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CEGEP JOHN ABBOTT COLLEGE

JOHN ABBOTT COLLEGE

SCIENCE PROGRAM 200.BO

Organic Chemistry II

Discipline: **Chemistry**
Course Code: **202-DDB-05**
Objectives: **OOUV, OOUU, OOXV**
Ponderation: **3-2-3**
Prerequisite: **202-DCP-05**
Credits: **2.67**
Day and Time:
Lecture:
Lab:

Semester: **Winter 2015**
Instructor:
Office:
Telephone:
Office Hours:

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.

Hence Organic 2 is presented with a BIOLOGICAL EMPHASIS.
Most importantly, for every synthetic reaction done in a lab (outside the human body) a biochemical parallel will be presented wherever possible.

- The most interesting and relevant context especially when we are taking Biology II
- We will study some of the most reactions of laboratory synthesis in order to highlight 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.

Will this be a Biochemistry Course?

- Not at all! In Biochemistry, you will study biochemical pathways and recognize the connections between various pathways;
- Because of Organic Biochemistry, you will be able to recognize the mechanisms that make the pathways possible.
- In Biochemistry, you study the forest without studying the trees.
  In Organic Chemistry II, you study the trees!

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.

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 most option courses taken late in the program by means of a Comprehensive Assessment (CA) component. It is the student's responsibility to enrol in courses that will lead to the completion of the CA.

Most option courses in the Science program at JAC offer the opportunity to complete at least part of the Comprehensive Assessment. Unless otherwise noted, (see exceptions below) passing the Comprehensive Assessment in any one of these courses will fulfill the CA requirements for obtaining a Science DEC at JAC.

There are three exceptions: Organic Chemistry I (202-DCP-05), Organic Chemistry II (202-DDB-05) and General Biology II (101-DCN-05). Passing the Comprehensive Assessment component in one of these courses will be insufficient for obtaining a DEC; the student will also need to pass the Comprehensive Assessment in any other option Science course, including the other two already listed. For example passing the Comprehensive Assessment in both Organic Chemistry I and General Biology II will be sufficient; so will completing it in Organic Chemistry I and Physics for Engineers.

The various competencies to be addressed in the Science Program are outlined in the outcomes and standards of the Science Program Exit Profile. The following competencies will be explicitly assessed in this course's Comprehensive Assessment:

7. to communicate effectively.
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.

Statement of the Competency

To enhance the skills acquired in Organic Chemistry I (00XV)**.**

Elements of the Competency

1. To review all elements of objective 00XV
2. To apply all chemistry learned in 202-DCP-05 to carbonyl compounds.
3. To synthesize, isolate and identify organic compounds

Elements of the Competency

1. Spectroscopic Identification

1.1 Ultraviolet and Visible Spectroscopy (UV/Vis)

1.2 Mass Spectrometry (MS)

1.3 Infrared Spectroscopy (IR)

1.4 Nuclear Magnetic Resonance (NMR)

General Performance Criteria:

- Use spectroscopic techniques to identify key structural features (structure determination)
- Carbonyl chemistry will be emphasized
- Apply learned reactions towards multi-step syntheses
- Nomenclature, mechanisms and stereochemistry of new reactions
- Application of acquired knowledge to new situations(00UV)

Specific Performance Criteria:

Specific performance criteria for each of the elements of the competency are shown below, with the corresponding **Intermediate Learning Objectives**. *For the items in the list of learning objectives, it is understood that each is preceded by:*

'The student is expected to be able to….'

Specific Performance Criteria:

1.1.1. Introduction to chromophores, effects of conjugation on λ_{max}, discussion of HOMO/LUMO. Effect of an auxochrome on observed spectra.

1.2.1. 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

1.3.1. 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.

