Lakeside View Global Vision
CEGEP JOHN ABBOTT COLLEGE

John Abbott Science Program 200.BO

Organic Chemistry II

A. General information:

Program:	Science	Office:	
Course Number:	202-DDB-05	Telephone:	
Ponderation:	3-2-3	E-mail:	
Credits:	2 2/3	Lab (3 hours):	
Competency code:	00UV,OOUU, OOXU	Lecture:	
Prerequisite:	202-DCP-05	Classroom:	
Semester:		Laboratory room:	
Instructor:		Office Hours:	

B. **Introduction:**

Organic Chemistry II is a Science Option course which is normally taken in the fourth semester. The course is taught at University level because students passing the course are allowed to enter Organic III in Quebec Universities. The course offers the student a chance to master the skills introduced in 202-DCP-05 (Organic I). Emphasis is placed on the same essential areas:

(1) Nomenclature and Stereochemistry
(2) Mechanisms of Organic Reactions
(3) Theoretical Explanations of Experimental Results
(4) Synthetic Design
(5) Instrumental Analysis (M.S., UV/Vis, I.R. and N.M.R.). Spectroscopic identification of unknowns is emphasized in the initial part of the course.
(6) The chemistry of carbonyl compounds is studied extensively as well as the chemistry of alcohols, ethers, epoxides and amines.
(7) Application of reactions in multistep synthesis is emphasized.
(8) As in 202-DCP-05 laboratory work is emphasised.

PRESENTATION of ORGANIC 2 with a Biological and Pharmacological Emphasis:

For most synthetic reaction done in a lab (outside the human body) a biochemical parallel will be presented wherever possible:

- We will study some of the most important reactions involved in laboratory synthesis at the same time highlighting the conceptual similarities between laboratory and biological chemistry.
- One of the most fascinating aspects of studying enzyme –catalyzed organic chemistry is that we can apply the knowledge that we know in order to understand how an enzyme is able to overcome the natural limitations of reaction conditions.
- The Organic II curriculum will not be compromised.

The path to knowledge in this course:

- Reactivity Principles: The Organic Chemistry of Biology and Common Mechanisms in Biology
- Structure and Function: Peptides and Proteins
- Organic Chemistry in Action: Core Metabolic Processes - Lipids, Steroids, Glycolysis, Amino Acid Degradation
- Tools and Techniques for Chemical Biology NMR, MRI and Mass Spectrometry
- Organic Chemistry of Biological Pathways: Drugs and Diagnostics

Following mechanisms related to Biology/Biochemistry will be presented:

- Glycolysis(relevant chemistry mechanism; Keto-Enol Tautomerisation and Schiff's base Intermediaries)
- TCA cycle
- Cholesterol Biosynthesis(Isoprenes)
- Fatty Acid synthesis and Catabolism(Enolates)
- Amino Acid synthesis and Catabolism.

Comprehensive Assessment and Integration in the Science Program

The Ministry of Education requires every student to pass a program comprehensive assessment and a program integrating activity (Exit Profile Competency 14: "to apply what has been learned to new situations" and Ministry objective 00UU: "to apply acquired knowledge to one or more subjects in the sciences"). The Ministry introduced these requirements because it recognized the importance of connecting the various components within each program.

The various competencies to be addressed in the Science Program are outlined in the outcomes and standards of the Science Program Exit Profile and are listed below. They are divided into two groups: those competencies that are taught and assessed in virtually every course in the program, and those that will be the primary focus of the option courses

The following competencies are taught and assessed in most courses of the program:

3. To apply the scientific method.
4. To apply a systematic approach to problem solving.
5. To use appropriate data processing techniques.
6. To reason with rigour, i.e. with precision.
8. To learn in an autonomous manner.
13. To display attitudes and behaviour compatible with the scientific spirit and method.
14. To apply what has been learned to new situations.

The following competencies will be the special focus of the option courses of the program:

7. To communicate effectively.
9. To work as a member of a team.
10. To recognize the links between science, technology and the evolution of society.
11. To develop a personal system of values.
12. To put into context the emergence and development of scientific concepts.

Rather than impose a major exam or paper at the end of the Science Program, or requiring a single course to fulfill these requirements, John Abbott College has integrated the fulfillment of these requirements into the option courses taken late in the program. These courses have been designed so that *by passing any three option courses* a student will have met the above requirements of the program.

