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DEPARTMENT OF CHEMISTRY

B.SC. H WITH APPLIED LIFE SCIENCE WITH AGROCHEMICALS AND PEST MANAGEMENT (Chemistry Component)

Semester-III

B.Sc. H with Applied Life Science with Agrochemicals and Pest Management

DISCIPLINE SPECIFIC CORE COURSE (DSC 03)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Organic Chemistry; ALS CHEM DSC 03	4	2	0	2	12th in science with Biology	NIL

Learning Objectives:

The Learning Objectives of this course are as follows:

- To make students learn the fundamentals of organic chemistry.
- To introduce the basic concepts of stereochemistry of organic molecules.
- To familiarize students to different types of organic reactions.
- To make students learn basics of reaction mechanism through different reactive intermediates.

Learning Outcomes:

By studying this course, students will be able to:

- Explain the relative behavior of organic compounds based on fundamental concepts learnt.
- Illustrate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Differentiate between various types of organic reactions possible on the basis of reaction conditions.

Unit 1: Basic Concepts **(6 Hours)**

Electronic displacements and their applications: Inductive, electromeric, resonance (mesomeric) effects and hyperconjugation. Dipole moment, acidic and basic behaviour of organic molecules.

Homolytic and heterolytic fissions. Types, shape and relative stability of carbocations, carbanions and free radicals. Electrophiles and nucleophiles.

Unit 2: Stereochemistry (10 Hours)

Stereoisomerism: Concept of asymmetry and Optical activity, Chirality in molecules with one and two stereocentres. Fischer projection, enantiomers, diastereomers and meso structures. Specific rotation.
Configuration: CIP rules: Erythro/Threo, D/L and R/S designations.
Geometrical isomerism: *cis-trans, syn-anti* and *E/Z* notations.
Conformational Isomerism: Newmann, Sawhorse, Fischer and their interconversion.
Conformations, relative stability and energy diagrams of Ethane, Propane and butane. Relative stability of cycloalkanes (Baeyer strain theory), Cyclohexane conformations with energy diagram. Conformations of monosubstituted cyclohexanes.

Unit 3: Types of organic reactions (10 Hours)

Introduction to substitution, addition, elimination, rearrangement, oxidation and reduction reactions.
Nucleophilic substitution reactions – SN1 and SN2 mechanisms with stereochemical aspects and effect of solvent.
Elimination reactions: E1and E2 mechanisms, Saytzeff, Hoffmann eliminations and Cope elimination. nucleophilic substitution vs. elimination.
Free radical substitutions: Halogenation of alkanes and concept of relative reactivity and selectivity.
Electrophilic Additions reactions of alkenes and alkynes: mechanism with suitable examples, (Markownikov's/anti- Markownikov's addition), syn and anti-addition; addition of hydrogen,halogens, hydroboration-oxidation, ozonolysis, hydroxylation.

Unit 4: Aromaticity (4 Hours)

Concept of Aromaticity: Electrophilic aromatic substitution (with their mechanism): halogenation, nitration, Friedel Crafts alkylation/ acylation, sulphonation. Orientation and reactivity in mono-substituted aromatic compounds.

PRACTICAL (60 Hours)

1. Purification of an organic compound by crystallization (from water and alcohol) and distillation

2. Calibration of thermometer
3. Criteria of purity: Determination of melting point
4. Effect of impurity on the melting point
5. Determination of boiling point of liquid compounds. (Boiling point lower than and more than100 °C by distillation and inverse capillary method)
6. Detection of extra elements
7. Separation of a mixture of two amino acids/sugars by radial/ascending paper chromatography
8. Preparations: (Mechanism of various reactions involved to be discussed).
    a. Bromination of phenol/aniline
    b. Benzoylation of phenol/aniline
    c. Nitration of nitrobenzene/toluene

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

Essential/Recommended readings

1. Mehta Bhupinder; Mehta Manju (2015), *Organic Chemistry***,** Second Edition, ISBN-978-81-203-5126-4, PHI Learning Pvt. Ltd. New Delhi.
2. Sykes, P.(2003), *A Guide Book to Mechanism in Organic Chemistry***,** 6th Edition Pearson Education.
3. Eliel, E. L. (2001), *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
4. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), *Organic Chemistry*, 7th Edition, Pearson Education.
5. Bahl, A; Bahl, B. S. (2019), *Advanced Organic Chemistry*, 22nd Edition, S. Chand.

Suggestive readings

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), *Vogel's Textbook of Practical Organic Chemistry*, Pearson.
2. Mann, F.G.; Saunders, B.C. (2009), *Practical Organic Chemistry*, Pearson Education.
3. Dhingra, S; Ahluwalia V.K., (2017), *Advanced Experimental Organic Chemistry*, Manakin Press.
4. Pasricha, S., Chaudhary, A. (2021), *Practical Organic Chemistry: Volume I*, I K International Publishing House Pvt. Ltd., New Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 01)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Heterocyclic Chemistry; ALS CHEM DSE 01	**4**	**2**	**0**	**2**	**12th in science with Biology**	**NIL**

Learning Objectives:

The Learning Objectives of this course are as follows:

- To teach students the fundamentals of heterocyclic chemistry.
- To make them familiar with classification and nomenclature of heterocyclic compounds.
- To study structural characteristics, physical properties, synthesis and chemical reactions of heterocyclic compounds
- To know the importance of heterocyclic compounds.

