

11.4.3 ORGANIC CHEMISTRY II

Program	BSc in Chemistry					
Module Name	Organic Chemistry					
Module code	Chem-M2041					
Module Number	04					
Course Title	Organic Chemistry II					
Course Code	Chem2042					
Pre-requisite	Chem2041					
Module coordinator name and addresses	TBA					
Instructor(s) name and addresses	TBA					
Lecture days, Hours & room	TBA					
Cr. Hrs/EtCTS	3/5					
Work load	Lecture	Tutorial	Lab	Asses sment	Home study	Total
	48	16	----	5	66	135
Target group	2 nd year chemistry students					
Semester	Semester II					
Mode of delivery	Semester based					
Status of the course	Core compulsory					

Course description

This course designed to make students aware of organic reactions in detail and depth. It will elaborate chemistry of aromatic, amine, carbonyl compounds, carboxylic acid, and oxidation reduction reactions. In addition, biological molecules such as carbohydrates, amino acids, peptides, lipid, and nucleic acids are introduced to address basic concepts about natural product chemistry. The aim of this part of the course is to introduce important carbon-carbon bond forming reactions within a mechanistic and synthetic framework, together with exposure to a selection of stereochemical issues.

Learning outcomes

By the end of this course students will be able to:

- Understand the concept of the aromaticity
- Characterize structures as aromatic, nonaromatic or antiaromatic.
- Provide mechanisms for nucleophilic aromatic substitution reactions.
- classify various functional groups as either electron-donating or withdrawing and predict their effects on the rates of electrophilic aromatic substitution (EAS) reactions,
- explain the factors that cause meta- versus ortho/para- substitution in EAS reactions, and predict the course of nucleophilic aromatic substitution (S_NAr) reactions based on mechanistic considerations.
- Predict regiochemical outcome of electrophilic aromatic substitution reactions.

- Explain the structure and chemistry of the heterocyclic systems, furan, thiophene and pyrrole as five-member ring heterocyclics, as well as pyridine and quinoline.
- predict the major organic product of nucleophilic addition reactions to aldehydes and ketones and contrast the mechanisms and products produced with the use of hydride reducing agents, organometallic reagents, Wittig reagents, primary and secondary amines, and alcohols as nucleophiles in these reactions.
- predict the major organic product of nucleophilic acyl substitution reactions of carboxylic acid derivatives and use a series of these reactions to interconvert between carboxylic acids, acid chlorides, anhydrides, esters, and amides.
- utilize the mechanism of enolate formation to predict the products of reactions involving α -substitution of a carbonyl group and propose synthetic schemes that utilize α -substitution followed by subsequent decarboxylation.
- Understand and describe carbonyl condensation reactions including aldol, Claisen, Dieckmann and Michael reactions
- predict the major organic products of aldol, crossed aldol, and intramolecular aldol reactions
- show the mechanistic similarities between various name reactions such as the Dieckmann cyclizations, Robinson annulations, Michael additions, Claisen condensations, and other enol-based condensations.
- Describe the various chemical properties and reactions of amines
- Classify various preparative methods of biological molecule such as carbohydrates, lipids, amino acids and proteins, and their important chemical properties
- predict which anomer of a carbohydrate is most stable, differentiate between reactions of anomeric alcohols and side chain alcohols, use Fischer projections and Haworth diagrams to indicate stereochemistry of saccharides, and indicate how the various anomeric linkages affect the structure and biochemistry of polysaccharides.

Course Outline and Schedule

Week	Contents	Teaching method	Activities	Readings
1	Unit 1. The Chemistry of Aromatic Compounds <ul style="list-style-type: none"> • Aromaticity • Properties of Benzene and its Derivatives • Heterocyclic Aromatic Compounds 	<ul style="list-style-type: none"> • Gapped Lecture • Question and answer • Small group discussion • Reading assignment 	<ul style="list-style-type: none"> • Listen to a lecture and take notes on the 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,
2	<ul style="list-style-type: none"> • Aromatic Substitution Reactions and their Mechanism <ul style="list-style-type: none"> ➤ Halogenation ➤ Nitration ➤ Friedel-Crafts Alkylation ➤ Acylation ➤ Sulphonation 	<ul style="list-style-type: none"> • Gapped Lecture • Question and answer • Small group discussion • Reflection 	<ul style="list-style-type: none"> • lesson treated, • Ask questions on unclear ideas, • Active participation in discussion 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,
Test 1 (10%)				