Note: **By passing the comprehensive assessment in 202-DCP-Organic 1, the student will be fulfilling half of the requirements set by the program.**

C. Objectives:Standards:

Statement of the Competency	**General Performance Criteria:**
To enhance the skills acquired in Organic Chemistry I (00XV)**.** **Elements of the Competency** 1. To apply the rules of nomenclature to all organic compounds. 2. To apply all chemistry learned in 202-DCP-05 to carbonyl compounds. 3. To be introduced to various mechanisms involving carbonyl groups and apply to real real-world chemistry 4. To theoretically conceive methods for synthesizing organic compounds on the basis of given products. 5. To understand the chemistry that are useful in biology and biochemistry: amines, carboxylic acids and their derivatives, lipids, amino acids, proteins, carbohydrates. 6. To synthesize, isolate and identify organic compounds 7. To identify organic molecules using instrumental techniques like NMR, IR and MS 8. Apply learned reactions towards multi-step syntheses **To apply acquired knowledge to one or more subjects in the sciences** (00UU). **Elements of the Competency** 1. To apply the experimental method. 2. To reason logically. 3. To communicate effectively. 4. To show evidence of independent learning in the choice of documentation or laboratory instruments. 5. To work as members of team.	• Use of the systematic and traditional nomenclature of organic compounds • Precision of the three-dimensional representation of organic molecules • Explanation of the influence of the main electronic effects on the principal types of reaction mechanisms • Analysis of nucleophilic addition, nucleophilic Acyl Substitutions placing emphasis on carbonyl chemistry • Justification of the mechanism proposed to explain a simple, newly encountered reaction • Ability to organize logically the principal reactions of the simple functional groups • Adherence to safety and environmental protection regulations • Capacity to establish connections between an experimental procedure and chemical theory • Quality of experimental design and practice • Quality of the laboratory report: presentation using a word processor, working hypotheses, coherence of the presentation, analysis and discussion of results, clarity and quality of language, bibliography • Use of an interdisciplinary approach • Application of acquired knowledge to new situations (00UV) **Specific Performance Criteria:** *Specific performance criteria for each of the elements of the competency are shown on pages 3-7, with the corresponding* **Intermediate Learning Objectives**. *For the items in the list of learning objectives on pages 3-7, it is understood that each is preceded by:* *'The student is expected to be able to….'*

D. Evaluation Plan:

Assessment	Ponderation*	Elementsof the Competency (cf. p. 3)	* Base ponderation. cf. following paragraphs for exceptions. The ponderation of individual laboratory experiments, quizzes and assignments are at the discretion of each teacher. Your teacher is responsible for letting you know ahead of time how much each one will be worth.
Unit Test 1 (6th week)	10%	(00XV)1,2,3	
Unit Test 2 (11th week)	10%	(00XV) 4,5	
Unit Test 3 (15th week)	10%	(00XV) 6,7	
Final Exam (TBA)	30%	(00XV)1,2,3,4,5,6,7	
Laboratory	20%	(00XV)8 (00UU)1, 2	
Comprehensive Assessment / Laboratory Project	10%	(00UU)1,2,3,4,5	
Quizzes/Assignments	10%	(00XV)1,2,3,4,5,6,7	

E. Course Content

Specific Performance Criteria	Intermediate Learning Objectives
1. Spectroscopic Identification	
1.1 Ultraviolet and Visible Spectroscopy (UV/Vis)	1.1.1. Introduction to chromophores, effects of conjugation on λ_{max}, Discussion of HOMO/LUMO. Effect of an auxochrome on observed spectra.
1.2 Mass Spectrometry (MS)	1.2.1. Understand how mass spectrometry can be used to determine the molecular mass of a compound 1.2.2. Understand how the relative intensities of the M, M+1 and M+2 peaks in a mass spectrum can be used to determine the formula of a compound. 1.2.3. Analyze fragmentation of small organic molecules. Identify key Fragments (radical/ion pairs) 1.2.4. Analyze isotopic patterns, notably Br and Cl. Rationalize M, M+2 peaks by understanding isotopic abundance 1.2.5. Introduce the nitrogen rule, understand effect on MS
1.3 Infrared Spectroscopy (IR)	1.3.1. Identify key regions of IR where organic molecules absorb 1.3.2. Identify functional groups by their respective absorbance; OH, C=O, C=C, C-H, C-O, N-H etc.
1.4 Nuclear Magnetic Resonance (NMR)	1.4.1. Understand basic theory of proton NMR including chemical shift, splitting, integration. 1.4.2. Identify equivalent/non-equivalent protons 1.4.3. Predict the appearance of signals (spin-spin couplings) 1.4.4. Recognize the appearance of, and conditions for distorted signals (exchangeable protons) 1.4.5. Given a compound, predict the proton NMR (chemical shift, splitting, integration) 1.4.6. Introduce ^{13}C-NMR as a complement to ^{1}H-NMR. 1.4.7. Use NMR in conjunction with other spectroscopic techniques To determine the structures of unknown organic compounds.

