COURSE DESCRIPTION

Retrosynthetic Analysis

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	Babeş-Bolyai University of Cluj-Napoca
1.2. Faculty	Faculty of Chemistry and Chemical Engineering
1.3. Department	Chemistry
1.4. Field	Chemistry
1.5. Level of study	Master's degree
1.6. Degree programme / Qualification	Advanced Chemistry / Chemist
1.7. Form of education	Full-time

2. Course-related data

2.1. Course title	**Retrosynthetic Analysis**			Course code	**CMR6132**
2.2. Course coordinator	Prof. Niculina Hădade				
2.3. Seminar coordinator	Prof. Niculina Hădade				
2.4. Year of study	II	2.5. Semester	1	2.6. Type of assessment	Exam
2.7. Course status	Compulsory			2.8. Course type	Specialisation subject

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**4**	of which: 3.2. course	**2**	3.3. seminar/ laboratory/ project	**2**
3.4. Total of hours in the curriculum	56	of which: 3.5. course	28	3.6. seminar/ laboratory	**28**
Time allocation for individual study (IS) and self-taught activities (ST)					**hours**
Learning from textbooks, course materials, bibliography, and notes (IS)					20
Additional research in the library, on subject-specific electronic platforms, and on-site					28
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					14
Tutoring (professional guidance)					2
Examinations					4
Other activities [					1
3.7. Total hours of individual study (IS) and self-taught activities (ST)				**69**	
3.8. Total hours per semester				**125**	
3.9. Number of credits				**5**	

4. Prerequisites (where applicable)

4.1. curriculum-related	Basic notions of organic chemistry
4.2 skills-related	Not applicable

5. Specific conditions (where applicable)

5.1. course-related	Students will access the course materials in PDF format via the group created on the Microsoft Teams platform. Interactive participation will be encouraged. Students must keep their phones switched off.
5.2. seminar/laboratory-related	Attendance is mandatory under the conditions established by the regulations. Students will have access to the educational resource for seminar preparation within the dedicated group created on the Microsoft Teams platform. Students shall attend the seminar with the bibliographic material indicated during the previous seminars.

6.1. Competencies resulting from the completion of the degree programme *(as referred to in the curriculum)*[1]

Professional competencies	
Competency code	**Competency**
PC1	Demonstrate disciplinary expertise
PC4	Manage chemical testing procedures
PC5	Interact professionally in research and professional environments
Transversal competencies	
Competency code	**Competency**
TC2	Work in teams
TC3	Think critically

6.2. Learning outcomes relevant to the degree programme (as referred to in the curriculum)[2]

Learning outcomes targeted by the subject		
Competency code	**Knowledge and comprehension**	**Specific academic skills**
CP5, CT2	The graduate understands norms, roles and working practices specific to academic and professional research environments, including communication and collaboration standards.	The graduate interacts professionally in research and professional environments, gives and uses feedback, and argues scientific decisions within teams.
CP3, CT3	The graduate understands quality criteria and standards of scientific argumentation (coherence, validity, reproducibility, relevance) used to evaluate conclusions.	The graduate critically evaluates results and interpretations and communicates well-argued conclusions and recommendations in academic/professional contexts, adapting the message to audiences and purpose.

7. Subject-specific learning outcomes

Knowledge and comprehension
1. Explains the terminology and fundamental concepts of retrosynthetic analysis, including the notions of target compound, transformation, retron, disconnection, synthon, and synthetic equivalent, as well as their role in the systematic reduction of molecular complexity.
2. Describes the main retrosynthetic analysis strategies based on transformations, functional-group interconversions, molecular skeleton disconnection, and the identification of retrons specific to acyclic and cyclic organic compounds.
3. Explains the criteria for selecting and evaluating retrosynthetic routes for monocyclic, polycyclic, heterocyclic, and macrocyclic structures, including the relevant topological and stereochemical aspects.
4. Understands the criteria of coherence, validity, and relevance used in arguing a retrosynthetic analysis and in justifying the stages proposed for the synthesis of a complex organic compound.
Specific academic skills
1. Develops retrosynthetic analyses for complex organic compounds by strategically identifying retrons, disconnections, relevant synthons, and their appropriate synthetic equivalents.