3	<ul style="list-style-type: none"> ➤ Directing Effects of Substituents ➤ Examples of Electrophilic Aromatic Substitution Reactions ➤ Representative Reactions of pyrrole, furane, thiophen and pyridine 	<ul style="list-style-type: none"> • Gapped Lecture • Question and answer • Small group discussion • Reflection 	<ul style="list-style-type: none"> • lesson treated, • Ask questions on unclear ideas, • Active participation in discussion 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,
4	<ul style="list-style-type: none"> • Nucleophilic Aromatic Substitution Reactions <ul style="list-style-type: none"> ➤ Reactions of Aryl halides ➤ Mechanisms of Nucleophilic Aromatic Substitution Reactions 	<ul style="list-style-type: none"> • Gapped Lecture • Question and answer • Small group discussion • Reflection 	<ul style="list-style-type: none"> • lesson treated, • Ask questions on unclear ideas, • Active participation in discussion 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,
5	<ul style="list-style-type: none"> • Reactions of Aromatic Side Chains <ul style="list-style-type: none"> ➤ Oxidation and Substitution of Alkyl Side-Chains ➤ Reduction of Nitro Groups and Aryl Ketones ➤ Conversion of Halogens to organometallic Reagents ➤ Hydrolysis and Fusion of Sulphonic Acids ➤ Modifying the Influence of Strong Activating Groups ➤ Diazotization of Primary Aromatic Amines and their Usefulness in Synthesis of Aromatic Derivatives 	<ul style="list-style-type: none"> • Gapped Lecture • Question and answer • Small group discussion • Reflection 	<ul style="list-style-type: none"> • lesson treated, • Ask questions on unclear ideas, • Active participation in discussion 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,
Assignment 1 (10%)				
6	Unit 2. Amines <ul style="list-style-type: none"> • Nomenclature & Structure • Properties of Amines: Physical and chemical properties • Basicity of Nitrogen Compounds • Acidity of Nitrogen Compounds • Reactions of Amines • Electrophilic Substitution at Nitrogen • Preparation of 1^o-, 2^o & 3^o-Amines • Reactions with Nitrous Acid • Reactions of Aryl Diazonium Intermediates (See Diazotization Reactions) • Elimination Reactions of Amines 	<ul style="list-style-type: none"> • Gapped Lecture • Question and answer • Small group discussion • Reflection 	<ul style="list-style-type: none"> • lesson treated, • Ask questions on unclear ideas, • Active participation in discussion 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,

	(See Hofmann Eliminations)			
7	Unit 3. Reactions of Carbonyl Compounds <ul style="list-style-type: none"> Addition Reactions <ul style="list-style-type: none"> Hydrates Hemiacetals Cyanohydrins Carbinolamines Addition of Grignard Reagents Addition of Hydrogen Hydride Additions (lithium-aluminum hydride and sodium-borohydride) 	<ul style="list-style-type: none"> Gapped Lecture Question and answer Small group discussion Reflection 	<ul style="list-style-type: none"> lesson treated, Ask questions on unclear ideas, Active participation in discussion 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,
Test 2 (10%)				
8	<ul style="list-style-type: none"> Addition-Elimination Reactions <ul style="list-style-type: none"> Imines and related compounds Wittig reaction Acetals Ester hydrolysis and formation Reactions of acid chlorides Reactions of acid anhydrides Reactions of amides Reductions of acid derivative 	<ul style="list-style-type: none"> Gapped Lecture Question and answer Small group discussion Reflection 	<ul style="list-style-type: none"> lesson treated, Ask questions on unclear ideas, Active participation in discussion 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,
9	<ul style="list-style-type: none"> Enolization-Ketonization reactions Haloform Reaction of Methyl Ketones Alkylations at the α-Carbon Aldol and Related Condensation reactions 	<ul style="list-style-type: none"> Gapped Lecture Question and answer Small group discussion Reflection 	<ul style="list-style-type: none"> lesson treated, Ask questions on unclear ideas, Active participation in discussion 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,
10	Unit 4. Oxidation–Reduction reactions <ul style="list-style-type: none"> Oxidation Reactions <ul style="list-style-type: none"> ➤ Alcohols ➤ Aldehydes ➤ Multiple Bonds 	<ul style="list-style-type: none"> Gapped Lecture Question and answer Small group discussion Reflection 	<ul style="list-style-type: none"> lesson treated, Ask questions on unclear ideas, Active participation in discussion 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,

