COURSE DESCRIPTION CARD - SYLLABUS

Course name
CHEMISTRY AND BIOTECHNOLOGY IN THE MODERN WORLD. A JOURNEY FROM HOUSEHOLD THROUGH LABORATORY TO INDUSTRY [S5NC>CBWS]

Course

Proposed by Discipline
–

Year/Semester
3/5

Level of study
Doctoral School

Course offered in
English

Form of study
full-time

Requirements
elective

Number of hours

Lecture
8

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

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Lecturers

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Prerequisites

Knowledge: PhD student has advanced knowledge of chemical principles and their applications in biological, environmental, and technological contexts. They understand both the beneficial and adverse effects of chemical substances and are aware of current challenges, such as xenobiotics, environmental contamination, and the sustainability of chemical innovations. Skills: PhD student is able to critically analyze scientific literature, evaluate chemical processes in real world scenarios, and apply chemical reasoning to assess environmental, technological, and societal impacts. They can plan and present scientific arguments, organize discussions, and identify potential risks and benefits of chemical interventions. Social competencies: PhD student is prepared to act responsibly in professional and societal contexts, understanding the ethical and ecological implications of chemical research. They can communicate scientific knowledge effectively, work collaboratively in interdisciplinary teams, and are motivated to engage in lifelong learning and science popularization.

Course objective

The course aims to highlight the central role of chemistry in understanding and shaping the modern world. Chemistry serves as the language through which we describe biological and technological processes, as well as a tool to consciously influence the environment, health, and industry. Participants will explore both the positive aspects of chemical knowledge, its applications in medicine, agriculture, industry and its potentially negative consequences. Topics will include the chemical and biological impacts of armed conflicts on the environment, the presence of xenobiotics, challenges in food production, as well as examples of scientific innovations and misguided trends. Additionally, participants will learn how to plan and conduct research from the perspective of a journal editor, gaining insight into publication quality criteria and the elements of a project that determine its value and likelihood of acceptance in high-impact journals. The course will also address issues such as the overproduction of publications (“paper milling”) and short-lived scientific trends (“scientific fashion”), raising awareness about the importance of responsible research planning and conscious development of one’s scientific output. The course is designed to foster critical thinking skills and demonstrate that chemistry as a central science permeates everyday life and influences societal decisions.

Course-related learning outcomes

Knowledge
A PhD student who graduated from doctoral school knows and understands:
1. to the extent that enables revision of existing paradigms - global achievements, covering theoretical basis as well as general and selected specific issues, that are specific to scientific disciplines studied at the doctoral school, [P8S_WG/SzD_W01]
2. key developmental trends of science disciplines in which education takes place at the doctoral school, [P8S_WG/SzD_W02]
3. principles of promoting scientific activity results, also in an open access mode, [P8S_WG/SzD_W04]
4. basic conditions of knowledge transfer to the economic and social sphere as well as commercialization of the results of scientific activities and know-how related to these results. [P8S_WK/SzD_W07]

Skills
A PhD student who graduated from doctoral school can:
1. use the knowledge from different branches of science to creatively identify, formulate and to innovatively solve complex problems or to execute research tasks in particular:
- define the aim and subject of scientific research, form a research hypothesis,
- develop research methods, techniques and tools and use them creatively,
- draw conclusions on the basis of research results, [P8S_UW/SzD_U01]
2. critically analyze and asses scientific research results, work of experts and other creative activities together with their contribution into knowledge development, [P8S_UW/SzD_U02]
3. take part in scientific discourse. [P8S_UK/SzD_U07]

Social competences
A PhD student who graduated from the doctoral school is ready to:
1. critically assess the achievements within a given scientific discipline, [P8S_KK/SzD_K01]
2. critically evaluate their own contribution to the development of a given scientific discipline, [P8S_KK/SzD_K02]
3. maintain and develop the ethos of research and creative communities, including:
- conducting independent scientific activity,
- respecting the principle of public ownership of the results of scientific activities, including the principles of intellectual property protection. [P8S_KR/SzD_K07]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecturer assess the doctoral students’ knowledge through an online test and their activity in the discussion during lectures.

