Douglas College

EFFECTIVE: SEPTEMBER 2003

CURRICULUM GUIDELINES

A: Division:	**Instructional**	Date:	**15 June 2002**
B: Department/ Program Area:	**Science and Technology**	New Course [ ]	Revision [X]
		If Revision, Section(s) Revised:	**D, F, G, H, N, O, P, Q**
		Date Last Revised:	**June 1980**

C:	**D:**	**E:**
CHEM 321	**Organic Chemistry - Part I**	**5**
Subject & Course No.	Descriptive Title	Semester Credits

F: Calendar Description: This is part one of a comprehensive second year organic chemistry course suitable for those majoring in chemistry/biochemistry or continuing on with studies in the Health Sciences. It begins with a brief review of the theories of bonding and molecular geometry and follows with nomenclature, reactions of alkanes, cycloalkanes, alkynes, organic halides, aromatics and alcohols. Reactions are approached from a mechanistic point of view with an emphasis on underlying reactivity. A significant amount of time will be spent on stereochemistry, conformational analysis, strain in organic chemistry, I.R. and U.V. spectroscopies.

G: Allocation of Contact Hours to Types of Instruction/Learning Settings:

Primary Methods of Instructional Delivery and/or Learning Settings:

Lecture/Laboratory

Number of Contact Hours: (per week / semester for each descriptor)

4 hours lecture
3 hours laboratory

Number of Weeks per Semester:
14

H: Course Prerequisites: CHEM 110 (C or better)

I. Course Corequisites:

J. Course for which this Course is a Prerequisite: CHEM 421

K. Maximum Class Size: 36

L: PLEASE INDICATE:

[ ] Non-Credit

[ ] College Credit Non-Transfer

[X] College Credit Transfer: Requested [ ] Granted [X]

SEE BC TRANSFER GUIDE FOR TRANSFER DETAILS (www.bccat.bc.ca)

UBC.	203+204 (with CHEM 421)
SFU	SFU CHEM 281 (4) & SFU CHEM (1)
U.Vic	UVIC CHEM 231 (1.5)

M: Course Objectives/Learning Outcomes: The student will be able to:

1. given the formula of an organic compound, give the IUPAC name, or the common name, if one exists.
2. given the formula of an organic compound, draw diagrams of all possible isomers, and describe each type of isomer.
3. be able to name and identify the common functional groups.
4. given the formulas of two compounds, list the types of intermolecular forces that apply to each molecule, and predict which will have the higher boiling point, or heat of vaporization.
5. given the structure of an organic compound and the type of functional groups present, be able to predict the relative acidity (pKa) or basicity (pKb).
6. be able to draw the lowest and highest energy conformations of alkanes via Newman projections and cyclohexanes in 3D indicating axial and equatorial bonds and 1,3-diaxial interactions
7. given an compound with a stereogenic centre, be able to identify it using the R/S system of nomenclature and for isomers with more than one stereocentre be able to draw the Fischer projection and identify if the isomer will exist as a meso compound or an enantiomeric pair.
8. define terms and give examples of reactions that are stereoselective, stereospecific, regioselective, or under thermodynamic or kinetic control.
9. be able to define and give examples of the types of ring strain found in cyclopropane through to cycloheptane.
10. be able to provide the mechanism of either an S_N1 or S_N2 substitution reaction indicating the structures of all transition states and intermediates including the stereochemical outcome of the reaction.
11. be able to provide the mechanism of either an E1 or E2 elimination reaction indicating the structures of all transition states and intermediates including dehydration reactions of alcohols.
12. given the formulas of the substrates and reagents be able to predict the major product of the reaction including competition between elimination and substitution, oxidations of alcohols and aldehydes, catalytic hydrogenation, hydration of alkenes, ring opening of epoxides, radical halogenation of alkanes, radical polymerization of alkenes.
13. given a list of carbocations, be able to rank their relative stabilities including the resonance stabilized allylic and benzylic carbocations.
14. given a list of radical species, be able to predict the relative stability.
15. given the structure of a desired synthetic target, and a list of allowed starting materials, be able to retrosynthetically design a synthesis of the target compound using reactions learned throughout the course.