11	<ul style="list-style-type: none"> Reduction Reaction <ul style="list-style-type: none"> ➤ Catalytic Hydrogenation ➤ Hydride Reduction ➤ Dissolving metal reduction ➤ Introduction to Chemistry of 	<ul style="list-style-type: none"> Gapped Lecture Question and answer Small group discussion Reflection 	<ul style="list-style-type: none"> lesson treated, Ask questions on unclear ideas, Active participation in discussion 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,
	Quiz (10%)			
12	Unit 5. Biomolecules <ul style="list-style-type: none"> Carbohydrates <ul style="list-style-type: none"> Glucose The Structure and Configuration of Glucose Anomeric forms of Monosaccharides Glycosides Disaccharides Polysaccharides 	<ul style="list-style-type: none"> Gapped Lecture Question and answer Small group discussion Reflection 	<ul style="list-style-type: none"> lesson treated, Ask questions on unclear ideas, Active participation in discussion 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,
13	<ul style="list-style-type: none"> Lipids <ul style="list-style-type: none"> Fatty Acids Fats & Oils Waxes Phospholipids Prostaglandins Terpenes Steroids 	<ul style="list-style-type: none"> Gapped Lecture Question and answer Small group discussion Reflection 	<ul style="list-style-type: none"> lesson treated, Ask questions on unclear ideas, Active participation in discussion 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,
14	<ul style="list-style-type: none"> Proteins and Amino Acids <ul style="list-style-type: none"> α-Amino Acids Reactions of Amino Acids Synthesis of Amino Acids Peptides & Proteins The Primary Structure of Peptides Secondary & Tertiary Structure of Large Peptides and Proteins Peptide Synthesis 	<ul style="list-style-type: none"> Gapped Lecture Question and answer Small group discussion Reflection 	<ul style="list-style-type: none"> lesson treated, Ask questions on unclear ideas, Active participation in discussion 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,
15	<ul style="list-style-type: none"> Nucleic Acids <ul style="list-style-type: none"> Introduction to the chemistry of Nucleic Acids (Structure and Chemistry) 	<ul style="list-style-type: none"> Gapped Lecture Question and answer Small group discussion Reflection 	<ul style="list-style-type: none"> lesson treated, Ask questions on unclear ideas, Active participation in discussion 	Menger, Goldsmith and Mandle, Solomons, McMurry, Francis A. Paula F. Carey,
	Presentation (10%)			

Mode of Assessment

continuous assessment (not more than 10% for each assessments)	50%
End of Semester Examination	50%

Course policy

Beside the university's policy on course delivery and evaluation, students are expected to actively participate in learning process by obeying the following course policies:

- Coming class on time (punctuality)
- Attend all class sessions
- Be prepared to learn and actively participate during class discussion
- Do all assignments, group works, project works, and presentations on time
- All students are expected to complete their own work to the best of their ability and cheating is strictly forbidden
- Do not miss quizzes, assignments, and exams unless you are forced due to health and other reasonable problems
- Cite all sources consulted to any extent (including material from the internet), whether or not assigned and whether or not quoted directly. It is strictly forbidden to take others work and present as own.
- Make-up class shall be conducted if classes are missed due to national holidays and/or when unpredicted conditions result in class dismissal

References

1. F.M. Menger, D.J. Goldsmith; L. Mandle, Organic chemistry: A Concise Approach, 2nd Ed., 1974
2. T.W G. Solomons, Organic Chemistry, 7th Ed., 2004.
3. J. McMurry, Organic Chemistry, 4th Ed., 1996.
4. F. A. Carey, Organic Chemistry, 3rd Ed., 1996.