code: 40.0500
Assessment Mode: Standardized Test: (ACS Organic Chemistry - 70 Questions/70 Points)

Semester Taught: Spring
GE Category: Lab Science
Separate Lab: Yes
Awareness Course: No
Intensive Writing Course: Yes

Prerequisites
CHM 235 with a grade of “C” or higher and ENG 101 with a grade of “C” or higher

Educational Value
Students will gain an understanding of the role organic chemistry plays in their lives and the role organic chemistry plays in the agricultural, industrial, and medical fields. Students learn how to identify problems and work as a team to solve those problems. Students learn how to predict reactions and devise methods to synthesize organic compounds. They learn to work as part of a cooperative team. Students design and conduct laboratory experiments and communicate the results through written laboratory reports. Students work together to present a "Chemistry Magic Show" to high school chemistry students. Students visit local industries to witness how organic chemistry is used in the industrial world.

Students learn the composition and reactivity of several chemicals they will encounter in their various scientific fields. The students learn about hazardous waste and safety precautions that must be followed when dealing with organic chemicals.

This course will be taught by an instructor prepared in intensive writing/critical inquiry skills through undergraduate and/or graduate coursework or through an in-service session. The instructional content of the course will include at least one formal writing assignment of not less than 1,500 words and a minimum of two additional writing assignments totaling 1,000 words or more. The instructor must provide students with feedback on selected writing assignments, addressing issues including but not limited to,
development, style, grammar, sentence, and organizational structure, use of sources, and logical consistency. The assignments must be designed to include feedback from peers, professionals, or the EAC Writing Center.

**Description**
Continuation of CHM 235. General principles of organic chemistry with continued emphasis on reactivity and synthesis. Topics include the study of alcohols, ethers, epoxides, sulfides, conjugated systems, aromatic compounds, ketones, aldehydes, amines, carboxylic acids and their derivatives, enols, carbohydrates, nucleic acids, amino acids, peptides, proteins, lipids, and polymers.

**Supplies**
Comp Book 5x5
Scientific Calculator

**Competencies and Performance Standards**

1. **Construct an understanding of the physical properties and synthesis of alcohols.**

   **Learning objectives**
   *What you will learn as you master the competency:*
   a. Draw and name all alkenes with a given molecular formula.
   b. Use the E-Z and cis-trans systems to name geometric isomers.
   c. Use heats of hydrogenation to compare stabilities of alkenes.
   d. Predict relative stabilities of alkenes and cycloalkenes, based on structure and stereochemistry.
   e. Predict the products of dehydrohalogenation of alkyl halides, dehalogenation of dibromides, and dehydration of alcohols, including major and minor products.
   f. Propose logical mechanisms for dehydrohalogenation, dehalogenation, and dehydration reactions.
   g. Predict and explain the stereochemistry of E2 eliminations to form alkenes.
   h. Propose effective single-step and multistep syntheses of alkenes.

   **Performance Standards**
   *Competence will be demonstrated:*
   o through completion of a weekly laboratory report
   o through successful completion of periodic written examinations

   **Criteria - Performance will be satisfactory when:***
   o learner completes assigned homework
   o learner participates in class activities
   o learner completes stipulated laboratory activities

2. **Illustrate the properties, reactivity, and synthesis of ethers and epoxides.**

   **Learning objectives**
   *What you will learn as you master the competency:*
   a. Draw and name ethers and heterocyclic ethers, including epoxides.
   b. Predict relative boiling points and solubilities of ethers.
c. Explain the stabilizing effects of ether solvents on electrophilic reagents.
d. Determine the structures of ethers from their spectra.
e. Devise efficient laboratory syntheses of ethers and epoxides.
f. Predict the products of the reactions of ethers and epoxides.