Assessment criteria (test):
3.0 (50.1 - 70.0%)
4.0 (70.1 - 90.0%)
5.0 (from 90.1%)

Programme content

The course highlights the central role of chemistry in understanding and shaping the modern world, showing how it serves as both a language for describing biological and technological processes and a tool for influencing the environment, health, and industry. Participants will explore both the beneficial applications of chemistry - in medicine, agriculture, and industry and its potential negative consequences. Topics include the chemical and biological impacts of armed conflicts, the presence of xenobiotics, challenges in food production, and examples of scientific innovations and short-lived trends. The course also addresses responsible research planning, publication quality, and phenomena such as “paper milling” and “scientific fashion,” fostering critical thinking and awareness of chemistry’s influence on everyday life and societal decisions.

Course topics

1. Poisons Around Us – From Food to Construction - An introduction to the world of chemistry that surrounds us in daily life – capable of nourishing, healing, but also harming. The lecture presents examples of chemical substances found in food products, building materials, and the human environment, highlighting their positive and negative roles.

2. When Modern Environmental Remediation Fails – Soil Contamination Removal, from Project to Case Study - A lecture dedicated to methods for remediating soils contaminated with chemical substances. A real research project combined with practical soil treatment will be discussed, where the expected outcomes of numerous new physico-chemical methods were not achieved. Particular emphasis will be placed on the role of chemistry in planning such studies and interpreting the results.

3. Ionic Liquids – A New Form of Environmental Contamination? - Discussion of ionic liquids from a new perspective. A critical and rigorous analysis of their properties, toxicity, and environmental fate, as well as exploration of whether ILs represent a genuine innovation or rather an example of “scientific fashion.”

4. Impact of Armed Conflicts on the Environment - An introduction to chemical and biological problems generated by armed conflicts. The lecture covers soil and water contamination, the use of toxic compounds, and the long-term chemical consequences of warfare for ecosystems and human health.

5. Geomicrobiology – Interactions Between Minerals and Microorganisms in the Environment- Discussion of the role of microorganisms in mineral transformation, ore formation and degradation, and generation of environmental problems such as water acidification or microbiological corrosion. The lecture combines chemical, geological, and biological perspectives, showing how microorganisms influence environmental chemistry.

6. Agriculture, Mass Food Production, Herbicides, and GMOs – What Is the Reality? - A chemical perspective on large-scale biomass production and its consequences. The lecture covers the use of plant protection agents, the impact of herbicides, and the real possibilities and limitations of genetic modifications in food production.

7. Sewage Epidemiology – How and Why to Estimate Drug Consumption? - A contemporary view on issues related to the overuse of medicinal substances in the population. Analytical methods used to monitor pharmaceuticals in wastewater and approaches to infer public health from such analyses are discussed.

8. How to Plan and Conduct Scientific Research from the Perspective of a Journal Editor - A discussion of the entire research process: from questions and hypotheses, through experimental design and choice of analytical methods, to data analysis and manuscript preparation. The lecture presents the perspective of a journal editor (why some papers do not even reach peer review) and critically addresses phenomena such as “paper milling” and “scientific fashion,” on the example of research projects and publications.

Teaching methods

Lectures, consultations, test based on materials presented during the lectures.

Bibliography

Basic

1. The Disappearing Spoon: And Other True Tales of Madness, Love, and the History of the World from the Periodic Table of the Elements, Sam Kean, 2010
2. Life 3.0: Being Human in the Age of Artificial Intelligence, Max Tegmark, 2017
3. Biotechnology for Beginners, Reinhard Renneberg, 2005
4. The Fourth Industrial Revolution, Klaus Schwab, 2016
5. The Innovators: How a Group of Hackers, Geniuses, and Geeks Created the Digital Revolution, Walter Isaacson, 2014
6. Biotechnology for Environmental Management and Resource Recovery, Nicholas V. C. Ralston, 2013

Additional
7. The Chemistry Book: From Gunpowder to Graphene, 250 Milestones in the History of Chemistry, Derek B. Lowe, 2016

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	8	0,00
Doctoral student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation)	42	2,00