Synthetic Organic Chemistry – Syllabus

Course: SC/CHEM 4021, SC/CHEM 5050 **Course Webpage**: none

Term: Fall Term 2015

Prerequisite / Co-requisite: SC/CHEM 3021 or permission from the course director

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Course Instructor

Arturo (Art) Orellana
(416) 736 2100 x 70760
Chemistry 440
aorellan@yorku.ca

Office hours: Tuesdays and Thursdays 4:00 - 5:00 or by appointment

Time and Location

Lectures	Tuesdays and Thursdays 5:30-7:00
Location	LSB 107

Expanded Course Description

Course Description. This course is designed to introduce students to the science of complex molecule synthesis. The course includes a brief introduction to retrosynthetic analysis, practical issues in synthesis, and selectivity issues. The bulk of the course will consist of a survey of some important classes of reactions, with particular emphasis on mechanistic understanding and rationale for observed selectivity when appropriate. The strategic use of some reactions in complex molecule synthesis will be highlighted.

Course Objectives. The purpose of this course is to provide the student with an appreciation of the area of complex molecule synthesis and some tools to analyze and solve synthetic problems.
At the end of the course the student should:

i) Be able to identify important structural elements in a synthetic target.
ii) Be able to analyze the synthetic problem and provide a reasonable synthetic solution based on known (or reasonable) chemical transformations.
iii) Have a good knowledge of some important modern synthetic methods, including their mechanisms and stereochemical implications.

Learning Outcomes

1. Identify the structural components (functional groups, functional group relationships, stereochemical relationships) in a synthetic target (a complex organic molecule).
2. Understand the theory and terminology of retrosynthetic analysis. Apply retrosynthetic analysis to the target in order to devise a plan for its synthesis
3. Understand the fundamental principles leading to selectivity in organic reactions (e.g. kinetic vs. thermodynamic control, conformation effects, stereoelectronic effects).
4. Apply these concepts to achieve regioselectivity, chemoselectivity, diastereoselectivity and/or enantioselectivity in a synthetic sequence leading to a target molecule.
5. Implement a practical approach when developing a synthesis plan, taking into account the effects of step count, divergent vs. convergent synthesis, and optimization of yield.
6. Apply conformational analysis to synthetic planning, and appreciate the effect of conformation on the selectivity of reactions.
7. Appreciate the relative acidity of a range of functional groups (pKa values) and use these in the design of reactions.
8. Appreciate all the factors involved in the formation and alkylation of ketone enolates. These factors include i) relative acidities, ii) kinetic vs. thermodynamic control, iii) stereoelectronic effects of enolate formation and enolate alkylation, iv) models for enolate formation (Ireland model) and alkylation (Stevens model), v) medium effects (solvent/salt effects).
9. Understand and apply the concept of chiral auxiliary and use chiral auxiliaries in diastereoselective reactions used to prepare enantioenriched products.
10. Appreciate the different variations of the aldol reaction, and the variety of factors that affect the outcome of these reactions (e.g. enolate geometry, facial selectivity, etc). Understand the Zimmerman-Traxler model for aldol reactions and use it to predict relative configuration in aldol products.
11. Understand the fundamental principles underlying additions of nucleophiles to carbonyl groups (chelation effects, substrate effects, geometric requirements), the stereochemical models that arise from them (Felkin-Anh-Eisenstein, chelation controlled additions, directed additions), and apply these in the synthesis of complex molecules. These include alkylations (carbon based nucleophiles such as allyl metal reagents, and enolates) and reductions (hydride reagents).
12. Understand and apply the concept of protecting groups in synthesis. Understand the underlying reaction mechanism for installation and removal of a range of protecting groups.
13. Suggest reagents required for the oxidation of a variety of functional groups, specially alcohols. Understand the mechanism of a range of oxidation methods (DMSO-based oxidation, Metal oxide oxidations (Mn, Cr, Ru), hypervalent iodine oxidations, peroxide oxidations).
14. Suggest reagents required for the installation of double bonds in complex synthetic targets. Understand the underlying mechanism and stereochemical aspects of these reactions, and how these control the geometry of the double bond in the product.