Elements of the Competency		**Specific Performance Criteria:**
2.	**Chemistry of Alcohols**	2.1.1. Synthesis of alcohols from alkenes, alkyl halides, Grignard reactions, reductions. 2.1.2. Use as starting materials in the synthesis of alkyl halides, alkoxides, sulfonates, tosylates and mesylates, and alcohol protection. 2.1.3. Use of PBr_3 and other reagents as alternatives in halide synthesis. 2.1.4. Re-introduce mechanism for dehydration 2.1.5. Oxidation of alcohols. Use of Chromium reagents, PCC etc.
3.	**Chemistry of Ethers and Epoxides**	3.2.1. Ester cleavage via substitution. 3.2.2. Peracid synthesis of epoxides via alkenes 3.2.3. Nucleophilic substitution reactions of ethers 3.2.4. Introduction to crown ethers 3.2.5. Formation of epoxides via halohydrin substitution (intramolecular) 3.2.6. Cleavage by acid or base. Examine selectivity.
4.	**Chemistry of Carbonyl Compounds**	
4.1	Addition Reaction	4.1.1. Write mechanism for the formation of hydrates, hemiacetals, hemiketals and cyanohydrins 4.1.2. Explain the kinetics and thermodynamics of an addition reaction. Relative reactivities of carbonyls. 4.1.3. Formation of cyclic hemiacetals/hemiketals in sugars 4.1.4. Acetals/ketals as protecting groups 4.1.5. Grignard Reagents 4.1.6. Synthetic sequences involving Grignard Strategy. 4.1.7. Additions to α,β-unsaturated carbonyls.
4.2	Addition/Elimination Reactions	4.2.1. Schiff's base formation. Mechanism and synthetic utility 4.2.2. Imine/enamine formation (mechanism) 4.2.3. Witting reaction (alkene formation). Explore mechanism, synthetic utility. 4.2.4. Ester hydrolysis, trans-esterification 4.2.5. Reactions of acyl halides/anhydrides with amines, alcohols, and other nucleophiles.
4.3	Enolate (enol) Formation	4.3.1. Mechanism for acid/base catalyzed keto/enol tautamerization 4.3.2. Acidity of the α-hydrogen, pKa. 4.3.3. Reactivity of enolate ions 4.3.4. HVZ reaction 4.3.5. Using LDA to for enolates 4.3.6. Alkylation of the α-carbon, enamines, Michael reaction 4.3.7. Aldol reactions, formation of β-hydroxy-carbonyls and α,β-unsaturated carbonyls. 4.3.8. Mixed Aldol addition 4.3.9. Claisen Condensation; Formation of β-keto-ester 4.3.10. Mixed Claisen 4.3.11. Diekmann Condensation 4.3.12. Intermolecular Aldol: Robinson Annulation 4.3.13. Decarboxylation of 3-oxocarboxylic acids 4.3.14. Malonic Ester synthesis 4.3.15. Acetoacetic ester synthesis