N: Course Content

Chemical Bonding - Review: Importance of carbon in organic chemistry. Types of chemical bonds - ionic, covalent, polar covalent, metallic. Covalent Bonding Theories - Lewis, VSEPR, Valence Bond, Molecular Orbital Theory.
Isomerism and Functional Group Overview - Review: Representation of structural formulas. Isomerism - definition, types, nomenclature. General formulas, physical properties, nomenclature and representative reactions for the following types of compounds - Hydrocarbons, Alkenes, Alkynes, Akyl Halides, Alcohols, Ethers, Amines, Aldehydes, Ketones, Carboxylic Acids, Amides and Esters.
Acids and Bases in Organic Chemistry: Bronsted/Lowry and Lewis Acid/Base theories - background, definitions, examples, and identification of common acids and bases. Use of curved arrows in Organic Chemistry and reaction mechanisms.
Alkanes and Cycloalkanes - Conformational Analysis: Newman projections - conformations of ethane, butane, and potential energy diagrams. Relative stabilities of cycloalkanes and ring strain. Banana bonds in cyclopropane, conformations of cylobutane and cyclohexane. Chair and boat forms of cyclohexane. Conformational analysis of substituted cyclohexanes. Reduction of alkyl halides and lithium diakylcuprates.
Optical Isomerism: Concept of chirality - examples and test for. Enantiomers and diastereomers - definition, differences in physical and chemical properties. Cahn - Ingold - Prelog R-S system of naming chiral centers. Optical activity - methods of determination, theory, specific rotation, optical purity. Fischer projection formulas.
Nucleophilic Substitution Reactions and Reaction Kinetics : Differences between radical and ionic reactions. Definition of nucleophilicity and electrophilicity. Reaction Kinetics – thermodynamic vs. kinetic control, transition states, collision theory, rate determining steps, endergonic and exergonic reactions. S_N2 reactions – mechanism, transition state, stereochemical outcomes, reaction kinetics. S_N1 reactions – mechanism, carbocation stability, stereochemical outcomes, kinetics. Factors affecting rates of S_N1 and S_N2 reactions – substrates, nucleophiles, concentrations, temperature, solvent type.
Radical Reactions: Formation, stability and reactions characteristic of radicals. Hammond – Leffler postulate.
Alkenes and Alkynes – Nomenclature and Synthesis: (E) – (Z) system for designating alkene diastereomers. Hydrogenation of alkenes and alkynes. Alkene stability. Elimination reactions and alkene synthesis. E1, E2 reactions – mechanisms, transition states, reaction kinetics, Zaitsev's rule, stereochemical implications. Dehydrohalogenation, dehydration of alcohols, molecular rearrangements.
Alkenes and Alkynes – Addition reactions: Energetics and mechanism of ionic addition reactions. Regioselective and regiospecific reactions and Markovnikov's rule. Radical addition of hydrogen bromide. Radical polymerization of alkenes. Oxidation of alkenes.
Alcohols and Ethers: Nomenclature, physical properties, synthesis (via hydration of alkenes, oxymercuration-demercuration, hydroboration). Conversion of alcohols into mesylates, tosylates and alkyl halides. Synthesis of ethers via the Williamson ether synthesis. Reactions of ethers and epoxides including ring opening reactions of epoxides.
Introduction to Carbonyl Compounds and Spectroscopy: Oxidation and Reduction reactions in organic chemistry. Oxidation reactions of alcohols, alkenes, aldehydes. Reduction of carbonyl compounds. Grignard reaction. U.V. and I.R. spectroscopy – theory and spectra interpretation.

Laboratory Content

The following laboratory experiments will be selected from the following list and performed during the lab period:

1. Lab Introduction: Simple and Fractional Distillation of an Acetone/Water Mixture
2. Melting Point Determination
3. Extraction: Separation of a Three Component System (Two Weeks)
4. Purification of Solid Compounds: Recrystallization and Sublimation
5. Isolation of Eugenol and Eugenol Acetate from Oil of Cloves (Three Weeks)
6. UV/Vis Spectroscopy: Spectrum of Suntan Lotion
7. Thin Layer Chromatography: Separation of Alkaloids From Tobacco
8. Practical Lab Exam

O: Methods of Instruction

The course will be presented using lectures, problem sessions and class discussion. Films and other audio-visual aids as well as programmed material will be used where appropriate. Problems will be assigned on a regular basis, to be handed in and evaluated. The laboratory course will be used to illustrate the practical aspects of the course material. Close coordination will be maintained between laboratory and classroom work whenever possible. This will be accomplished by discussing laboratory experiments in class and, when necessary, by using the lab period for problem solving.

P: Textbooks and Materials to be Purchased by Students

Bruice, Paula Yurkanis, *Organic Chemistry* 3rd Edition, Prentice Hall, 2001.
Molecular Model Kit, HGS
Douglas College, *Chemistry 321 Laboratory Manual*

Q: Means of Assessment

The final grade assigned for the course will be based upon the following components:

1. **Lecture Material (70%)**
   a) Two or three-in class tests will be given during the semester (30%)
   b) A final exam covering the entire semester's work will be given during the final examination period (30%)
   c) Any or all of the following evaluations, at the discretion of the instructor: problem assignments, quizzes, class participation [5% maximum] (10% in total)

2. **Laboratory (30%)**
   a) Written reports and pre-labs will be collected for each experiment and will be graded. These reports will be complete reports, to be handed in the laboratory notebook. In addition, some written quizzes based on laboratory material will be evaluated (15%)
   b) Qualitative/Quantitative results of experiments performed on unknown samples will be graded (5%).
   c) Final Lab Exam - Practical (5%), - Written (5%).

R: Prior Learning Assessment and Recognition: specify whether course is open for PLAR

NO

Course Designer(s)

Education Council/Curriculum Committee Representative

Dean/Director

Registrar