

**GENERIC ELECTIVES -13: – CHEMISTRY OF OXYGEN CONTAINING  
FUNCTIONAL GROUPS AND THEIR APPLICATIONS TO BIOLOGY**

**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
		Lecture	Tutorial	Practical/Practice		
Chemistry of Oxygen containing Functional Groups and their Applications to Biology (GE-5)	4	2	0	2	Class XII Pass	----

**Learning Objectives**

- To teach the fundamental chemistry of oxygen containing functional groups.
- To establish these concepts typical reactions of alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives.
- To make students understand the relevance of oxygen containing functional groups to biology and the importance of these compounds in real world.

**Learning outcomes**

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

- Understand and explain the differential behavior of organic compounds based on reaction chemistry.
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Understand the applications of functional group chemistry to biology.

**Syllabus - Theory:**

**Unit 1: Alcohols (upto 5 Carbon) 5 Hours**

Structure and classification of alcohols as  $1^{\circ}$ ,  $2^{\circ}$  &  $3^{\circ}$ , Reactions: Acidic character of alcohols and reaction with sodium, with HX (Lucas Test), esterification, oxidation (with PCC, alkaline  $\text{KMnO}_4$ , acidic  $\text{K}_2\text{Cr}_2\text{O}_7$  and conc.  $\text{HNO}_3$ ), Oppeneauer Oxidation, Biological oxidation Reactions

**Unit 2: Phenols** **4 Hours**

Acidity of phenols and factors affecting their acidity, Reactions: Electrophilic substitution reactions, *viz.* nitration, halogenation, sulphonation, Reimer-Tiemann reaction, Gattermann-Koch reaction, Houben-Hoesch condensation; Reaction due to OH group: Schotten-Baumann reaction

**Unit 3: Aldehydes and Ketones (Aliphatic and Aromatic)** **12 Hours**

Reactions: Nucleophilic addition, nucleophilic addition-elimination reaction including reaction with HCN, ROH,  $\text{NaHSO}_3$ ,  $\text{NH}_2$ -G derivatives. Iodoform test, Aldol condensation and its biological application, Cannizzaro's reaction, Wittig reaction, Benzoin condensation, Clemmensen reduction, Wolff Kishner reduction, Meerwein-Ponndorf Verley reduction, enzyme-catalyzed additions to  $\alpha, \beta$ -unsaturated carbonyl compounds.

**Unit 4: Carboxylic acids and their derivatives (Aliphatic and Aromatic)** **9 Hours**

Reactions: Hell-Volhard Zelinsky reaction, acidity of carboxylic acids, effect of substitution on acid strength, Claisen condensation and its biological applications, decarboxylation in biological systems, relative reactivities of acid derivatives towards nucleophiles, activation of carboxylate ions for nucleophilic acyl substitution reactions in biological systems, Reformatsky reaction, Perkin condensation.

**Practicals: :** **60 Hours**

Preparations: (Mechanism of various reactions involved to be discussed) (Recrystallization, determination of melting point and calculation of quantitative yields to be done in all cases)

1. Oxime of aldehydes and ketones
2. 2,4-Dinitrophenylhydrazone of aldehydes and ketones
3. Aldol condensation using green method.
4. Benzoin condensation using Thiamine Hydrochloride as a catalyst.
5. Alkaline hydrolysis of amide/ester.
6. Benzoylation of one of the following amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine) or one of the following phenols ( $\beta$ -naphthol, resorcinol, *p*-cresol) by Schotten-Baumann reaction.
7. Identification of functional group for monofunctional organic compounds (Alcohols, phenols, aldehydes, ketones, carboxylic acids).

**References:**

**Theory:**

1. Sykes, P. (2005), **A Guide Book to Mechanism in Organic Chemistry**, Orient Longman.
2. Eliel, E. L. (2000), **Stereochemistry of Carbon Compounds**, Tata McGraw Hill.
3. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7<sup>th</sup> Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Mehta B.; Mehta M. (2015), **Organic Chemistry**, PHI Learning Private Limited Bahl,
5. Bahl, A., Bahl, B. S. (2012), **Advanced Organic Chemistry**, S. Chand.
6. Bruice, Paula Y. (2020), **Organic Chemistry**, 8<sup>th</sup> Edition, Pearson.

**Practicals:**

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.

**Keywords:** Alcohols, Lucas Test, Phenol, Aldehydes, Ketones, Nucleophilic addition, nucleophilic addition – elimination, Cannizzaro's reaction, Wittig reaction, Benzoin condensation, Enzyme-catalysed reaction, Carboxylic acid, Claisen condensation

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