

**Organic Chemistry Study List****I. Structure and bonding****1. Covalent bonds**

- ✓ Be able to differentiate between  $\sigma$ -bonds and  $\pi$ -bonds
- ✓ Know the characteristic bond angles and types of bonding for different hybridizations ( $sp$ ,  $sp^2$ ,  $sp^3$ )
- ✓ Understand valence shell electron pair repulsion and know how to draw Lewis dot structures
- ✓ Be able to calculate the formal charge of a molecule
- ✓ Know how to draw resonance structures
- ✓ Know important bond lengths and energies
- ✓ Understand the polarity of a molecule
- ✓ Be clear about the Lewis definition of acids and bases and how resonance and inductive effects affect the acid or basic character of a compound

**2. Stereochemistry**

- ✓ Know how to identify chiral centres
- ✓ Understand what isomers are and the different types of isomers
- ✓ Understand how light is polarized and what specific rotation is
- ✓ Know how to draw Fischer projections and be clear about absolute and relative configuration and the difference between them
- ✓ Be able to differentiate between enantiomers, diastereomers, and meso compounds

**II. Hydrocarbons****1. Alkanes**

- ✓ Know how to name alkanes
- ✓ Know the important physical properties of alkanes
- ✓ Know how to draw Newman projections
- ✓ Understand the concept of steric strain and how it affects stability

**2. Cycloalkanes**

- ✓ Know how to name cycloalkanes
- ✓ Understand the concept of ring strain and ring flip
- ✓ Be clear about the difference between cis and trans conformations
- ✓ Be able to differentiate between boat and chair conformations

**3. Alkenes**

- ✓ Know how to name alkenes
- ✓ Understand the stability of alkenes and what affects their stability

- ✓ Understand the electrophilic addition of HX and be able to draw the reaction mechanisms
- ✓ Be clear about Markovnikov's rule
- ✓ Know how to calculate the degree of unsaturation

#### 4. Alkyl halides

- ✓ Know how to name alkyl halides
- ✓ Know how to prepare alkyl halides with the following reactions and how to draw the reaction mechanisms
  - i. Radical halogenation
  - ii. Allylic bromination
  - iii. Alkyl halides from Primary and Secondary alcohols
  - iv. Reactions of alkyl halides such as those with Grignard reagents
    - ✓ Understand nucleophilic substitution and elimination reactions and know how to draw the reaction mechanisms
    - ✓ Be clear about the difference between nucleophiles, bases, and leaving groups
    - ✓ Understand  $S_N2$ ,  $S_N1$ , E2, E1 reactions and be able to draw the reaction mechanisms
    - ✓ Understand Zaitsev's rule

### III. Oxygen-containing compounds

#### 1. Alcohols and phenols

- ✓ Know how to name alcohols and phenols
- ✓ Understand the acid and basic properties
- ✓ Understand how alcohols and phenols hydrogen bond
- ✓ Know how alcohols are prepared and know how to draw the reaction mechanisms
- ✓ Understand pinacol rearrangements
- ✓ Know how alcohols and phenols react with  $SOCl_2$  and  $PBr_3$
- ✓ Understand the esterification reaction and how to draw the reaction mechanism

#### 2. Aldehydes and ketones

- ✓ Know how to name aldehydes and ketones
- ✓ Understand how substituents affect the reactivity of C=O and steric hindrance
- ✓ Be clear about the acidic characteristic of the  $\alpha$ H
- ✓ Understand what carbanions are and how they function
- ✓ Know what  $\alpha,\beta$ -unsaturated carbonyls are and how they are formed
- ✓ Understand how aldehydes and ketones are prepared and know the reaction mechanisms

- ✓ Understand nucleophilic addition reactions at the C=O bond
- ✓ Be able to differentiate between acetals, hemiacetals, imines, and enamines
- ✓ Understand reactions that occur at the adjacent position such as:
  - i. Haloform reactions
  - ii. Aldol condensation
  - iii. Oxidation
- ✓ Know the other important reactions below and how to draw the reaction mechanism
  - i. 1,3-dicarbonyls and internal H-bonding
  - ii. Keto-enol tautomerisms
  - iii. Wolff-Kishner reaction
- ✓ Know organometallic reagents