**Performance Standards**

*Competence will be demonstrated:*
- through completion of a weekly laboratory report
- through successful completion of periodic written examinations

*Criteria - Performance will be satisfactory when:*
- learner completes assigned homework
- learner participates in class activities
- learner completes stipulated laboratory activities

3. **Discuss the properties and reactions of simple carbonyl compounds.**

**Learning objectives**

*What you will learn as you master the competency:*

a. Name ketones and aldehydes, and draw the structures from their names.
b. Interpret the IR, NMR, UV, and mass spectra of ketones and aldehydes.
c. Write equations for syntheses of ketones and aldehydes from various functional groups.
d. Propose effective single-step and multistep syntheses of ketones and aldehydes.
e. Predict the products of reactions of ketones and aldehydes with various functional groups.
f. Show how to convert ketones and aldehydes to other functional groups.
g. Use retrosynthetic analysis to propose effective multistep syntheses using ketones and aldehydes as intermediates and protecting the carbonyl group if necessary.

**Performance Standards**

*Competence will be demonstrated:*
- through completion of a weekly laboratory report
- through successful completion of periodic written examinations

*Criteria - Performance will be satisfactory when:*
- learner completes assigned homework
- learner participates in class activities
- learner completes stipulated laboratory activities

4. **Study the properties and structures of amines and their use as drugs and medicines.**

**Learning objectives**

*What you will learn as you master the competency:*

a. Name amines and draw the structures from their names.
b. Interpret the IR, NMR, and mass spectra of amines, and use the spectral information to determine the structures.
c. Explain how the basicity of amines varies with hybridization and aromaticity.
d. Contrast the physical properties of amines with those of their salts.
e. Predict the products of reactions of amines with various types of functional groups.
f. Illustrate the uses and mechanisms of the Hofmann and Cope eliminations, and predict the major products.
g. Show how to synthesize amines from other organic compounds.

**Performance Standards**

*Competence will be demonstrated:*
- through completion of a weekly laboratory report
- through successful completion of periodic written examinations

**Criteria - Performance will be satisfactory when:**
- learner completes assigned homework
- learner participates in class activities
- learner completes stipulated laboratory activities

5. **Discuss the properties and reactions of carboxylic acids.**

**Learning objectives**

*What you will learn as you master the competency:*

a. Name carboxylic acids, and draw the structures from their names.
b. Show how the acidity of acids varies with their substitution.
c. Contrast the physical properties of carboxylic acids and their salts.
d. Interpret the IR, UV, NMR, and mass spectra of carboxylic acids.
e. Show how to synthesize carboxylic acids.
f. Show how acids are converted to esters and amides using acid chlorides as intermediates.
g. Give the mechanism of the Fischer esterification.
h. Predict the products of reactions of carboxylic acids with various functional groups.

**Performance Standards**

*Competence will be demonstrated:*
- through completion of a weekly laboratory report
- through successful completion of periodic written examinations

**Criteria - Performance will be satisfactory when:**
- learner completes assigned homework
- learner participates in class activities
- learner completes stipulated laboratory activities

6. **Discuss the properties and reactions of carboxylic acid derivatives.**

**Learning objectives**

*What you will learn as you master the competency:*

a. Name carboxylic acids derivatives and draw the structures from their names.
b. Contrast the physical properties of carboxylic acids derivatives.
c. Interpret the IR, UV, NMR, and mass spectra of carboxylic acid derivatives.
d. Show how acid catalysis is used to synthesize acid derivatives.
e. Show how acid derivatives hydrolyze to carboxylic acids.
f. Show what reagents are used to reduce acid derivatives.
g. Summarize the importance, uses, and special reactions of each type of acid derivative.

Performance Standards

Competence will be demonstrated:

- through completion of a weekly laboratory report
- through successful completion of periodic written examinations

Criteria - Performance will be satisfactory when:

- learner completes assigned homework
- learner participates in class activities
- learner completes stipulated laboratory activities

7. Discuss alpha substitution and carbonyl condensations.

Learning objectives

What you will learn as you master the competency:

a. Show how enols and enolate ions act as nucleophiles.
b. Give mechanisms for acid-catalyzed and base-promoted alpha halogenation of ketones and acid-catalyzed halogenation of acids (the HVZ reaction).
c. Show how alkylation and acylation of enamines and lithium enolates are used synthetically
d. Predict the products of aldol and crossed aldol reactions.
e. Predict the products of Wittig reactions.
f. Predict the products of Claisen and crossed Claisen condensations, and give mechanisms.
g. Show how the malonic ester synthesis and the acetoacetic ester synthesis are used to make substituted acetic acids and substituted acetones.
h. Predict the products of Michael additions.

