UCLouvain

lchm1244

2024

Organic chemistry 2: deepening of basic concepts

4.00 credits	30.0 h + 22.5 h	Q1

Teacher(s)	Riant Olivier ;
Language :	French
Place of the course	Louvain-la-Neuve
Prerequisites	It is recommended to have acquired the knowledge and skills developed in the teaching units: LCHM1111 Chimie générale LCHM1141 Chimie organique *The prerequisite(s) for this Teaching Unit (Unité d'enseignement – UE) for the programmes/courses that offer this Teaching Unit are specified at the end of this sheet.*
Main themes	The thermodynamic and kinetic aspects will be re-introduced and supplemented by the notions of control of a reaction (Hammond's postulate, kinetic vs thermodynamic control). Electronic effects will also be reviewed and related to the concepts of charge stabilization and acid-base properties of certain classes of organic functions. The HSAB concept will also be introduced and linked to the concepts of electronegativity and polarizability. These principles will be applied to the chemistry of aromatics and the notions of orientation in electrophilic aromatic substitution reactions will be developed and applied in concrete problems of everyday life (paracetamol, ibuprofen, '). The chemistry of nitrogen compounds will introduce the large classes of functions carrying these heteroatoms and their existence in the field of biological molecules (DNA, peptides, ATP, '). The deepening of mechanisms and notions of orientation and selectivity will be done by studying the large classes of reaction related to the chemistry of these heteroatoms. The interconversions between nitrogen functional groups will be supplemented by the notions of organic reagents carrying a heteroatom. The notion of organic synthesis for the construction of a molecule will also be used to illustrate the course in different areas of everyday life. • Introduction to the notion of carbanions. • Physico-chemistry and structures. • Stabilization effects. The chemistry of enolates and related carbanions will be reintroduced and deepened in aspects of preparation, reactivity and selectivity. • Alkylation reactions, aldol condensation and Michael's reaction. • Unstabilized organometallic chemistry. • Organomagnesiums, organoliths and organocuprates. • Base-nucleophilic duality. • Application in carbon-carbon bond creation reactions. • Comparisons between different families of organometallics.
Learning outcomes	**At the end of this learning unit, the student is able to :** 1 In the continuation of the first-year organic chemistry course, the focus will be on deepening the basic principles of chemical reactivity applied to organic chemistry. The course will be divided into three major complementary parts : In the first part, the notions of control, orientation and electronic effects will be introduced and applied in the chemistry of aromatic compounds. The second part of the course will be devoted to the description of the chemistry of fundamental heteroatoms (nitrogen, phosphorus and sulfur). Major classes of biological molecules and biochemical mechanisms will serve as examples to link matter to life. The last part proposes a complete teaching of carbanion chemistry and organometallic compounds related to this class of compounds. The aim here is to focus student training on the major carbon-carbon bond formation reactions through the use of organometallics and related carbanions. This course is also an opportunity to focus the applications towards the aspects of selectivity (regioselectivity, stereoselectivity) essential to the learning of organic synthesis.

Evaluation methods	Practical training is an integral and inseparable part of the organic chemistry course. Participation in all **practical sessions** is therefore **MANDATORY**. The practical work (output tests, yield and purity of products, reports) **account for 1/8 of the final grade.** Any REASONED absence (justified by a medical certificate in case of illness, or by an official document in other cases) will result in the simple **cancellation of the laboratory session, without any subsequent make-up session.** Any NON-MOTIVATED absence will in principle be sanctioned by a NEGATIVE mark of 5 POINTSon the final score, and may, depending on the degree of recurrence and the assessment of the situation by the teaching staff, result in a non-negotiable final mark of ZERO out of 20. These conditions are also valid for BIS students EXCEPT if they have obtained a grade in the practical work that is higher than or equal to **10/20** (final grade), in which case they will be exempted. **The final exam will account for 7/8 of the final grade**. It will only include a written test.
Teaching methods	Lectures with slides and note taking on the blackboard, exercise sessions and labs.
Content	**I. Reminders and basic complements in organic chemistry** **II. Electronic effects :** Definition of mesomeric and inductive effects. Concrete examples of stabilization of a positive and a negative charge, pKa of phenols. Nucleophile and electrophile reminders and principles of reactivity. **III. Principles of thermodynamics and kinetics applied to organic chemistry** *1. Thermodynamics* Principles of thermodynamics, chemical equilibrium, equilibrium shifts (esterification, hydrolysis and acetalization reactions, practical methods). *2. Kinetics* Principles of kinetics using reaction energy diagrams, definition of rate constants, transition state. Hammond's postulate. Applications to SN2 and SN1 reactions (reminders from Bac11). *3. Kinetic vs thermodynamic control* Definitions, relation with Hammond's postulate. Example of 1,2 vs 1,4 addition of HCN on methylvinylketone (cf Clayden), definition of a 1,4 addition. Kinetic and thermodynamic enolates. **IV. Reminders and complements on the chemistry of carbonyl derivatives** Writing of mechanisms. Electrophiles and nucleophiles. Influence of substituents on the electrophilic character of carbonyl derivatives. Reminders and complements: aldehydes, ketones, acids and acid derivatives, esters, amides and nitriles. 4.1 Aldehydes and ketones 4.1.1 Nucleophilic addition on the carbonyl function - HCN and alcohols (proton catalysis); Organomagnesiums and hydrides (Lewis acid electrophilic assistance). 4.1.2 Enolates and aldol reaction - Aldol reaction, acid and base catalysis, cross aldolization, Knoevenagel reaction. The enolate function. Preparation and reactivity (aldol reaction, alkylation, conjugated additions, acylation, Claisen reaction) 4.2 Acids and derivatives 4.2.1 Preparation and electrophilic reactivity 4.2.2 Interconversion-quality of leaving groups. Hydrolysis of esters, acid chlorides, ... **V. SEAr reactions (aromatic electrophilic substitution) :** *1. Aromaticity* Definition of aromaticity, Hückel's rule, examples *2. The SEAr reaction* SEAr definition and mechanism, kinetic aspects. Classes of reactions (halogenation reaction, nitration, sulfonation, alkylation, Friedel-Craft acylation). *3. Polycondensations* Orientation rules. Industrial applications. **VI. Nitrogenous compounds in organic chemistry** 1. Amines : 1-1-Definitions and physicochemistry of organic amines. 1-2-Synthesis of amines and reactivity
Inline resources	The essential course materials are all available on the Moodle platform : - Slides presented in the course - Exercise session outlines - Practical work manuals (laboratories)
Bibliography	• Chimie organique, P. Bruice – Pearson 2° Edition • Organic Chemistry, Clayden

Faculty or entity in charge	CHIM

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Bachelor in Chemistry	CHIM1BA	4		🔍
Bachelor in Bioengineering	BIR1BA	4	LCHM1141B	🔍