

**THE UNIVERSITY OF ZAMBIA
DEPARTMENT OF CHEMISTRY**

CHE 1000: INTRODUCTORY CHEMISTRY

**COURSE OUTLINE: ORGANIC CHEMISTRY COMPONENT (4 WEEKS)
2019/2020 ACADEMIC YEAR**

Specific Objectives:

At the end of the teaching of this component, the students should be able to:

- (a) Draw the MO diagrams for organic molecules (methane, ethane, ethene, ethyne, allene, HCHO, CH₃CHO, H₂C=C=O)
- (b) recognise as well as describe types of bonds (σ - and π - bonds; σ - bond as sp^y-sp^z σ bond), functional groups and types of carbon and hydrogen atoms (as $sp^3/sp^2/sp$; primary/secondary/tertiary/quaternary and allylic/vinyllic/ acetylinic) in organic compounds and explain differences between σ - and π -bonds.
- (c) classify and name organic molecules -by IUPAC rules as well as trivial/, systematic names and draw structures corresponding to given names.
- (d) Draw structural and geometrical isomers (alkenes only) corresponding to a given molecular formula and recognise isomeric relationships.
- (e) Describe sources of hydrocarbons and predict as well as explain their physical properties in terms of their molecular structure.
- (f) Recognise formal charges on molecules.

Course Outline

1.0 Introduction to organic chemistry

- What is organic chemistry?
- Scope, relevance and natural occurrence
- Why it has to be studied separately?

2.0 Review of bonding in organic compounds (2 hours)

- Brief overview of hybridisation of C, N and O and how a covalent bond is formed-LCAO? (covered in earlier part of CHE 1000);
- M.O. diagrams/pictures for methane, ethane, ethene, ethyne, methanal, allene, ketene
- Types of C-H, C-C, C-N, C-O and C-X bonds in organic compounds: σ - and π -bonds, description of σ -bonds as (sp^y-sp^z) and (sp^y-s), differences between σ - and π -bonds.

3.0 Elemental Composition and classifications of Organic Compounds (2 hours)

3.1 Classification based types of elements present:

- Compounds containing carbon and hydrogen only (*Hydrocarbons*)
- Compounds containing C, H and other elements, N,O, X (*Hydrocarbon derivatives*)

3.2 Further classification of hydrocarbons:

- based on nature of carbon chain and types of C-C bonds:

- (i) Aliphatic hydrocarbons: alkanes (cyclic and acyclic), alkenes (cyclic and acyclic) and alkynes, general formulae, alkenynes, examples
- (ii) Aromatic hydrocarbons: benzene, toluene and xylenes

3.3 Further classification of hydrocarbon derivatives:

- Definitions; structures, names and examples of functional groups; priority order of functional groups, polarity and acid/base/neutral characteristics.
- classification of hydrocarbon derivatives based on functional groups: Alkyl halides, alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, nitro compounds, amines, amides, amino acids; Difunctional compounds.

4.0 Representation of Organic Compounds (1 hour)

4.1 Representation of aliphatic organic compounds

- Molecular and structural formulae,
- Representation of structural formulae- Lewis, Kekule, expanded, condensed and bond-line (or line) structures- line structures preferred.

4.2 Representation aromatic organic compounds- limited to benzene and its derivatives:

- Benzene: molecular formula, orbital picture, Kekule structures, toluene, xylenes, mono- and di-substituted benzenes.

4.3 Classification of carbons, hydrogens and nitrogens:

- (i) primary, secondary, tertiary, quaternary
- (ii) alkyl, vinylic, allylic, alkynyl/acetylinic, benzylic

4.4 Formal charges, resonance

5.0 Nomenclature of Organic Compounds (4.5 hours)

5.1 Systems of nomenclature: trivial (common), systematic and IUPAC – scope and limitations

5.2 IUPAC system of nomenclature:

- introduction, definitions of terminology, underlying principles,
- Architecture of IUPAC nomenclature: root, prefixes and suffixes; multipliers, punctuation marks

5.3 IUPAC nomenclature of aliphatic cyclic and acyclic organic compounds in detail

- Prefixes and suffixes for all common functional groups
- IUPAC rules for naming organic compounds in detail (all common functional groups)
- Naming cyclic and acyclic alkanes, mono-, di- and tri-functional compounds by IUPAC rules: Liberal examples covering all common functional groups and alkenynes.

5.4 IUPAC nomenclature of aromatic compounds – benzene derivatives only

- IUPAC nomenclature rules for benzene derivatives
- Naming mono- and di- substituted benzenes:

6.0 Isomerism (2 hours)

6.1 Definitions, terminology and classification- constitutional- and stereo-isomers.

6.2 *Constitutional isomers*:

- Definitions, further classification, examples
- Differences in properties of structural isomers

6.3 *Stereoisomerism*: limited to geometrical isomerism in alkenes

- Origin, definitions and classification.
- *Geometrical isomerism in alkenes*: restricted rotation about double bonds,
- IUPAC nomenclature of geometrical isomers, configurational labels- (i) *Cis*- and *Trans*- (ii) (*E*)- and (*Z*)-

6.4 *Drawing structures for isomers corresponding to given MF*:

- Index of hydrogen deficiency (IHD) or unsaturation number (UN): brief explanation, calculation and interpretation of IHD
- Guidelines for writing structures for isomers corresponding to given MF.

7.0 Sources and Properties of Hydrocarbons

7.1 Sources of hydrocarbons

7.2 Physical properties alkanes, alkenes, alkynes, benzene: polarity, solubility, acidity-pKa, b.p.

RECOMMENDED TEXTBOOK

Stevens S. Zumdahl and Susan A. Zumdahl (2014), Chemistry 9th Edition, Brooks/Cole, USA

Advise: 1. Revise chapter 9: Covalent bonding done earlier (pages 415-422 and 428-430)

2. Study Chapter 22: Organic and Biological Molecules, pages 1022- 1044 and attempt questions and exercises on pages 1071 – 1074.

3. In addition, you may need to read organic chemistry book(s) - *to be advised during lectures*.

4. Two tutorial sheets/review questions will be given and posted on Moodle. Please attempt all questions. Sample answers for selected questions will be posted on Moodle.

Topic Delivery:

1. Lecture notes on organic chemistry sub-topics will be uploaded on Moodle. The lecture notes will cover fundamental concepts, illustrated with 1 or 2 examples, as far as possible. Please note that the uploaded notes are not modules.

2. To enhance understanding, some practice questions with solutions on some topics will also be uploaded on Moodle, where necessary.

3. Two/three Tutorial sheets will be uploaded on Moodle. The class is requested to attempt all questions, preferably before their scheduled tutorial session, as far as possible.

4. The concepts and material will be explained further through tutorials during scheduled tutorial sessions.

Assessment:

1. Two (2) Quizzes will be given on Moodle, Dates to be announced.

2. CHE1000 Course Coordinator will advise the class on Test 2.