		Specific Performance Criteria:
		4.3.16. Using LDA to for enolates 4.3.17. Alkylation of the α-carbon, enamines, Michael reaction 4.3.18. Aldol reactions, formation of β-hydroxy-carbonyls and α,β-unsaturated carbonyls. 4.3.19. Mixed Aldol addition 4.3.20. Claisen Condensation; Formation of β-keto-ester 4.3.21. Mixed Claisen 4.3.22. Diekmann Condensation 4.3.23. Intermolecular Aldol: Robinson Annulation 4.3.24. Decarboxylation of 3-oxocarboxylic acids 4.3.25. Malonic Ester synthesis 4.3.26. Acetoacetic ester synthesis
		4.4.1. Synthesis of via oxidation, hydrolysis of nitriles, Grignard (with CO_2) and ozonolysis. 4.4.2. Reactions to form acyl halides, anhydrides, esters and amides.
5.	Chemistry of Amines	5.1.1. Properties of amines 5.1.2. Nomenclature 5.1.3. Hoffman elimination 5.1.4. Phase transfer catalysis 5.1.5. Synthesis via reduction of nitro, nitrile, amides, azides 5.1.6. Reductive amination (from imines/enamines) 5.1.7. Gabriel Synthesis 5.1.8. Reactions of diazonium salts. Application in aromatic chemistry 5.1.9. Mechanism for the formation of a benzene diazonium ion from aniline. 5.1.10. Employ diazonium salt in synthesis (replace N_2^+ by: H, I, OH, CN, Br, Cl, F)
6.	Carbohydrates and lipids	6.1.1. Fischer projection representation of various sugars 6.1.2. Nomenclature, D/L sugars 6.1.3. Synthesis: Killiani-Fischer synthesis, Wohl degradation 6.1.4. Lipid definition 6.1.5. Common fatty acids (properties and synthesis from glycerol)
7.	Amino Acids	7.1.1. Names of several common amino acids 7.1.2. pKa, zwitterions, most stable for at a given pH. 7.1.3. Synthesis: Strecker, Gabriel, HVZ.
8.	**Laboratory Work**	
8.1	Synthesis, isolation, and identification of organic compounds	8.1.1 Carry out various synthetic reactions. Isolate and identify the products 8.1.2. Identify an unknown compound through determination of its chemical and physical properties; Spectroscopic analysis.

Elements of the Competency		**Specific Performance Criteria:**	
9.	**Integration, Comprehensive assessment and exit profile.**		
9.1	Recognition of links among science, Technology and the evolution of society	9.1.1.	Discuss the implications of science and technology for the evolution of soci
9.2	Development of a personal system of values	9.2.1.	Develop an opinion on an issue and have the arguments to defend the posi
		9.2.2.	Display an awareness and understanding of the social and ethical implicatio scientific work.
9.3	Apply what is learned to new situations	9.3.1.	Understand the links between the emergence and development of scientifi concepts and advances in technology and society.
		9.3.2.	Integrate what has been learned and apply it to solving problems in new
		9.3.3.	Demonstrate and interpret links between chemistry and at least one other discipline.

F. Required Text and Material:

1. *Organic Chemistry with Students Solutions Manual*, 12th edition, T.W. Graham Solomons, Graig B. Fryhle, Scott A. Snyder, Wiley. (~ $175).(or any other college level text book)
2. A molecular model kit (~ $28).
3. Lab coat and safety glasses (~ $35).
4. The major course costs are specified above. However, an instructor may require the student to purchase additional materials, such as a laboratory notebook or course notes.

Laboratory Requirements:

1. A laboratory notebook. The instructor will give instructions concerning this notebook.
2. Safety glasses must be worn at all times in the laboratory. Good quality safety glasses are available from the bookstore or from most hardware stores (approx. $10-20).
3. A sturdy cotton lab coat is required (approx. $10-20).

G. Bibliography:

Determined by individual teacher.

H. Teaching Methods:

The course will be 75 hours, divided into Lecture and Laboratory periods; media, lectures/hand- outs posted on Lea:

Lectures: 45 hours
Two 1.5-hour lectures per week, consisting of the introduction of new material.

Laboratory: 30 hours
In Organic Chemistry II, the laboratory periods are 3 hours in length so the student will be in the laboratory for at least 10 periods. There will be tutorial or workshops but most of the weeks the student will perform experiments utilizing some of the standard techniques [recrystallization, reflux, distillation, extraction] and instrumentation [for melting point, infra-red, gas chromatography] of organic chemistry.

