Chemistry 471/571: Advanced Organic Chemistry (3 credits)

Instructor:
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Time and Location:
Lecture: 9:00-10:00 MWF  Review Session: (optional but recommended) 7:00-8:00 pm T

Textbooks:
Required: Advanced Organic Chemistry. Part B: Reactions and Synthesis. Carey & Sundberg
Recommended: Modern Organic Synthesis: Lecture Notes. Dale L. Boger

Prerequisites:
Either Chemistry 336 or Chemistry 337

Evaluation:
Unannounced Quizzes on the Reading Assignments (10%)
Problem Sets (15%); CH571 will have a literature component
Two Midterm Exams (2 x 25%)
For CH471: Final Exam (25%)
For CH571: Final Written Exam (15%); Final literature analysis project (10%)

Learning Outcomes:
Problem sets and exams will measure the following outcomes in approximately equal proportions:

- Knowledge of new concepts not presented in CH 300 series; learning assessed by student’s ability to identify/recall appropriate reaction substrate, reagents, or products on exams
  Example: After completing Section III, students should be able to provide conditions for the production of conversion of carbonyls (aldehydes, ketones, esters) to alkynes or alkenes with control of double-bond geometry.

- Comprehension of fundamental organic reactivity and stereoechemical outcomes; assessed by application of stereoechemical models for predicting reaction outcomes in problem sets and exams
  Example: After completing Section I, students should be able to provide conditions for stereoselective generation of E or Z enolates and their formation of anti or syn aldols.

- Synthesis of 6-membered transition states for diverse reactions; assessed by ability to use appropriate models to account for reaction products of new reactions presented on exams
  Example: The Zimmerman-Traxler model presented in Section I for aldol stereochemistry will be used in Section IV to rationalize stereochemistry in the Claisen rearrangement. Exam questions will ask for explanation of stereochemistry in other (e.g. carbonyl reduction, allylboration of carbonyls) related processes.
• Knowledge of types of selectivity; assessed by the ability to identify enantio-, diastereo-, regio-, chemoselective reactions on problem sets and exams
  Example: Section I will introduce simple, induced, and double diastereoselectivity as it relates to aldol chemistry. Section III will cover enantioselectivity in alkene hydrogenations. A topic in Section II will be the chemoselective manganese dioxide oxidation. Students will be asked to provide examples of types of reaction selectivity.

• Analysis of chirality; assessed by ability to identify homo-, diastereo-, and enantiotopic atoms on problem sets and exams
  Example: Section II will cover both simple nonselective carbonyl reductions and using the CBS catalyst for both enantioselective and reagent controlled (diastereoselective) carbonyl reductions. Students will be asked to provide explanations for why chiral or achiral reagents were used for particular transformations (e.g. alkene hydrogenation, catalysis of Diels-Alder reactions)

**Additional Outcomes for CH571:**

• Evaluation of reactions in the chemical literature; assessed by ability to offer critical analysis of current publications as part of problem sets and final literature analysis project
  Example: As part of the problem sets, graduate students will be required to use the current literature to find examples of reactions covered in the lectures. They will be required to evaluate the strategic use of the reaction.

• Synthesis of lecture material with the chemical literature; assessed by the ability to blend examples from the lecture with published reactions.
  Example: Graduate students will be required to find reactions in the literature that are similar to those covered in the lecture. Undoubtedly, literature reactions will use nuanced conditions not specifically covered in the lecture. Graduate students will explain why specific conditions may have been used in the literature examples.

• Analysis of elegance and beauty in science; assessed by ability to point out particularly satisfying experiments (i.e. those that build chemical complexity, involve desymmetrization, unusual pattern recognition) in the literature analysis project
  Example: The special topics presented in the course offer an opportunity for students to see modern and spectacular examples of lecture material in complex molecules. Graduate students will be required as part of their final exam to select a publication from the literature that has similar artistic beauty and formulate a written argument for why the example is outstanding.

• Communication of science; assessed by the ability to present final literature project.
  Example: In addition to the written assignment (see example above) graduate students will be required to present their argument orally and field questions about the publication.
Course Topics (approximate number of lectures):

* time permitting; special topics are underlined

Section I: Enolates and the Aldol (7)
Acidity: Quantifying carbon acidity with pKa values
Enolate Formation: Regioselectivity and Stereoselectivity
Enolate Alkylation: C vs. O (Hard-Soft Theory), Diastereoselectivity (Seebach* and Evans Methods)
The Aldol Reaction: Stereospecificity, Zimmerman-Traxler, Felkin-Ahn, and Cram Chelate Models
Double Diastereoselective Aldols: The Evans Aldol and Retrosynthetic Analysis of Polyketides

Section II: Redox Chemistry and Other Functional Group Interconversions (7)
Alcohol Oxidation: Swern, Dess-Martin, Manganese Dioxide, Pinnick Oxidation*
Sharpless Asymmetric Dihydroxylation and Epoxidation
Oxidative Cleavage of Alkenes
Bayer-Villiger Oxidation and Schmidt Rearrangement*
Enantioselective Alkene Hydrogenation and the Takasago Menthol Process
Carbonyl Reduction: DIBAL, L-Selectride, Chelate controlled reductions, CBS Reduction
Organometallic Additions to Carbonyls*
Hydroboration of Alkenes*

Section III: Olefinations (5)
Stereoselective Alkene Formation: Methods for E and Z alkene formation from carbonyls
Alkyne Formation: Corey-Fuchs Reaction, Gilbert Reagent*
Methylenation: Tebbe and related reactions
Olefination: Grubbs Magic Rings

Section IV: Pericyclic Reactions (7)
Diels-Alder Reaction: Regiochemistry, Diastereoselectivity (endo rule), Enantioselective methods
Sigmatropic Rearrangements: Cope and Claisen Rearrangements (review of Zimmerman-Traxler)
Electrocyclizations: Woodward-Hoffman Rules and Biomimetic Synthesis

Section V: Palladium and Modern Cross-Coupling Reactions (4, time permitting)
Overview of organometallic chemistry
Cross-Couplings: Stille, Suzuki, Sonogashira, Negishi* Couplings
The Heck Reaction and Overman’s Scopadulcic Acid Synthesis

Conduct is expected to follow OSU guidelines. See: http://oregonstate.edu/studentconduct/achon.htm

Students with Disabilities: Accommodations are collaborative efforts between students, faculty and Disability Access Services (DAS). Students with accommodations approved through DAS are responsible for contacting the faculty member in charge of the course prior to or during the first week of the term to discuss accommodations. Students who believe they are eligible for accommodations but who have not yet obtained approval through DAS should contact DAS immediately at 737-4098.