[1] The professional and/or transversal skills targeted by the subject for which the course description is prepared will be copied from the curriculum of the degree programme. For each competency, the complete entry, including the competency code, will be copied with the exact wording that appears in the curriculum, without any changes. If no competency is copied from either of the two categories, the row corresponding to that category is deleted from the table.

[2] The learning outcomes relevant for the degree programme and targeted by the subject for which the course description is prepared will be listed. The entries, copied without any changes from the Curriculum by subject type (Core Subject/Specialisation Subject/Complementary Subject), are listed under the corresponding competency.

2. Critically compares alternative synthetic routes and argues for the choice of a retrosynthetic strategy based on chemical feasibility, step economy, stereochemical control, and precursor accessibility.
3. Communicates clearly and persuasively, both orally and in writing, the conclusions of a retrosynthetic analysis and collaborates effectively in seminar activities by formulating, supporting, and revising the proposed solutions.

8. Contents

8.1. Course	**Teaching and learning methods**	**Remarks[3]**
8.1.1. Definition of terms specific to retrosynthetic analysis (target compound, transformation, retron, disconnection, synthons).	Lecture, discussion, problem-based learning	2 hours
8.1.2. Strategies based on transformations and functional groups. Structural simplification transformations based on molecular skeleton disconnection: chain disconnection (synthons for carbon-chain formation).	Lecture, discussion, problem-based learning	2 hours
8.1.3. Structural simplification transformations based on identifying a retron of the difunctionalized aliphatic residue type (disconnection of 1,2- and 1,3-difunctional derivatives).	Lecture, discussion, problem-based learning	2 hours
8.1.4. Structural simplification transformations based on identifying a retron of the difunctionalized aliphatic residue type (disconnection of 1,4-, 1,5-, and 1,6-difunctional derivatives).	Lecture, discussion, problem-based learning	2 hours
8.1.5. Structural simplification transformations based on identifying a ring-type retron. Disconnection of small rings (3, 4 atoms/(hetero)atoms).	Lecture, discussion, problem-based learning	2 hours
8.1.6. Structural simplification transformations based on identifying a medium-ring retron. Disconnection of medium rings (5, 6 atoms).	Lecture, discussion, problem-based learning	2 hours
8.1.7. Transformations without simplification of the molecular skeleton (molecular skeleton rearrangements, functional-group rearrangements, inversion of stereocenter configuration).	Lecture, discussion, problem-based learning	2 hours
8.1.8. Transformations based on reaction mechanisms.	Lecture, discussion, problem-based learning	2 hours
8.1.9. Strategies based on the similarity between the structure of the target compound and the structures of starting materials.	Lecture, discussion, problem-based learning	2 hours
8.1.10. Topological strategies: for acyclic systems and polycyclic systems (isolated, spiro, or bridged rings).	Lecture, discussion, problem-based learning	2 hours
8.1.11. The strategy of stereochemical approaches and functional-group modification.	Lecture, discussion, problem-based learning	2 hours
8.1.12. Multistrategic retrosynthetic analysis of macrocyclic structures.	Lecture, discussion, problem-based learning	2 hours

[3] For example, organisational aspects, recommendations for students, specific aspects relating to the course/seminar, such as inviting experts in the field, etc.