I. Departmental Policies:

Please Note:

a) A student may drop the lowest unit test mark, if it is lower than the final exam mark, so that the remaining unit tests are worth 20% of the final grade, and the final exam is worth 40% of the final grade. Please note that this arrangement is not available for a student who is assigned a grade of zero on a unit test because of cheating.

b) To pass the laboratory portion of the course, a minimum of 60% of the total laboratory grade must be obtained. Failing this, a laboratory grade of **zero** will be given and a maximum grade of 55 will be allowed for the course.

c) Notwithstanding other class grades, if a student passes the laboratory portion of the course, a grade of 60% or more on the final exam will guarantee a pass in the course.

d) Every effort will be made to ensure equivalence **amongst the various sections** of the course. Laboratory experiments are common to all sections, common policies are used with respect to replacement of term grades with final exam marks, the requirements of lab projects are reviewed by the course committee, the standard required to pass the course is that of the common text used, and the final exam is both agreed upon and graded by all members of the course committee.

Regulations:

a) Regular attendance is expected. If lectures are missed, it is the responsibility of the student to cover the material missed and to be aware of any announcements made concerning assignments, quizzes, tests or changes to the laboratory schedule.

b) Students must attend the laboratory session in which they are officially registered.

c) There will be no make-up tests, quizzes or laboratory periods. If you miss an evaluation session or deadline due to illness, you must notify your instructor as soon as possible. A valid medical note is required to prove absence for a medical reason. If a test is missed for a valid reason, then the final exam mark will be used as a basis for a substitute for the missed test mark. Late homework policy will be determined by individual teacher.

d) Periodically there will be workshops held during the laboratory period. Attendance is required. Quizzes or assignments may be given during these workshops.

e) **A special note concerning the use of chemicals:** this course uses chemicals as part of its normal teaching practices. If a student has experienced allergic reactions in the past due to any particular chemical or chemicals he or she must inform the instructor. In the event that an allergic reaction is experienced at the college, the student should report to Campus Security immediately (local 5226, 5231, or 9-514-398-7777).

f) Cell phones and computers may only be used during class for pedagogical purposes.

g) Students are expected to behave respectfully towards their classmates and teachers. In case of inappropriate behavior a student will be asked to leave the class or the lab session. If an assessment is planned for this session, a mark of zero will be given in that case.

J. College Policies:

Policy No. 7 – IPESA, Institutional Policy on the Evaluation of Student Achievement: http://johnabbott.qc.ca/ipesa

a. **Changes to Evaluation Plan in Course Outline** (Article 5.3)
Changes require documented unanimous consent from regularly attending students and approval by the department and the program dean.

b. **Religious Holidays** (Article 3.2.13 and 4.1.6)
Students who wish to miss classes in order to observe religious holidays must inform their teacher of their intent in writing within the first two weeks of the semester.

c. **Student Rights and Responsibilities:** (Article 3.2.18)
It is the responsibility of students to keep all assessed material returned to them and/or all digital work submitted to the teacher in the event of a grade review. (The deadline for a Grade Review is 4 weeks after the start of the next regular semester.)
(Article 3.3.6)
Students have the right to receive graded evaluations, for regular day division courses, within two weeks after the due date or exam/test date, except in extenuating circumstances. A maximum of three (3) weeks may apply in certain circumstances (ex. major essays) if approved by the department and stated on the course outline. For evaluations at the end of the semester/course, the results must be given to the student by the grade submission deadline (see current Academic Calendar). For intensive courses (i.e.: intersession, abridged courses) and AEC courses, timely feedback must be adjusted accordingly;

d. **Academic Procedure: Academic Integrity, Cheating and Plagiarism** (Article 9.1 and 9.2)
Cheating and plagiarism are unacceptable at John Abbott College. They represent infractions against academic integrity. Students are expected to conduct themselves accordingly and must be responsible for all of their actions.

- **College definition of Cheating:**

Cheating means any dishonest or deceptive practice relative to examinations, tests, quizzes, lab assignments, research papers or other forms of evaluation tasks. Cheating includes, but is not restricted to, making use of or being in possession of unauthorized material or devices and/or obtaining or providing unauthorized assistance in writing examinations, papers or any other evaluation task and submitting the same work in more than one course without the teacher's permission. It is

incumbent upon the department through the teacher to ensure students are forewarned about unauthorized material, devices or practices that are not permitted.

- **College definition of Plagiarism:**

Plagiarism is a form of cheating. It includes copying or paraphrasing (expressing the ideas of someone else in one's own words), of another person's work or the use of another person's work or ideas without acknowledgement of its source. Plagiarism can be from any source including books, magazines, electronic or photographic media or another student's paper or work.