### 3. Carboxylic acids

- ✓ Know how to name carboxylic acids
- ✓ Understand the H-bonding of carboxylic acids and their solubility
- ✓ Understand the concept of dimerization
- ✓ Be clear about the acidic property of the carboxyl group
- ✓ Understand the resonance stability of the carboxylate anion
- ✓ Know how to prepare carboxylic acids and how to draw the reaction mechanisms
- ✓ Know the other important reactions below and how to draw the reaction mechanisms
  - i. Nucleophilic attack
  - ii. Reduction
  - iii. Decarboxylation
  - iv. Esterification
  - v. Halogenation
  - vi. Substitution

### 4. Acid derivatives

- ✓ Know how to name the acid derivatives
- ✓ Understand the relative reactivity between the acid derivatives
- ✓ Understand the steric effects, electronic effects, and strain of the acid derivatives
- ✓ Know how to prepare acid derivatives and how to draw the reaction mechanisms
- ✓ Know the other important reactions below and how to draw the reaction mechanism
  - i. Nucleophilic substitution
  - ii. Hoffman degradation of amides and migration of the aryl group
  - iii. Transesterification
  - iv. Saponification

- v. Hydrolysis of amides

### 5. Keto acids and esters

- ✓ Know how to name keto acids and esters
- ✓ Understand the acidic characteristic of the  $\alpha$ H and  $\beta$ -keto ester
- ✓ Know the other important reactions below and how to draw the reaction mechanisms
- i. Decarboxylation
- ii. Acetoacetic ester synthesis

### Amines

- ✓ Know how to name amines
- ✓ Understand the basic characteristic of amines and how substituents affect the basicity of aromatic amines
- ✓ Be clear about the how the adjacent carbocation is stabilized
- ✓ Know how to prepare amines and how to draw the reaction mechanisms
- ✓ Know the other important reactions below and how to draw the reaction mechanism
- i. Reaction with nitrous acid
- ii. Alkylation
- iii. Hoffman elimination

## IV. Biological molecules

### 1. Amino acids

- ✓ Know how to name the different amino acids
- ✓ Differentiate between the different structures: Primary, Secondary, Tertiary, Quaternary
- ✓ Be able to classify the different amino acids as:
  - i. Hydrophobic
  - ii. Hydrophilic
  - iii. Sulfur-containing
  - iv. Proline
  - v. Acidic
  - vi. Basic
- ✓ Know the following important reactions and how to draw the reaction mechanisms:
  - i. Peptide linkage
  - ii. Hydrolysis

### 2. Carbohydrates

- ✓ Know how to name carbohydrates and how to differentiate between monosaccharids and disaccharides

- ✓ Be clear about the absolute configuration of carbohydrates and their cyclic structures
- ✓ Know the difference between epimers and anomers
- ✓ Know the following important reaction and how to draw the reaction mechanism
- i. Hydrolysis of glycoside linkage

### 3. Lipids

- ✓ Know how to name lipids and the following structures:
  - i. Steroids
  - ii. Terpenes
  - iii. Triacyl glycerols
  - iv. Fatty acids

### 4. Phosphorous compounds

- ✓ Know the structures of phosphorous compounds
- ✓ Know the following important reaction and how to draw the reaction mechanism
- i. Wittig reaction

## V. Lab techniques and spectroscopy

### 1. Separations and purifications

- ✓ Understand and be able to differentiate between the following techniques:
  - i. Extraction
  - ii. Crystallization and precipitation
  - iii. Distillation: Simple distillation and Fractional distillation
  - iv. Chromatography: Thin-layer chromatography and Gas chromatography

### 2. Spectroscopy

- ✓ Understand how infrared spectroscopy works using:
  - i. Stretching frequencies
- ✓ Understand how mass spectrometry works
- ✓ Understand how nuclear magnetic resonance (NMR) works using:
  - i. Chemically equivalent protons
  - ii. Chemical shift
  - iii. Integration
  - iv. Splitting