Miami Dade College

Course Description

CHM2210 | Organic Chemistry 1 | 3.00 credits

In Organic Chemistry 1, students will learn about aliphatic hydrocarbons and their derivatives. Lectures are supplemented by laboratory preparation of representative compounds. Prerequisite: CHM1046 and CHM1046L; Corequisite: CHM2210L.

Course Competencies:

Competency 1: The student will demonstrate knowledge of the association between the structure, bonding, reactivity, and stability of organic molecules by:

1. Drawing condensed structural formulas, bond-line formulas, perspective drawings, Newman projections, Fischer projections, Kekulé structures, and Lewis structures of organic molecules
2. Applying the principles of Valence Shell Electron Pair Repulsion (VSEPR)Theory to ascertain the molecular geometry and bond angles of complex organic molecules
3. Applying the principles of the Valence Bond Model to ascertain the hybridization of atoms involved in bonding and to describe sigma and pi bonding
4. Applying the principles of Molecular Orbital (MO) Theory to construct MO diagrams, identify bonding mos, anti-bonding mos, the Highest Occupied Molecular Orbital (HOMO), the Lowest Unoccupied Molecular Orbital (LUMO), nodal planes, and the relationship that exists between molecular stability and reactivity
5. Using curved arrows to interconvert between resonance contributors
6. Distinguishing between equivalent, major, and minor resonance contributors
7. Evaluating the relative contribution that various resonance structures provide to the resonance hybrid
8. Discussing the relationship between structure and acidity, basicity, nucleophilicity, and electrophilicity
9. Interpreting Maps of Electrostatic Potential (MEPs) to discern sites of nucleophilicity and electrophilicity
10. Assessing whether substances are constitutional isomers, conformers, stereoisomers, enantiomers, diastereomers, resonance structures, identical or unrelated
11. Predicting the relative stability of alkane and substituted alkane conformers, substituted cyclohexane conformers, cycloalkanes, alkenes, dienes, polyenes, carbocations and free radicals

Competency 2: The student will demonstrate knowledge of the classification, composition, and behavior of families of carbon compounds by:

1. Detecting to which functional group(s) an organic compound belongs
2. Designating the intermolecular force(s) present in organic molecules
3. Discussing the relationship that exists between the chemical and physical properties of families of carbon compounds and their composition
4. Predicting relative physical properties such as boiling point, melting point, water solubility, and molecular polarity of families of carbon compounds
5. Drawing specified types of constitutional isomers, conformers, and stereoisomers within families of carbon compounds
6. Assessing whether a specified family of carbon compounds can behave as a bronsted-lowry acid, bronsted-lowry base, Lewis acid, Lewis base, nucleophile, and electrophile
7. Predicting the relative acid strength, pk a, and base strength of families of carbon compounds.

Competency 3: The student will demonstrate knowledge of using the International Union of Pure and Applied Chemistry (IUPAC) rules for nomenclature by:

1. Naming alkanes, alkyl halides, alkenes, alkynes, alcohols, ethers, and epoxides when a condensed structural formula, bond-line formula, Fischer projection, or a Lewis structure is provided
2. Drawing the structure of alkanes, alkyl halides, alkenes, alkynes, alcohols, ethers, and epoxides when a substance's IUPAC name and, in some instances, when its common name is provided
3. Naming stereoisomers written as perspective drawings, Newman projections, or Fischer projections
4. Drawing the structure of stereoisomers as perspective drawings, Newman projections, or Fischer projections when its IUPAC name is provided.

Competency 4: The student will demonstrate knowledge of the spatial arrangement, properties, and reactivity of stereoisomers by:

1. Outlining the molecular attributes that generate chirality, stereoisomers, enantiomers, diastereomers, meso compounds, optical activity, and racemic mixtures
2. Describing the relationship that exists between the optical rotation and specific rotation of chiral substances, achiral substances, and racemic mixtures
3. Applying the cahn-ingold-prelog rules to assign a stereochemical configuration to perspective drawings, Newman projections, and Fischer projections
4. Ascertaining the geometric configuration (cis or trans and e or z) of disubstituted cycloalkanes and alkenes having at least two stereocenters
5. Predicting the maximum number of stereoisomers in a compound.
6. Predicting the stereochemical outcome of stereospecific reactions involving alkyl halides, alkenes, alkynes, alcohols, ethers, and epoxides.

Competency 5: The student will demonstrate an extension of their knowledge of thermodynamic chemical principles by:

1. Predicting the stability of compounds such as cycloalkanes, alkenes, and free radicals by examining thermodynamic data.
2. Predicting the relative magnitude of the equilibrium constant (K) and standard free-energy (ÄG) of acid-base reactions.
3. Evaluating potential energy diagrams to determine the relative energy of reactants and products and to establish whether a reaction is endothermic, exothermic, endergonic, or exergonic.
4. Evaluating potential energy diagrams to determine the relative stability of conformers.
5. Justifying the observed product distribution in thermodynamically controlled addition reactions involving dienes and polyenes.

