



## Course Number and Title: CHM 240 Organic Chemistry I

### Campus Location:

Georgetown, Dover, Stanton, Wilmington

### Effective Date:

2020-51

### Prerequisite:

CHM 150, CHM 151 or concurrent

### Co-Requisites:

None

### Course Credits and Hours:

4.00 credits

3.00 lecture hours/week

3.00 lab hours/week

### Course Description:

This course is a study of the molecular structure, bonding, nomenclature, properties, reactions, stereochemistry, and spectrometric analysis of alkanes, cycloalkanes, alkenes, dienes, alkynes, alkyl halides, and aromatic hydrocarbons. The laboratory consists of isolation, purification, synthesis, and analysis techniques related to the above.

### Required Text(s):

Obtain current textbook information by viewing the [campus bookstore - https://www.dtcc.edu/bookstores](https://www.dtcc.edu/bookstores) online or visit a campus bookstore. Check your course schedule for the course number and section.

### Additional Materials:

None

### Schedule Type:

Classroom Course

### Disclaimer:

None

### Core Course Performance Objectives (CCPOs):

1. Examine the relationship between molecular structure and chemical and physical properties of hydrocarbons and their halide derivatives. (CCC 6; PGC BIS 1, CEM 1, CHM 1)
2. Describe and write major types of organic reactions, including but not limited to oxidation, reduction, rearrangement, substitution, addition, and elimination. (CCC 6; PGC BIS 1, CEM 1, CHM 1)
3. Identify and apply the International Union of Pure and Applied Chemistry (IUPAC) rules of nomenclature to name organic compounds. (CCC 6; PGC BIS 1, CEM 1, CHM 1)
4. Write equations, and compare common methods of synthesis and reactions of organic compounds. (CCC 6; PGC BIS 1, CEM 1, CHM 1)
5. Describe natural and industrial sources and applications and uses of important hydrocarbons and haloalkanes. (CCC6; PGC BIS 1, CEM 1, CHM 1)
6. Explain and apply principles of stereochemistry. (CCC 6; PGC BIS 1, CEM 1, CHM 1)
7. Safely assemble and conduct effective organic reactions, separations, and product identifications; interpret infrared spectra. (CCC 2, 6; PGC BIS 1, 3, 6, CEM 1, 2, 3, 6, 8, 9, CHM 1, 2, 3, 6, 8, 9)
8. Document laboratory observations and data in a laboratory notebook in accordance with accepted professional standards. (CCC 1; PGC BIT 3, 9, CEM 4, 7, CHM 4, 7)

See Core Curriculum Competencies and Program Graduate Competencies at the end of the syllabus. CCPOs are linked to every competency they develop.

### Measurable Performance Objectives (MPOs):

Upon completion of this course, the student will:

1. Examine the relationship between molecular structure and chemical and physical properties of hydrocarbons and their halide derivatives.
  1. Define *organic chemistry*, and discuss its significance.
  2. Describe the structure and formation of ionic and covalent bonds.
  3. Describe the formation of a covalent bond in terms of molecular orbital theory.
  4. Describe the hybridization and geometry of a carbon atom with four single bonds and with a double or triple bond.
  5. Draw and interpret skeletal and condensed structural formulas, and use them to generate molecular formulas.
  6. Calculate the formal charge for an atom in a molecule.