Learning Outcomes:

By studying this course, students will be able to:

- Classify and name heterocyclic compounds.
- Analyze the important synthetic routes, physical properties, chemical properties and reactivity of five and six membered heterocyclic compounds.
- Explain the hetero cyclic structures in biologically active compounds,
- Apply the study of heterocyclic compounds in medicine, agrochemicals, dyes and pigments, plastics and polymers.

Unit 1: Introduction and Nomenclature of Heterocyclic Compounds (4 Hours)

Introduction and classification of heterocyclic compounds. Nomenclature: Trivial names of common ring systems, Systematic (Hantzsch- Widman) nomenclature for heterocyclic compounds, naming of fused ring systems, Replacement nomenclature.

Unit 2: **(8 Hours)**

General discussion on the following aspects of five and six membered heterocyclic compounds containing one heteroatom: Structure, aromaticity, basicity, physical properties and general methods of synthesis for Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, and Pyridine (Hantzsch synthesis)

Unit 3: **(10 Hours)**

Orientation and reactivity towards electrophilic substitution reactions with mechanism. Discussion on the following reactions for Furan, Pyrrole, Thiophene, Pyridine: Nitration, sulphonation, halogenation, formylation, acylation, mercuration and carboxylation. Reactions exhibiting acidic /basic character. Oxidation, reduction and addition reactions. Diels-Alder reaction, reaction with diazonium salts. Nucleophilic substitution in Pyridine and its orientation.

Unit 4: **(8 Hours)**

Importance of Heterocyclic compounds:

- Structure and importance of the following selected biologically active compounds to be discussed:
  Heterocyclic Amino Acids; Proline, Hydroxyproline, Histidine, Tryptophan.
  Heterocyclic Vitamins; Niacin (Vitamin B3), Pyridoxine (Vitamin B6) , Riboflavin (Vitamin B2) , Thiamin (Vitamin B1) and Ascorbic acid(Vitamin C) .
  Pigments of Life; Hemoglobin and Chlorophyll.
  Nucleic acids; Ribonucleic Acid (RNA) and Deoxyribonucleic Acid (DNA); Purines and Pyrimidines.
- Structure and importance of the following selected Natural Products**:**
  Alkaloids, Marine Heterocycles, Halogenated Heterocycles, Macrocycles containing Oxazoles and Thiazoles, Anthocyanins and Flavones.
- Structure and importance of heterocyclic compounds in Medicine, Agrochemicals, Dyes and pigments, Plastics and polymers.

PRACTICAL **(60 Hours)**

The following synthesis should be done by using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

1. Synthesis of oxygen containing heterocyclic compounds:
   (a)Phthalic anhydride (b) 7- Hydroxy-4-methylcoumarin
2. Synthesis of nitrogen containing heterocyclic compounds:

(a) Phthalimide (b) Phthaloylglycine

3. Synthesis of Imidazole derivatives:
   (a) Benzimidazole (b)2-Benzylbenzimidazole (c)2-Methylbenzimidazole
4. Synthesis of Pyrazole derivatives:
   (a) 3-Methyl-2-pyrazolin-5-one (b)3,5-Dimethylpyrazole
5. Synthesis of Pseudothiohydantoin

Essential/Recommended readings

1. Mehta Bhupinder and Mehta Manju (2015) "*Organic Chemistry", 2ndEdn*., PHI Learning Pvt. Ltd. New Delhi. ISBN-978-81-203-5126-4.
2. Bansal Raj K "*Heterocyclic Chemistry".;5th Ed*, New Age International *Publishers*, ISBN 978-81-224-3143-8
3. J. A. Joule, K. Mills and G. F. Smith, "*Heterocyclic Chemistry" 5th Edn* Wiley International Publications, ISBN: 978-1-4051-3300-5
4. Thomas. L. Gilchrist "*Heterocyclic Chemistry" (3rd Edition)*, Prentice Hall Publication, ISBN 978-0-5822-7843-1.
5. R. M. Acheson, "*An Introduction to the Chemistry of Heterocyclic compounds 3rd Edn* " Wiley India Pvt. Ltd.; ISBN-13:978-8126516605.
6. I L Finar, "*Organic Chemistry" Vol. 1* " Published by Pearson Education; ISBN 10: 8177585428.
7. T. W. Graham Solomons, "*Organic Chemistry*" Published by John Wiley; ISBN-10: 1118133579.

Suggestive readings

1. A.O. Fitton and R.K. Smalley,"*Practical Heterocyclic Chemistry* 1stEdn"., Academic Press; ISBN:9781483270791.

2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), *Vogel's Textbook of Practical Organic Chemistry*, Pearson.

3. Mann, F.G.; Saunders, B.C. (2009), *Practical Organic Chemistry*, Pearson Education.

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