Competency 6: The student will demonstrate knowledge of kinetic chemical principles by:

1. Evaluating potential energy diagrams of substitution (SN1 and SN2) and elimination (E1 and E2) reactions to point out the number of mechanical steps involved in a reaction and their energy of activation, which are fast steps and which is the rate-determining step, and where along the reaction coordinate the location of transition states and reaction intermediates are found.
2. Predicting the molecularity for the most predominant mechanistic pathway that substitution (SN1 and SN2) and elimination (E1 and E2) reactions are expected to take depending on existing reaction conditions (e.g., substrate identity, nucleophile/base identity, leaving group identity, solvent identity and temperature.
3. Writing the rate law for the most predominant mechanistic pathway that substitution (SN1 and SN2) and elimination (E1 and E2) reactions are expected to take depending on existing reaction conditions (e.g., substrate identity, nucleophile/base identity, leaving group identity, solvent identity, and temperature).
4. Predicting the change in rate and product distribution of substitution (SN1 and SN2) and elimination (E1 and E2) reactions resulting from reaction condition manipulations, such as changing the solvent concentration, nucleophile/base concentration, solvent polarity/dielectric constant or temperature.
5. Constructing potential energy diagrams of substitution reactions (SN1 and SN2), elimination reactions (E1 and E2) and 1,2 and 1,4 addition reactions to dienes.
6. Predicting the relative reaction rate of substitution (SN1 and SN2) and elimination (E1 and E2) reactions depending on existing reaction conditions (e.g., substrate identity, nucleophile/base identity, leaving group identity, solvent identity, and temperature).
7. Predicting the relative reaction rate of free-radical halogenation reactions of alkanes depending on existing reaction conditions (e.g., substrate identity and identity of halogen).
8. Justifying the observed product distribution in kinetically controlled addition reactions involving dienes and polyenes.

Competency 7: The student will demonstrate knowledge of the types of reactions that classes of organic compounds undergo by:

1. Predicting the molecular outcome of combustion reactions
2. Predicting the outcome of Brønsted-Lowry and Lewis acid-base reactions
3. Predicting the molecular outcome of the oxidative cleavage of alkenes and alkynes
4. Predicting the molecular and stereochemical outcome of the catalytic reduction of alkenes and alkynes with hydrogen.
5. Predicting the molecular and stereochemical outcome of dissolving metal reduction reactions of alkynes.
6. Predicting the molecular and stereochemical outcome of substitution reactions of alkyl halides, alkyl sulfonates, and alcohols.
7. Predicting the molecular and regiochemical outcome of free-radical halogenation reactions of alkanes and free-radical allylic substitution reactions
8. Predicting the molecular, stereochemical, and regiochemical outcome of elimination reactions of alkyl halides, alkyl sulfonates, and alcohols
9. Predicting the molecular, stereochemical, and regiochemical outcome of addition reactions of alkenes and alkynes.
10. Predicting the molecular, stereochemical, and regiochemical outcome of ring-opening reactions involving epoxides.
11. Predicting the molecular, stereochemical, and regiochemical outcome of simple addition, conjugate addition, and Diels-Alder reactions involving dienes

Competency 8: The student will demonstrate knowledge of using curved arrows to establish the process, stereochemistry, and radiochemistry by which organic reactions occur by:

1. Illustrating the mechanism involved in acid based reactions.
2. Illustrating the mechanism involved in additional reactions of halogens to alkenes.
3. Illustrating the mechanism involved in Markovnikov and Anti-Markovnikov addition reactions.
4. Illustrating the mechanism involved in free-radical substitution reactions of alkanes.
5. Illustrating the mechanism involved in free radical allylic substitution reactions.
6. Illustrating the mechanism involved in SN2 reactions, SN1 reactions, E1 reactions and E2 reactions of alkyl halides.
7. Illustrating the mechanism involved in Diels-Alder reactions.
8. Illustrating the mechanism involved in reactions involving carbocation rearrangement.

Competency 9: The student will demonstrate knowledge of organic synthesis by:

1. Producing plausible reaction sequences to prepare and transform hydrocarbons such as alkanes, alkenes, and alkynes from appropriate starting materials.
2. Producing plausible reaction sequences to prepare and transform alkyl halides from appropriate starting materials.
3. Producing plausible reaction sequences to prepare and transform alcohols from appropriate starting materials.
4. Producing plausible reaction sequences to prepare and transform ethers from appropriate
5. Starting materials.
6. Producing plausible reaction sequences to prepare and transform epoxides from appropriate starting materials.

<u>**Learning Outcomes:**</u>

- Communicate effectively using listening, speaking, reading, and writing skills
- Use quantitative analytical skills to evaluate and process numerical data
- Formulate strategies to locate, evaluate, and apply information