7. Use electronegativity values to describe inductive effects and the character of a chemical bond.
8. Define *dipole moment*, and describe its effect on molecular properties.
9. Define *acids* and *bases* in terms of Bronsted–Lowry and Lewis definitions.
10. Define *functional group*, and recognize the major types.
11. Draw structures of alkanes and distinguish isomers; classify carbon atoms by type.
12. Discuss the chemical and physical properties of alkanes.
13. Calculate the degree of unsaturation for a compound.
14. Describe the electronic structure of alkenes.
15. Describe the electronic structure of alkynes.
16. Classify alkyl halides as primary, secondary, tertiary, allylic, or vinylic.
17. Describe the effects of halogens on boiling point and solubility.
18. Describe the biochemical stability and reactivity of alkyl halides.
19. Distinguish aliphatic and aromatic compounds.
20. Describe the electronic structure of benzene and the effects of resonance.
21. Discuss the molecular orbital model of benzene.
22. Explain the significance of the Hückel rule in the definition of aromaticity.
23. Name and describe the structure of polycyclic aromatic hydrocarbons.
2. Describe and write major types of organic reactions, including but not limited to oxidation, reduction, rearrangement, substitution, addition, and elimination.
  1. Distinguish addition, elimination, substitution, and rearrangement reactions.
  2. Define the terms used in describing reaction mechanisms.
  3. Describe the processes that occur in reactions, and define the neutral and charged intermediate particles that are formed.
  4. Describe the mechanism of a radical reaction (halogenation of an alkane).
  5. Describe the mechanism of a polar reaction (addition to an alkene).
  6. Discuss influence of reaction rate and equilibrium on chemical systems.
  7. Use equilibrium constant expressions to describe the extent of a reaction.
  8. Draw reaction energy diagrams and use them to describe transition states, intermediates, activation energy, and heat of reaction.
  9. Describe the mechanism and orientation of the addition of hydrogen halide (HX) to alkenes; state and apply Markovnikov's rule.
  10. Discuss the structure and relative stability of carbocations.
  11. State the Hammond postulate.
  12. Discuss the competition between substitution and elimination reactions.
  13. State and apply Zaitsev's rule in elimination reactions.
  14. Describe the structure of conjugated dienes and the stability of allylic carbocations.
  15. Explain how resonance accounts for 1, 4-addition reactions of dienes.
  16. Use reaction energy diagrams to explain the difference between kinetic and thermodynamic control of reactions.
3. Identify and apply the International Union of Pure and Applied Chemistry (IUPAC) rules of nomenclature to name organic compounds.
  1. Name alkanes using common names and IUPAC rules.
  2. Draw and name cycloalkanes; recognize and name cis–trans isomers.
  3. Name alkenes using common names and IUPAC rules.
  4. Name isomeric alkenes using the cis–trans and entgegen/zusammen (E/Z) systems.
  5. Name alkynes by common names and IUPAC rules.
  6. Name halogen compounds using common names and IUPAC rules.
  7. Name aromatic compounds by common names and IUPAC rules.
4. Write equations, and compare common methods of synthesis and reactions of organic compounds.
  1. Write equations for the synthesis of alkenes by dehydrohalogenation and dehydration.
  2. Write equations for the reactions of alkenes by addition of halogen, hypochlorous acid (HOCl), and water (by oxymercuration and hydroboration).
  3. Write equations for the addition of HX to alkenes both in the absence and presence of peroxide; describe the mechanisms involved.
  4. Write equations for addition of hydrogen to alkenes.
  5. Write equations for the hydroxylation of alkenes to 1, 2-diols.
  6. Write equations for the oxidative cleavage of 1, 2-diols.
  7. Write equations for the synthesis of alkynes from dihalides.
  8. Write equations for the addition reactions of alkynes with HX, halogen, water, borane, and hydrogen.
  9. Write equations for the reduction of alkynes with lithium in ammonia.
  10. Write equations for the reaction of terminal acetylenes with sodium amide.
  11. Write equations for the alkylation of terminal acetylides with alkyl halides.
  12. Write equations for the synthesis of halogen compounds by halogenation of alkanes, allylic substitution, addition to alkenes and alkynes, and substitution of alcohols.
  13. Write equations for the synthesis and utilization of Grignard reagents.
  14. Write equations for the conversion of alkyl halides to alcohols, ethers, nitriles, thiols, alkynes, amines, and alkyl iodides.
  15. Describe how the silver nitrate and sodium iodide tests are used to classify halogen compounds
  16. Write equations for the synthesis of conjugated dienes.
  17. Describe the Diels–Alder cycloaddition reaction, and write equations for reactions of dienes and dienophiles.
5. Describe natural and industrial sources and applications and uses of important hydrocarbons and haloalkanes.
  1. Discuss the natural sources and industrial uses of alkanes.
  2. Describe the industrial preparation and uses of ethene, propene, and butane.

3. Describe the important uses and applications of alkyl halides such as methylene chloride, CFCs, vinyl chloride, and tetrafluoroethylene.
4. Describe the principal natural sources of aromatic compounds.
6. Explain and apply principles of stereochemistry.
  1. Recognize and distinguish conformers.
  2. Draw and interpret Newman projection formulas.
  3. Recognize axial and equatorial groups; discuss conformations of cycloalkanes and steric strain.
  4. Discuss the origin of chirality in organic molecules and the relationship of stereoisomers.
  5. Discuss how optical activity is observed with a polarimeter, and explain the structural information it can provide.
  6. Calculate the specific rotation of a substance from experimental data.
  7. Use sequence rules to specify configuration of stereogenic centers.
  8. Recognize and discuss the relationships of diastereomers and meso compounds.
  9. Discuss the relationship of multiple stereogenic centers to the number of possible stereoisomers.
  10. Describe the composition of racemic mixtures.
  11. Distinguish types of isomers and the similarities and differences in their physical properties.
  12. Draw and interpret Fischer projection formulas.
  13. Discuss the consequences of chirality on the outcome of organic reactions.
  14. Describe the experimental evidence for inversion of configuration in nucleophilic substitution.
  15. Describe the kinetics, characteristics, and stereochemistry of nucleophilic substitution ( $S_N1$  and  $S_N2$ ) reactions.
  16. Describe the kinetics, characteristics, and stereochemistry of elimination (E1 and E2) reactions.
7. Safely assemble and conduct effective organic reactions, separations, and product identifications; interpret infrared spectra.
  1. Describe the principles of absorption of infrared (IR) energy by chemical bonds.
  2. Describe the operation of an IR spectrometer.
  3. Use an IR spectrometer to obtain spectra of liquid and solid organic compounds.
  4. List the principal regions of the mid-IR and the types of information they provide.
  5. Use correlation charts and tables to interpret IR spectra and deduce functional groups and structural features.
  6. Accurately measure melting points and boiling points of organic compounds.
  7. Separate, isolate, purify, and identify the components of a mixture of organic compounds using recrystallization, distillation, extraction, column chromatography, and thin layer chromatography.
  8. Assemble and operate organic laboratory apparatus for performing simple reactions at room temperature and at reflux.
  9. Obtain infrared spectra of liquid and solid organic compounds.
  10. Use the secondary chemical literature to locate physical and chemical data for organic compounds.
  11. Observe and adhere to accepted good laboratory practices for working safely and maintaining conditions for high quality work in an organic laboratory.
8. Document laboratory observations and data in a laboratory notebook in accordance with accepted professional standards.
  1. Obtain and record laboratory observations and data in a laboratory notebook in accordance with accepted professional standards.
  2. Apply IUPAC nomenclature to organic compounds.
  3. Obtain data on the chemical and physical properties of substances using printed and online resources.

