HUMANITAS UNIVERSITY

MEDTEC SHOOL

Course: Chemistry and Organic Chemistry

Year (1st-2nd-3rd-4th-5th-6th): _1st_

Period (1st-2nd semester – annual): _1st semester

Credits: _6

Objectives

The Course in Chemistry and Organic Chemistry is designed to emphasize the fundamental principles of the science and to reflect its interdisciplinary nature. Because chemistry is the "central" science, a wide variety of opportunities awaits those with training in this field. This Course provides the students with an important background to understand the molecular basis of the bio-medical sciences. The Course offers a program meeting the needs of students who anticipate careers as healthcare professionals in the medical sciences, such as medicine and biomedical research. In particular, the Course aims to provide the students with an introduction to the fundamental concepts required to rationalize and predict molecular structure, molecular interactions, and chemical reactivity. More specifically, the first part of the Course aims to provide the students with an appreciation of the quantum mechanical basis of the Periodic Table and in turn with the ability to explain trends in the chemical behavior of the different elements. The course moves on to provide the students an insight into chemical bonding, from simple inorganic molecules to more sophisticated organic molecules and polymers. Parallel to these components of the Course, an introduction to thermodynamics and kinetics is also provided allowing the students to rationalize and predict chemical reactivity and to study the equilibria in water solutions, with particular emphasis for acid-base and electrochemical equilibria. The second part of the Course dedicated to organic chemistry aims to provide the students with an insight to the principal functional groups, their properties and reactivity on the basis of the knowledge acquired during the first part. Particular attention will be paid on the three-dimensional structure of organic molecules and on those reactions that are fundamental to understand biological processes. An introduction to the structure and chemistry of biopolymers, such as peptides and proteins, carbohydrates, DNA and RNA will be treated to provide the students with a solid background to understand the involvement of such biopolymers in many biological processes. During the Course different multiple-choice tests will be held to provide the students a method of self-evaluation. The relevance of chemistry/organic chemistry to deeply understand biochemical processes will be outlined in planned transdisciplinary lessons.

Prerequisites

Basic knowledge of chemistry concepts at high-school level that include the structure and periodic properties of the atoms, ionic and covalent bonds, relative atomic and molecular mass, and the concept of mole could be helpful, even if not mandatory. Basic knowledge of mathematics and physics is considered as prerequisites.

Contents

5. CHEMICAL EQUILIBRIUM AND CHEMICAL KINETICS (**Week 5, 4h lesson and 2h exercises**)

- Concept of equilibrium and equilibrium constants
- Factors that affect the chemical equilibrium
- Homogenous and heterogeneous equilibrium
- Collision theory and rate of a reaction
- Activation energy and reaction mechanism
- The rate law
- Factors that affect the kinetic of a reaction: catalysis
- The relationship between chemical equilibrium and chemical kinetic

6. IONIC EQUILIBRIA IN WATER, PART I: ACIDS AND BASES (**Week 6-7, 6h lesson and 2h exercises**)

- Bronsted and Lewis acids and bases
- Strength of acids, bases, and ionization constants
- pH
- Buffer solutions
- Hydrolysis and solubility

7. IONIC EQUILIBRIA IN WATER, PART II: ELECTROCHEMISTRY (**Week 7-8, 4h lesson and 2h exercises**)

- Redox reactions
- Galvanic cells
- Standard reduction potential and battery Emf
- Electrolysis

8. INTRODUCTION TO ORGANIC CHEMISTRY AND HYDROCARBONS (**week 9, 5h lesson and 1h exercises**)

- Classes of organic molecules: functional groups
- Type of organic chemical reactions: substitution, addition, elimination, reduction and oxidation
- Alkanes, Alkenes, Alkynes, and Aromatic Compounds: nomenclature, physical properties and reactivity

9. STEREOISOMERISM AND ALKYL HALIDES (**week 10, 5h lesson and 1h exercises**)

- Chirality and sterocenters
- Enantiomers and diastereoisomrs
- Halo alkanes: nomenclature, physical properties and reactivity

10. FUNCTIONAL GROUPS CONTANING C-O AND C-S SINGLE BONDS (**week 11, 2h lesson and 1h exercises**)

Alcohols: nomenclature, physical properties and reactivity

Ethers: nomenclature, physical properties and reactivity

Thiols, sulfides and disulfides: nomenclature, physical properties and reactivity

11. THE CARBONYL GROUP (**week 11, 2h lesson and 1h exercises**)

Carbonyl compounds: nomenclature, physical properties and reactivity

12. AMINES (**week 12, 2h lesson and 1h exercises**)

Amines: nomenclature, physical properties and reactivity

13. THE CHEMISTRY OF AROMATIC COMPOUNDS (**week 12, 2h lesson and 1h exercises**)

Chemistry of substituted aromatic compounds

Introduction to aromatic heterocycles

14. CARBOXYLIC ACIDS AND DERIVATIVES (**week 13, 2h lesson and 1h exercises**)

Carboxylic acids: nomenclature, physical properties and reactivity

Esters: nomenclature, physical properties and reactivity

Amides: nomenclature, physical properties and reactivity

15. INTRODUTION TO BIOPOLYMERS (**week 13, 2h lesson and 1h exercises**)

Saccharides: structure, properties and chemistry

Peptides and proteins: structure and properties

Nucleic acids: classification, structure and properties

Teaching Methods

The course foresees frontal theoretical lessons and exercises. At the end of any topics a multiple-choice test will be held to provide the students a method of self-evaluation. Moreover, two transdisciplinary lessons will be organized with the teacher of the Biochemistry Course in order to highlight the relevance of chemistry/organic chemistry to deeply understand biochemistry and to stimulate the curiosity among the connection between two disciplines. Students are encouraged to actively participate to the lectures with questions and comments. If possible according to the availability of the didactic laboratory at Department of Chemistry, Material and Chemical Engineering, Politecnico di Milano, a half day chemical workshop will be organized.

Assessment

The exam consists of a written test and an oral discussion. The written test is composed of 10 exercises/open questions on the whole program with a maximum mark of 33/30. The written test will be

the subject of the oral discussion for those students with a written evaluation starting from 18/30. The exam may be taken in February (two separate tests), or July (two tests) or September (one test).

Texts

Janice G. Smith, **GENERAL, ORGANIC, & BIOLOGICAL CHEMISTRY.** 4th Edition. McGRAW-HILL
This text must be integrated with notes

Raymond Chang, Kenneth A. Goldsby, **GENERAL CHEMISTRY** – The essential concepts. 7th Edition. McGRAW-HILL International 2014
This text is a comprehensive text for General Chemistry

Janice G. Smith, **ORGANIC CHEMISTRY**. 6th Edition. McGRAW-HILL
This text is a comprehensive text for Organic Chemistry

Slides and exercises will be available on Beep site.