Performance Standards

Competence will be demonstrated:

- through completion of a weekly laboratory report
- through successful completion of periodic written examinations

Criteria - Performance will be satisfactory when:

- learner completes assigned homework
- learner participates in class activities
- learner completes stipulated laboratory activities

8. Demonstrate the use of carbohydrates and nucleic acids in the use of consumer products.

Learning objectives

What you will learn as you master the competency:

a. Recognize the structures of other anomers and epimers of glucose, drawn as either Fischer projections or chair structures, by noticing the differences from the glucose structure.
b. Correctly name monosaccharides and disaccharides, and draw their structures from
their names.

c. Predict which carbohydrates mutarotate, which reduce Tollens reagent, and which undergo epimerization and isomerization under basic conditions.

d. Draw the common types of glycosidic linkages, and recognize these linkages in disaccharides and polysaccharides.

e. Recognize the structures of DNA and RNA, and draw the structures of a ribonucleotide and a deoxyribonucleotide.

**Performance Standards**

*Competence will be demonstrated:*
- through completion of a weekly laboratory report
- through successful completion of periodic written examinations

*Criteria - Performance will be satisfactory when:*
- learner completes assigned homework
- learner participates in class activities
- learner completes stipulated laboratory activities

9. Obtain a basic understanding of amino acids, peptides, and proteins along with their functions.

**Learning objectives**

*What you will learn as you master the competency:*

a. Name amino acids and peptides, and draw the structures from their names.

b. Explain which amino acids are acidic, which are basic, and which are neutral.

c. Show how amino acids might be synthesized.

d. Predict products of the following reactions of amino acids: esterification, acylation, reaction with ninhydrin.

e. Use information from terminal residue analysis and partial hydrolysis to determine the structure of an unknown peptide.

f. Show how solution-phase peptide synthesis or solid-phase peptide synthesis would be used to make a given peptide.

g. Discuss and identify the four levels of protein structure (primary, secondary, tertiary, quaternary).

**Performance Standards**

*Competence will be demonstrated:*
- through completion of a weekly laboratory report
- through successful completion of periodic written examinations

*Criteria - Performance will be satisfactory when:*
- learner completes assigned homework
- learner participates in class activities
- learner completes stipulated laboratory activities

10. Discuss the properties and uses of lipids.

**Learning objectives**

*What you will learn as you master the competency:*

a. Classify lipids both into the large classifications and into the more specific classifications.
b. Predict the physical properties of fats and oils from their structures.
c. Identify the isoprene units in terpenes, and classify terpenes according to the number of carbon atoms.
d. Predict the products of reactions of lipids with standard organic reagents. In particular, consider the reactions of the ester and olefinic groups of glycerides and the carboxyl groups of fatty acids.
e. Explain how soaps and detergents work, with particular attention to their similarities and differences.

**Performance Standards**

*Competence will be demonstrated:*
- through completion of a weekly laboratory report
- through successful completion of periodic written examinations

*Criteria - Performance will be satisfactory when:*
- learner completes assigned homework
- learner participates in class activities
- learner completes stipulated laboratory activities

11. Discuss the fundamental principles of polymer chemistry.

**Learning objectives**

*What you will learn as you master the competency:*

a. Differentiate between addition and condensation polymers.
b. Predict whether a given structure will polymerize to give an addition or a condensation polymer.
c. Explain how a specific monomer will polymerize under acidic, basic, or free-radical conditions.
d. Predict the general characteristics of a polymer based on its structure.
e. Explain how chain branching, cross-linking, and plasticizers affect the properties of polymers.
f. Compare the stereochemistry of isotactic, syndiotactic, and atactic polymers.

