**Ph. D. course in organic chemistry**

**For first semester 2017-2018**

**Department of Chemistry**

**College of Science**

Learning Outcomes

## Department of Chemistry

The Chemistry Department has overriding goals which have an impact on both our graduate and undergraduate programs. These include:

* Developing students as successful professionals.
* Developing students as effective researchers.
* Maintaining and enhancing the overall quality of the program.
* **Ph.D in Chemistry**

1. Students should have an advanced level understanding of Analytical, Inorganic, Organic, and Physical Chemistry. They should master graduate material in their major area(s) of research. In addition to course work, Ph.D. students are required to pass four cumulative exams covering current topics in chemistry during their first three semesters of graduate study.

2. Students should broaden their professional foundations through activities such as teaching, internships, fellowships, and grant applications.

3. Students should be able to communicate the results of their scientific research in writing and in oral presentation. In addition to the final department seminar required of all graduate students, Ph.D. students are required to make an additional presentation at a department seminar or professional meeting.

4. Students should acquire the tools to become fully independent chemical researchers. They should be able to synthesize advanced material from the different areas of chemistry and formulate and carry out a research project that can lead to publication(s) in a refereed journal.

* **Program Enhancement**

To maintain and improve both the undergraduate and graduate programs, the department aims to:

1. Continue to be competitive by attracting high quality students;

2. Provide effective mentoring that encourages students to graduate in a timely manner;

3. Place graduates in positions in industry and academics

4. Maintain a nationally recognized faculty that is large enough and appropriately distributed across chemistry disciplines to offer students a wide range of fields and expertise.

**The outlines of Ph. D. course in organic chemistry**

**- Nucleophilic Substitution**

Nucleophilic substitution at tetravalent (sp3) carbon is a fundamental reaction of broad synthetic utility and has been the subject of detailed mechanistic study.

**- Polar Addition and Elimination Reactions**

Addition and elimination processes are the formal reverse of one another, and in some cases the reaction can occur in either direction.

**- Carbanion Character of Organometallic Compounds**

The organometallic derivatives of lithium, magnesium, and other strongly electropositive metals have some of the properties expected for salts of carbanions.

**- Addition, Condensation and Substitution Reactions of Carbonyl Compounds**

In broad terms, there are three possible mechanisms for addition of a nucleophile and a proton to give a tetrahedral intermediate in a carbonyl addition reaction.

**- Electrophilic Aromatic Substitution Reactions**

Electrophilic aromatic substitution (abbreviated EAS in this chapter) reactions are important for synthetic purposes and are also among the most thoroughly studied classes of organic reactions from a mechanistic point of view.

**- Nucleophilic Aromatic Substitution by the Addition-Elimination Mechanism**

The addition-elimination mechanism uses one of the vacant π∗ orbitals for bonding interaction with the nucleophile. This permits addition of the nucleophile to the aromatic ring without displacing any of the existing substituents.

**- Concerted Pericyclic Reactions**

*Concerted reactions* occur without an intermediate. The transition structure involves both bond breaking and bond formation, although not necessarily to the same degree. There are numerous examples of both unimolecular and bimolecular concerted reactions. A particularly important group consists of the *concerted pericyclic reactions*, which are characterized by a continuous reorganization of electrons through *cyclic transition structures*. Furthermore, the cyclic TS must correspond to an arrangement of the participating orbitals that can maintain a bonding interaction between the reacting atoms throughout the course of the reaction. We shall see shortly that these requirements make pericyclic reactions predictable in terms of relative reactivity, regioselectivity, and stereoselectivity.

**- Free Radical Reactions**

A free radical reaction involves molecules having unpaired electrons. The radical can be a starting compound or a product, but radicals are usually intermediates in reactions. Most of the reactions discussed to this point have been *heterolytic processes* involving polar intermediates and/or transition structures *in which all electrons remained paired throughout the course of the reaction*. In radical reactions, *homolytic bond cleavages* occur, with each fragment retaining one of the bonding electrons.

**- Special topics**

**Stereochemistry**

* Baldwin’s Rule and Dunitz’s angle of attack
* Cieplak Model
* Conformation analysis of cycloalkanes
* Cram’s Model
* Enatiotopic and diastereotopic atoms, groups & faces
* Felkin-Ahn Model
* Optical purity
* Sterospecific and stereoselective synthesis

**Organic Reaction Mechanisms**

* Arndt-Eistert Synthesis
* Beckmann Rearrangement
* Benzil-Benzilic acid
* Carbanions
* Carbenes
* Favorskii Rearrangement
* Gattermann-Koch reaction
* Hunsdieker reaction
* Mechanism of nucleophilic substitution (internal)
* Nitrenes
* Pinacol-Pinacolone Rearrangement
* Sandmeyer reaction
* Smiles Rearrangement
* Wagner-Meerwein Rearrangement

**Oxidation and Reduction**

* Baeyer Villiger Oxidation
* Catalytic Hydrogenation
* Clemmenson’s Reduction
* Metal Reductions
* Meerwin Pondorf Varely Reduction
* Oppenauer oxidation
* Prevost Reaction
* Swern oxidation
* Wolf Kishner Reduction

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FRANCIS A. CAREY and RICHARD J. SUNDBERG, Advanced Organic Chemistry 5th EDITION, Part A & Part B: Structure and Mechanisms, 2007, Springer Science Business Media, LLC.

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