

6.00 credits


30.0 h + 40.0 h

Q1

Teacher(s)	Elias Benjamin ;Riant Olivier ;
Language :	English
Place of the course	Louvain-la-Neuve
Main themes	<p><b>Courses :</b></p> <ol style="list-style-type: none"> <li>1. Introduction to organic synthesis <ul style="list-style-type: none"> <li>- Retrosynthetic analysis</li> <li>- Activation and protection of functional groups</li> <li>- Chemoselectivity, regioselectivity</li> <li>- Anchimeric assistance</li> <li>- Stereoselectivity and asymmetric synthesis</li> </ul> </li> <li>2. Modern methods for organic synthesis <ul style="list-style-type: none"> <li>- Modern method for the activation in organic synthesis (piezo-chemistry, micro-waves, high pressure activation)</li> <li>- Clean reaction media (ionic liquids, supercritical media)</li> <li>- Solid supported catalysts</li> </ul> </li> <li>3. Parallel synthesis and methods for combinatorial chemistry.</li> </ol> <p>The methods and concepts will be illustrated by examples in various fields of application such as in the natural product synthesis and in the pharmaceutical industry.</p> <p><b>Exercises :</b></p> <p>Main themes</p> <ul style="list-style-type: none"> <li>- Multi-step synthesis of components illustrating practical applications in the daily field: examples of insecticides (chrysanthemic acid) and herbicides</li> <li>- Spectroscopic analysis, manipulation of NMR simulation software, synthesis report and presentation of results</li> <li>- Introduction to bibliographic research on data bases and in research libraries</li> </ul>
Learning outcomes	<p><b>At the end of this learning unit, the student is able to :</b></p> <p>Organic synthesis is an important area of chemistry which requires the integration various knowledge's and concepts.</p> <p>The first aim of this course is to teach the students the best to analyse a target structure in order to design a synthetic scheme.</p> <p>The second aim is to acquire the expertise toward synthesis by the manipulation of both activation methods and selectivity control.</p> <p>Those objectives will be completed by an initiation to the modern methods used in organic synthesis.</p> <p>1 New synthetic methods related to novel activation methods and the use of non pollution media (green chemistry) will be presented.</p> <p>Finally, new notions related to structural diversity and combinatorial chemistry will be done by an introduction to liquid and solid phase parallel synthesis.</p> <p>Following the exercises in organic chemistry from the preceding year, the aim of those practicals will be focussed to learning multi-step organic synthesis.</p> <p>The laboratories will deal with projects meaning to illustrate practical applications in the daily field such as herbicides, insecticides, antibiotics or perfumes.</p>