#### Evaluation Criteria/Policies:

Students must demonstrate proficiency on all CCPOs at a minimal 75 percent level to successfully complete the course. The grade will be determined using the Delaware Tech grading system:

|    |   |     |   |   |
|----|---|-----|---|---|
| 92 | - | 100 | = | A |
| 83 | - | 91  | = | B |
| 75 | - | 82  | = | C |
| 0  | - | 74  | = | F |

Students should refer to the [Student Handbook - https://www.dtcc.edu/handbook](https://www.dtcc.edu/handbook) for information on the Academic Standing Policy, the Academic Integrity Policy, Student Rights and Responsibilities, and other policies relevant to their academic progress.

#### Final Course Grade:

Calculated using the following weighted average

| Evaluation Measure                                   | Percentage of final grade |
|--|---------------------------|
| Summative: Tests (equally weighted)                  | 65%                       |
| Summative: Laboratory Experiments (equally weighted) | 30%                       |
| Formative:   | 5%                        |
| TOTAL  | 100%                      |

**Core Curriculum Competencies (CCCs are the competencies every graduate will develop):**

1. Apply clear and effective communication skills.
2. Use critical thinking to solve problems.
3. Collaborate to achieve a common goal.
4. Demonstrate professional and ethical conduct.
5. Use information literacy for effective vocational and/or academic research.
6. Apply quantitative reasoning and/or scientific inquiry to solve practical problems.

**Program Graduate Competencies (PGCs are the competencies every graduate will develop specific to his or her major):**

**Biological Sciences**

1. Apply knowledge of the theories and principles of biology and biotechnology.
2. Employ good laboratory practices (GLP) and safety guidelines to conduct common laboratory operations.
3. Employ standard laboratory documentation practices for data management and laboratory notebooks.
4. Utilize chemical principles and apply mathematics in the preparation of laboratory solutions.
5. Analyze samples by common quantitative and qualitative techniques.
6. Perform separation techniques on biological samples and interpret results.
7. Perform laboratory techniques used in microbiology, immunology and biotechnology.
8. Apply calculus to the solution of problems.
9. Demonstrate professional behavior and communications skills.

**Chemistry**

1. Apply knowledge of the theories and principles of chemistry.
2. Follow safety procedures.
3. Perform basic laboratory operations and techniques.
4. Keep a laboratory notebook following standard laboratory practices and present data in an organized written format.
5. Prepare common laboratory solutions.
6. Prepare and purify samples using common techniques.
7. Communicate in a professional manner.
8. Analyze samples by common qualitative and quantitative techniques.
9. Use and maintain common laboratory instruments and equipment.
10. Apply mathematical concepts to the solution of scientific problems.

**Chemistry Math Concentration**

1. Apply knowledge of the theories and principles of chemistry.
2. Follow safety procedures.
3. Perform basic laboratory operations and techniques.
4. Keep a laboratory notebook following standard laboratory practices and present data in an organized written format.
5. Prepare common laboratory solutions.
6. Prepare and purify samples using common techniques.
7. Communicate in a professional manner.
8. Analyze samples by common qualitative and quantitative techniques.
9. Use and maintain common laboratory instruments and equipment.
10. Apply differential and integral calculus in the solution of problems.

**Disabilities Support Statement:**

The College is committed to providing reasonable accommodations for students with disabilities. Students are encouraged to schedule an appointment with the campus Disabilities Support Counselor to request an accommodation needed due to a disability. A listing of campus Disabilities Support Counselors and contact information can be found at the [disabilities services - https://www.dtcc.edu/disabilitysupport](https://www.dtcc.edu/disabilitysupport) web page or visit the campus Advising Center.