1.4.1. 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 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

Elements of the Competency		**Specific Performance Criteria:**
(4.3 con't)		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
4.4	Carboxylic acids and derivatives	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**	8.1.1. Carry out various synthetic reactions. Isolate and identify the products
8.1	Synthesis, isolation, and identification of organic compounds	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 society.
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 position.
		9.2.2.	Display an awareness and understanding of the social and ethical implications of scientific work.
9.3	Apply what is learned to new situations	9.3.1.	Understand the links between the emergence and development of sc concepts and advances in technology and society.
		9.3.2.	Integrate what has been learned and apply it to solving problems in situations
		9.3.3.	Demonstrate and interpret links between chemistry and at least one science discipline.

Course Information

Methodology

The course will be 75 hours, divided into Lecture and Laboratory periods as follows:

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. There may be the occasional tutorial or workshop but most of the weeks the student will perform experiments utilizing some of the standard techniques (recrystallization, reflux, distillation, extraction) and instrumentation (melting point, infra-red, gas chromatography, refractive index) of organic chemistry.

Bibliography

Recommended Material:

1. Organic Chemistry, 7th edition, P.Y. Bruice, Prentice Hall, New Jersey, 2014
2. A molecular model kit (approx. $25).

Laboratory Requirement

1. A laboratory notebook. Instructions concerning this notebook can be found in the Student Guide.
2. *Safety glasses must be worn at all times in the laboratory*. Good quality safety glasses are available from the bookstore or most hardware stores (approx.$10-20) Normal prescription glasses may be worn but *for safety reasons the use of contact lenses is not permitted.*
3. A lab coat is required (approx,$10)

Evaluation:

(See attached schedule for tentative evaluation dates)

Unit tests (3 tests of equal value)	30%
Final Examination	30%*
Laboratory	25%
Comprehensive Assessment	10%
Assignments (3)	5%

*Note: Current replacement policy
If the final exam mark is greater than one or more of the unit test marks, the final exam mark will replace the LOWEST of the unit test marks in the calculation of the course grade. In this case the final exam mark would be worth 40% of the total grade.

Please Note:

a) 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.

b) 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.

c) 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 comprehensive assessment modules 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 set and graded by all members of the course committee.

Course Costs:

The major course costs are specified above. However, an instructor may require the student to purchase additional materials, such as a laboratory notebook (approx. $10-20) or course notes (approx. $10).

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

e) All assigned work is to be submitted on time. Late submission may be accepted, with or without penalty, at the discretion of individual instructors.

f) 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.

g) **Cell-phones, laptops and other technology:** Use of personal cell phones and/or computers and/or other electronic devices are not permitted in the classroom or laboratory unless approved by the instructor.

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

i) Safety glasses must be worn during all "wet-labs".

j) Changes to the evaluation plan, during the semester, require unanimous consent.

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 **(loc. 5226-5231 or 9-514-398-7770)**.

College Policies

1. Cheating and Plagiarism: Cheating and plagiarism are serious offences. Students must be aware of the College policy on cheating and plagiarism as presented in the Institutional Policy on the Evaluation of Student Achievement (IPESA). A copy of the IPESA is reprinted in the College Calendar as well as in the Student Agenda

Cheating and plagiarism are serious infractions against academic integrity which is highly valued at the College; they are unacceptable at John Abbott College.

- 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.

- PLAGIARISM is a form of cheating. It includes the intentional 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.

  It is the responsibility of teachers to show students (especially first semester students) how to paraphrase and cite and allow them to practice this skill;

Please refer to (College Website): (About the college/Academic Administration/Academic Policies & Procedures/Cheating and Plagiarism.)

2. Student Academic Rights and Responsibilities: Students should be aware of their rights and responsibilities. For more information please consult your copy of the IPESA.

3. Note: It is the responsibility of students to keep all assessed material for at least one month past the grade review deadline in the event that they want to request a grade review. Students can learn more about their rights and responsibilities by reading the IPESA.

4. Students must inform their instructor, in advance, of anticipated absences, including ***religious holidays***. Students who wish to observe religious holidays must inform their teacher of their intent, in writing, within the first two weeks of the semester.

5. Mid-semester Assessment: All students will receive a mid-semester assessment, to give them some idea of how they are progressing in the course. This assessment has no percentage value in calculating the final grade.