8.1.13. Multistrategic retrosynthetic analysis of heterocyclic structures.	Lecture with PPT support, discussion, problem-based learning	2 hours
8.1.14. Multistrategic retrosynthetic analysis of polycyclic structures.	Lecture, discussion, problem-based learning	2 hours
Bibliography		
1. E. J. Corey, Xue-Min Cheng, The Logic of Chemical Synthesis, Wiley, 1995. 2. P. Laszlo, Logique de la synthese organique, Marketing, Paris, 1993. 3. M. B. Smith, Organic Synthesis, McGraw-Hill, 1994. 4. R. O. C. Norman, Principles of Organic Synthesis, Chapman and Hall, 1981.		
8.2. Seminar/ laboratory	**Teaching and learning methods**	**Remarks**
8.2.1. Simplifying transformations, disconnections, synthons, and their synthetic equivalents.	Problem solving	2 hours
8.2.2. Functional-group interconversions in the structure of organic compounds.	Problem solving	2 hours
8.2.3. Retrosynthetic analysis and transformation-based strategies for the 1,2-difunctional retron (1,2-diols, α-hydroxy carbonyls, α-diketones, α-oxo acids).	Problem solving	2 hours
8.2.4. Retrosynthetic analysis and transformation-based strategies for the 1,3-difunctional retron (β-hydroxy carbonyls, β-diketones, β-oxo acids).	Problem solving	2 hours
8.2.5. Retrosynthetic analysis and transformation-based strategies for the 1,4-difunctional retron (hydroxy carbonyls, hydroxy acids, unsaturated acids).	Problem solving	2 hours
8.2.6. Retrosynthetic analysis and transformation-based strategies for the 1,5-difunctional retron (hydroxy carbonyls, hydroxy acids, unsaturated acids).	Problem solving	2 hours
8.2.7. Retrosynthetic analysis and transformation-based strategies for the 1,6-difunctional retron (hydroxy carbonyls, hydroxy acids, unsaturated acids).	Problem solving	2 hours
8.2.8. Retrosynthetic analysis and transformation-based strategies for monocyclic compounds (retron: cyclopropane).	Problem solving	2 hours
8.2.9. Retrosynthetic analysis and transformation-based strategies for monocyclic compounds (retron: cyclobutane).	Problem solving	2 hours
8.2.10. Retrosynthetic analysis and transformation-based strategies for monocyclic compounds (retron: cyclopentane).	Problem solving	2 hours
8.2.11. Retrosynthetic analysis and transformation-based strategies for monocyclic compounds (retron: cyclohexane).	Problem solving	2 hours
8.2.12. Retrosynthetic analysis and transformation-based strategies for monocyclic polycyclic compounds (with isolated and spiro rings).	Problem solving	2 hours

8.2.13. Retrosynthetic analysis and synthesis strategy of polycyclic compounds (with fused rings).	Problem solving	2 hours
8.2.14. Multistrategic retrosynthetic analysis.	Problem solving	2 hours
Bibliography: **1.** I. Schiketanz, I. Costea, Retrosinteza Organica, Printech, 2006. **2.** M. E. Alonso, The Art of Problem Solving in Organic Chemistry, John Wiley & Sons, 1987. **3.** C. Cristea, I. Hopârtean, I. A. Silberg, Chimia organică a produşilor naturali, Risoprint, 2002.		

9. Evaluation

Type of activity	9.1 Evaluation criteria[4]	9.2 Evaluation methods[5]	9.3 Percentage in the final grade
9.4. Course	Knowledge of the concepts underlying the theoretical methods for the systematic reduction of the molecular complexity of organic compounds. Development of skills for using the concepts of retrosynthetic analysis in planning the synthesis of organic compounds.	Written paper in which the retrosynthetic analysis of a complex target organic compound and the planning of the chemical synthesis stages are described in detail. Oral presentation, with PPT support, of the key elements of the retrosynthetic analysis and the planning of the synthesis stages. Answers to the questions.	80 %
9.5. Seminar/ laboratory	Understanding and assimilation of the topics covered in the course and seminar. Capacity for the appropriate use of theoretical concepts and methods.	Active participation in problem solving. Completion of assignments during the semester.	20%
9.6 Minimum standard for passing			
Grade 5 (five): systematic reduction of the molecular complexity of an organic compound with a cyclic structure, side chains, and functional groups.			

10. SDG labels (Sustainable Development Goals)[6]

	○	Sustainable Development Generic Label

[4] The evaluation criteria must directly reflect the learning outcomes targeted at the level of the degree programme respectively at the level of the subject. More specifically, the learning outcomes set out in the expected learning outcomes are assessed.

[5] Both final evaluation methods and ongoing evaluation strategies should be established.

[6] Select a single label which, according to the *Implementation of SDG labels in the academic process*, best matches the subject. If the subject addresses sustainable development in a generic manner (i.e. by presenting/introducing the general framework of sustainable development, etc.), then the Sustainable Development generic label may be applied. If none of the labels describe the subject, select the last option: *"No label applies."*

			X					
								No label applies

Date of entry:
17.04.2026

Signature of course coordinator

Prof. Dr. Niculina Hădade

Signature of seminar coordinator

Prof. Dr. Niculina Hădade

Date of approval in the department:
24.04.2026

Signature of the head of department

Prof. Dr. Monica Toșa