COURSE DESCRIPTION

Functional Dyes from Synthesis to Applications

Academic year 2025-2026

1. Programme-related data

1.1. Higher Education Institution	Babes-Bolyai University, Cluj-Napoca
1.2. Faculty	Chemistry and Chemical Engineering
1.3. Department	Doctoral School of Chemistry
1.4. Field	Chemistry
1.5. Level of study	Doctoral
1.6. Degree programme / Qualification	Doctoral training/PhD in Chemistry
1.7. Form of education	IF

2. Course-related data

2.1. Course title	*Functional Dyes from Synthesis to Applications*			Course code	SDC-19-15
2.2. Course coordinator	Gaina Luiza				
2.3. Seminar coordinator	Gaina Luiza				
2.4. Year of study		2.5. Semester		2.6. Type of assessment	Exam
2.7. Course status	Optional			2.8. Course type	Specialisation subject

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

3.1. Number of hours per week	**3**	of which: 3.2. course	**2**	3.3. seminar/ laboratory/ project	**1**
3.4. Total of hours in the curriculum	36	of which: 3.5. course	24	3.6. seminar/ laboratory	**12**

Time allocation for individual study (IS) and self-taught activities (ST)	**hours**
Learning from textbooks, course materials, bibliography, and notes (IS)	50
Additional research in the library, on subject-specific electronic platforms, and on-site	86
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays	70
Tutoring (professional guidance)	4
Examinations	2
Other activities	2
3.7. Total hours of individual study (IS) and self-taught activities (ST)	**214**
3.8. Total hours per semester	**250**
3.9. Number of credits	**10**

4. Prerequisites (where applicable)

4.1. curriculum-related	Organic Chemistry
4.2 skills-related	

5. Specific conditions (where applicable)

5.1. course-related	Minimum of 2 students
5.2. seminar/laboratory-related	Minimum of 2 students

6.1. Competencies resulting from the completion of the degree programme[1]

[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.

Professional competencies	
Competency code	**Competency**
PC1	Advanced expertise in chemistry and doctoral-level research topics
PC4	Planning, designing, and implementing an original scientific research project, in compliance with academic ethics and integrity
PC5	Applying and developing advanced research and analytical methods; critically interpreting data and formulating innovative solutions
Transversal competencies	
Competency code	**Competency**
TC2	Advanced scientific communication in Romanian and English; collaboration in interdisciplinary and multicultural settings
TC3	Advanced digital skills for research, data analysis, and dissemination; responsible use of digital tools.

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**
PC1	Advanced and up-to-date knowledge in chemistry and the research field; critical understanding of the scientific literature.	Applies and synthesizes advanced concepts/theories to formulate research hypotheses; justifies the choice of scientific approaches.
PC4	Advanced research methodologies: experimental design, modern synthesis and characterization techniques, analysis and validation; principles of research project management.	Designs, plans and implements a research project; applies quality and safety procedures and documents stages and data with full traceability.
PC5	Advanced strategies for data analysis, interpretation, and integration; evaluation of methodological limitations, reproducibility, and scientific impact.	Critically analyses complex data, estimates uncertainty and formulates conclusions; proposes methodological improvements and directions for research/innovation.
TC2	Scientific terminology and communication in Romanian and English; the structure of scientific articles and presentations; good citation practices.	Writes and presents scientific results in Romanian/English coherently; provides well-argued responses to comments and peer reviews.
TC3	Digital tools for research, citation, and data processing (databases, specialized software, reference managers); responsible use of digital resources.	Uses discipline-specific digital tools effectively; manages citations; uses digital resources responsibly in research activities.

7. Subject-specific learning outcomes

Knowledge and comprehension
1. Critical understanding of structure-functional properties-industrial applications relationships based on scientific literature.
2. Evaluation of the use of functional dyes at an industrial level.
3. Proficiency in scientific language and terminology in the field of functional dye chemistry (in Romanian and English).
4. Advanced knowledge of digital tools for scientific documentation and applications dedicated to scientific data analysis and processing.

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.

Specific academic skills
1. Apply appropriate methods for obtaining and using functional dyes at an industrial level.
2. Propose and substantiate methodological improvements, identify new directions for research and innovation regarding the applications of functional dyes.
3. Writes and presents scientific research results in a clear, structured, and coherent manner for dissemination in the scientific community (in Romanian and English).
4. Uses IT resources responsibly in functional dye research.