**Performance Standards**

*Competence will be demonstrated:*
- through completion of a weekly laboratory report
- through successful completion of periodic written examinations

*Performance will be satisfactory when:*
- learner completes assigned homework
- learner participates in class activities
- learner completes stipulated laboratory activities

12. Consider molecular orbitals in conjugated pi systems and pericyclic reactions.

**Learning objectives**

*What you will learn as you master the competency:*

a. Show how to construct the molecular orbitals of conjugated systems up to 8 pi electrons.
b. Identify the HOMO and LUMO in molecular orbital diagrams for both the ground state and the excited state.

c. Recognize reactions that are enhanced by resonance stabilization of the intermediates.

d. Classify sigmatropic reactions by order and identify each as proceeding by suprafacial or antarafacial stereochemistry.

e. Predict the stereochemistry of pericyclic reactions.

f. Predict which cycloadditions will be thermally allowed and which will be photochemically allowed.

**Performance Standards**

*Competence will be demonstrated:*

- through completion of a weekly laboratory report
- through successful completion of periodic written examinations

*Criteria - Performance will be satisfactory when:*

- learner completes assigned homework
- learner participates in class activities
- learner completes stipulated laboratory activities

13. **Evaluate a laboratory report for correct science and readability.**

*Learning objectives*

*What you will learn as you master the competency:*

a. Review a peer’s laboratory report for readability.

b. Examine the laboratory report for correct chemistry.

*Performance Standards*

*Competence will be demonstrated:*

- upon completion of a peer review

*Criteria - Performance will be satisfactory when:*

- learner reviews a peer's laboratory report for correct science and readability

14. **Revise a laboratory report based on feedback.**

*Learning objectives*

*What you will learn as you master the competency:*

a. Evaluate and utilize instructor, peer, and writing tutor comments to revise written lab reports.

b. Build on previous lab reports to strengthen subsequent formal lab reports.

*Performance Standards*

*Competence will be demonstrated:*

- upon submission of formal lab reports

*Criteria - Performance will be satisfactory when:*

- learner submits a satisfactory written lab report
15. Communicate the results of a laboratory experiment through written means.

**Learning objectives**

*What you will learn as you master the competency:*

a. Use the Scientific Method in conducting laboratory experiments.

b. Communicate the results of laboratory experiments through formal lab reports.

c. Use the ACS Style Guide for references.

d. Use proper grammar, sentence structure, in organizing the report similar to journal articles in refereed scientific journals.

**Performance Standards**

*Competence will be demonstrated:*

- through several informal lab reports written in a laboratory notebook
- through at least two written, peer reviewed written lab reports, of at least 750 words
- through at least one 1500 word written report

*Criteria - Performance will be satisfactory when:*

- learner submits satisfactory written lab reports

**Types of Instruction**

Classroom Lecture / Discussion

Cooperative Learning Activities

Laboratory Activities / Field Trips

**Grading Information**

**Grading Rationale**

Exams will be given after every two or three chapters in the textbook. Laboratory activities will be held each week. Laboratory notebooks will be turned in and graded by the instructor who will provide feedback on proper chemistry, development, style, grammar, structure, and references. Students will peer review each other’s written laboratory reports. A post test will be administered at the end of the semester.

Homework counts 15% of the final grade.

Laboratory activities count 25% of the final grade and are composed of the following:

- Informal Lab Reports (8-12)
- 500 word Critical Review of a Scientific Journal Article
- Formal Lab Reports (at least 2) of at least 750 words
- Peer Review of a Laboratory Report (at least 3)
- Evaluation of each formal laboratory report by a Writing Tutor
- 1,500 word Formal Laboratory Report (at least 1)

Exams count 50% of the final grade.

ACS Standardized Exam counts 10% of the final grade. The Standardized Test is an American Chemical Society National Standardized Organic Chemistry Exam.
### Grading Scale

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<th>Grade</th>
<th>Percentage</th>
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<tr>
<td>A</td>
<td>90-100%</td>
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<td>B</td>
<td>80-89%</td>
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