Course Text / Readings

Tools and Textbooks. *The use of chemical model kits is strongly encouraged* as a study tool as you review, solve problems and write exams. Your ability to appreciate molecules as three-dimensional entities will greatly enhance your understanding of the material.
Problems and questions will be provided on a regular basis and will be briefly discussed in the following lecture.
Course notes will be provided in the form of PDF files as the course progresses. Although they are fairly comprehensive, there will be discussion that is not included in the notes. I **strongly** encourage you to print these notes before the lecture and have them with you during the class. The use of **laptop computers** during class is **strongly discouraged**. No textbook is required, however, the following texts have been placed on reserve at the Steacie Science library.

Advanced Organic Chemistry Part A 4th Edition
Carey and Sundberg (2000)
QD 251.2 C36 2000 PT.A
Also available as an e-resource

Advanced Organic Chemistry Part B 4th Edition
Carey and Sundberg (2000)
QD 251.2 C36 2000 PT.B
Organic Chemistry
Also available as an e-resource

Organic Chemistry
Clayden, Greeves, Warren and Wothers (2001, 1st Ed./ 2012, 2nd Ed.)
QD 251.3 O64 2001
QD 251.3 O64 2012

Strategic Applications of Named Reactions in Organic Synthesis
Laszlo Kurti and Barbara Czako (2005)
QD 262 K48 2005

Evaluation *

The final grade for the course will be based on the following items weighted as indicated:

Assignment #1:	5%*
Assignment #2:	5%*
Assignment #3:	10%*
Midterm 1:	25%** October 13
Midterm 2:	25%** November 5
Final Examination:	30%** TBD

*You may work on problem sets alone or with a study group. I do not discourage either practice but I do strongly discourage you from simply copying answers and handing those in. You will not benefit at all by doing this and this will be reflected on your performance during exams. Assignments must be handed in at the beginning of the following class, ***no exceptions*****.**

****Graduate students enrolled in CHEM 5050 will have additional questions in all exams.

Missed Tests: No make-up tests are given. The weight of a missed test is transferred to the final exam.

"Final course grades may be adjusted to conform to Program or Faculty grades distribution profiles."

Grading: The grading scheme for the course conforms to the 9-point grading system used in undergraduate programs at York (e.g., A+ = 9, A = 8, B+ - 7, C+ = 5, etc.). Assignments and tests* will bear either a letter grade designation or a corresponding number grade (e.g. A+ = 90 to 100, A = 80 to 90, B+ = 75 to 79, etc.)
(For a full description of York grading system see the York University Undergraduate Calendar - http://calendars.registrar.yorku.ca/2010-2011/academic/index.htm

NOTE: Grading for graduate courses differ from undergraduate courses. As a guideline, A+ grades are assigned for total evaluations in the 90-100 range, A for evaluations in the 85-90 range, A- for evaluations in the 80-85 range.

Students may take a limited number of courses for degree credit on an ungraded (pass/fail) basis. For full information on this option see Alternative Grading Option in the Faculty of Science section of the Undergraduate Calendar: http://www.yorku.ca/roweb/enrol/passfail/

IMPORTANT COURSE INFORMATION FOR STUDENTS

All students are expected to familiarize themselves with the following information, available on the Senate Committee on Academic Standards, Curriculum & Pedagogy webpage (see Reports, Initiatives, Documents) - http://secretariat.info.yorku.ca/files/CourseInformationForStudentsAugust20121.pdf
Senate Policy on Academic Honesty and the Academic Integrity Website

- Ethics Review Process for research involving human participants
- Course requirement accommodation for students with disabilities, including physical, medical, systemic, learning and psychiatric disabilities
- Student Conduct Standards
- Religious Observance Accommodation

September 2015