8. Contents

8.1. Course	**Teaching and learning methods**	**Remarks[3]**
Fundamental concepts	Presentation; Conversation; Problematization	4 h
Dyes for staining biological tissue	Presentation; Conversation; Problematization	4 h
Photosensitizers in photodynamic therapy	Presentation; Conversation; Problematization	4 h
Functional dyes with applications in forensics chemistry	Presentation; Conversation; Problematization	4 h
Photochromic, thermochromic, and cryochromic dyes	Presentation; Conversation; Problematization	4 h
Functional dyes, colorimetric sensors for oxygen, CO_2, amines, sulfur compounds, etc.	Presentation; Conversation; Problematization	4 h

Bibliography:
Yousuke Ooyama, Shigeyuki Yagi, **Progress in the Science of Functional Dyes,** Ed. Springer Singapore, 2021
Sung-Hoon Kim, Functional Dyes. Ed. Elsevier Science, 1st Edition – 2006.
Raffaello Papadakis, Dyes and Pigments - Novel Applications and Waste Treatment, Ed. IntechOpen, 2021
B. Stoean (Vasile), R. Pop, D. Rugina, A. M.V. Branzanic, A. Turza, C. Cristea, A. Nicolescu, R. Silaghi-Dumitrescu, L. Gaina*. Photosensitizer activity of phenothiazinium derivatives against melanoma cells and DFT insights into singlet oxygen generation. Bioorganic Chemistry 2025, 163, 108720. https://doi.org/10.1016/j.bioorg.2025.108720.
M. Gal, L. Gaina, T. Lovasz, E. Gal, AM. Craciun, M. Focsan, A. Turza, D. Rugina, D A.M.V. Brânzanic, S. Pesek, R. Silaghi-Dumitrescu, C. Cristea. Sonochemical synthesis, optical properties and DFT studies on novel (N-arylamino)phenothiazinium dyes suitable for fluorescence cells imaging. Spectrochimica Acta part A-Molecular and Biomolecular Spectroscopy, 2024, 322, 124768. DOI10.1016/j.saa.2024.124768.
B. Stoean, M. Lehene, C. Zagrean-Tuza, R. Silaghi-Dumitrescu, C. Cristea, L. Gaina*.
Transient radical species and oxygen colorimetric indicators grounded on phenothiazinium dyes. Spectrochimica Acta part A-Molecular and Biomolecular Spectroscopy, 2024, 320, 124602. DOI 10.1016/j.saa.2024.124602.
B. Stoean, I. Lupan, C. Cristea, M. Silion, L. Silaghi-Dumitrescu, R. Silaghi-Dumitrescu, L. Gaina*, Outcomes of folic acid esterification upon the properties of hydrophilic phenothiazinium dyes: New photosensitizers for antimicrobial photodynamic therapy. Journal of Photochemistry and Photobiology A: Chemistry 2024, 451, 115500, https://doi.org/10.1016/j.jphotochem.2024.115500
M. Zetes, A.M. Hada, M. Todea, L. Gaina, S. Astilean, A.M. Craciun. Dual-emissive solid-state histidine-stabilized gold nanoclusters for applications in white-light generation. Nanoscale Advances, 2023, 5(21), 5810-5818 https://doi.org/10.1039/D3NA00555K
M. Gal, C. Cristea, A. M. Craciun, A. Turza, L. Barbu-Tudoran, B. Brem, T. Lovasz, L. Silaghi-Dumitrescu, L. Gaina*. New fluorescent electrospun polymer materials containing phenothiazinyl carboxylate metal salts for versatile latent fingerprint detection. Dyes and Pigments 2023, 111085. https://doi.org/10.1016/j.dyepig.2023.111085

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

8.2. Seminar/ laboratory	Teaching and learning methods	Remarks
Seminar topics presentation	Explanation; Conversation; Problem-solving; Debate	4h
Fluorescent dyes for marking biological tissue	Explanation; Conversation; Problem-solving; Debate	4h
Functional dyes with applications in forensics	Explanation; Conversation; Problem-solving; Debate	4h
Bibliography: Bibliografie: Yousuke Ooyama, Shigeyuki Yagi, **Progress in the Science of Functional Dyes,** Ed. Springer Singapore, 2021 Sung-Hoon Kim, Functional Dyes. Ed. Elsevier Science, 1st Edition – 2006. Raffaello Papadakis, Dyes and Pigments - Novel Applications and Waste Treatment, Ed. IntechOpen, 2021 Scientific articles related to the course topics		

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	Theoretical knowledge and conceptual understanding of dye classes and their properties.	Oral presentation	75%
	Demonstration of understanding of the correlations between dye structure and function.		
	Correct identification of the advantages and risks of using functional dyes, proposal of responsible solutions.		
9.5. Seminar/ laboratory	Assessment of the ability to communicate scientific results clearly, coherently, in a structured and logical manner, using correct scientific terminology	Individual Project	25%
9.6 Minimum standard for passing			
Grade 5 (five) on the exam and project according to the grading scale. Timely completion of seminar assignments.			

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:
03.02.2026

Signature of course coordinator

Signature of seminar coordinator

Date of approval in CDSC:

Signature of the Director of the DSC

Prof. dr. Niculina Daniela Hădade