Evaluation methods	<p><b>Theoretical teaching</b> is completed by <b>practical training (laboratory sessions)</b>. <b>Practical training</b> is an integral and inseparable part of the teaching of organic chemistry.</p> <p>Participation in all <b>laboratory sessions</b> is compulsory and is subject to continuous evaluation, taking into account in particular the keeping of the laboratory notebook, behaviour in the laboratory and the quality of the manipulations performed. The laboratory grade accounts for <b>30% of the final grade of the exam, all sessions included, if and only if the written exam related to the theoretical part of the course is passed (grade greater than or equal to 10/20 - mathematical rounding is applied)</b>.</p> <p>Any <b>absence from the practical work</b> must be <b>justified</b> (justified by a medical certificate in case of illness or by an official document in case of death of a relative).</p> <p>Any other absence or any absence <b>without justification</b> is sanctioned by a mark of 0/20. <b>There are no make-up sessions.</b></p> <p>These conditions are also valid for <b>BIS students</b> unless they have already obtained a mark of <b>10/20</b> or higher in the practical work, in which case they are <b>exempt</b>.</p> <p>Participation in the practical work is compulsory and indispensable to validate the teaching unit.</p> <p>Any unjustified absence will result in a penalty in the examination of the unit, which may go as far as the cancellation of the examination grade for the year of study concerned (0/20).</p> <p>In case of repeated absences, even if justified, the teacher can propose to the jury to oppose the registration to the examination related to the UE in accordance with article 72 of the RGEE.</p> <p>The final examination covers the content of the course and the laboratories. It takes the form of a written examination which may include open-ended questions and multiple choice questions. The final exam covers the content of the course, the exercises and the laboratories. The final exam is a written exam that may include open-ended questions and MCQs. In case of technical problems during the written exam or if there is a suspicion of fraud, the teachers reserve the right to orally question the students concerned.</p> <p>The exam grade is <b>70% of the final grade, all sessions combined (see note above for lab sessions)</b>.</p> <p><b>The grades are added together, taking into account all the figures after the decimal point. The final grade obtained is rounded to the nearest whole number according to the following rule :</b></p> <p>For any grade greater than or equal to X.50, <b>the overall grade</b> is rounded up to the next unit (i.e. X+1)</p> <p>For any mark strictly inferior to X.50, <b>the global mark</b> is rounded down to the lower unit (i.e. X-1)</p>
Teaching methods	<p>The teaching takes place in person.</p> <p>However, it is possible that some sessions are held remotely depending on the time constraints of the speakers.</p>
Content	<p><b>Part 1 :</b></p> <p><b>Concepts and tools in retrosynthetic analysis/organic synthesis.</b></p> <p>Recent examples of disconnection/reconnection.</p> <ul style="list-style-type: none"> <li>- Strategies, convergence, selectivity, cascade reactions, synthetic equivalents, polarity inversion.</li> <li>- Activation methods, protection/deprotection of the main functional groups. Chirality control.</li> <li>- Resolution (chemical, enzymatic, by chromatography).</li> <li>- Use of chiroins.</li> <li>- Use of chiral auxiliaries.</li> <li>- Asymmetric catalysis.</li> </ul> <p>Some examples will be chosen in the field of medicinal chemistry: naproxene, monobactams and carbapenems (antibiotics), lateral chain of taxol, diltiazem, captopril, ...</p> <p><b>Part 2 :</b></p> <p><b>Modern methods for activation in organic synthesis :</b></p> <p>Piezo-chemistry, micro-waves, high pressure methods.</p> <p>Introduction to "Green Chemistry".</p> <p>New reaction media; ionic liquids, supercritical CO<sub>2</sub>, perfluorinated solvents;</p> <p>Recoverable and recyclable catalysts: Solid phase supported homogeneous catalysts, grafting of homogeneous catalysts on soluble polymers.</p> <p><b>Part 3 :</b></p> <p><b>Solution combinatorial synthesis :</b></p> <p>Multicomponent reactions, Purification and analysis of libraries of compounds, selective extraction and use of capture resins.</p> <p>Solid phase synthesis: Resins for solid phase synthesis and linkers.</p> <p>Strategies for synthesis and methods,</p> <p>Applications (heterocycles synthesis and olefin metathesis).</p> <p>Summary for the exercises (content and methods)</p> <p>The students will work independently on a multi-step synthesis using furnished procedure, that they will eventually have to adapt. The products and some intermediates will be characterised. Every synthesis is fully reported and detailed in the laboratory book.</p> <p>The overall work will be presented during the final seminar and will be a part of the final evaluation.</p> <p>The current techniques used are the following: crystallisation, liquid-liquid and liquid-solid extraction, distillation, vacuum line manipulations, manipulation in anhydrous and anaerobic conditions, semi-micro scale synthesis, column chromatography.</p>

	The techniques used for the analysis and control of the purity of the products are: Infra red and NMR spectroscopies, TLC, polarimetry, liquid chromatography (HPLC). The students will also be trained to use NMR simulation programmes and bibliography databases.
Inline resources	Essential course materials are available on the Moodle platform : <ul style="list-style-type: none"> <li>• Slides presented during the course</li> <li>• Practical work manual (laboratories)</li> </ul>
Bibliography	Livres de référence disponibles à la BST : <ul style="list-style-type: none"> <li>• Carey, Sundberg – Chimie Organique Avancée (tomes 1 et 2), De Boeck ;</li> <li>• Warren, Wyatt – Organic Synthesis, the disconnection approach, Wiley ;</li> <li>• Clayden, Chimie Organique, De Boeck.</li> <li>• Asymmetric Synthesis of Natural Products (A. M. P. Koskinen).</li> </ul>
Faculty or entity in charge	CHIM

<b>Programmes containing this learning unit (UE)</b>				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Chemistry	<a href="#">CHIM2M</a>	6		
Master [60] in Chemistry	<a href="#">CHIM2M1</a>	6		