UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

## Chemistry

**2526-4-G8501R046-G8501R073M**

### Course title

Chemistry

### Topics and course structure

The course presents the basic concepts of modern chemistry applied to concrete experiences in relation to the more general themes reported in the 2012 National Indications and chemistry in ecology and environmental education, also in connection with the topics of the other module of the same course .

### Objectives

With this course, and through consistent and active participation in the lessons, the following educational objectives are pursued, as outlined in the regulations and the curriculum framework:

KNOWLEDGE AND COMPREHENSION SKILLS

1. Knowledge of fundamental scientific concepts, selected based on their relevance and accessibility in the context of early childhood and primary education.
2. Knowledge of formalized languages and their use to represent and construct models of relationships between objects and events.
3. Knowledge of scientific methods for the observation, understanding, and study of natural phenomena and their interdependent relationships.
4. Knowledge of the biotic and abiotic elements of the natural environment, their mutual interaction, and their transformations, including reference to the biological, chemical, and physical environmental impact of

human society on the Earth's ecosystem.
5. Basic knowledge and understanding of some chemical, physical, and biological aspects in everyday life.
6. Understanding the phenomena that characterize the relationship between humans and their environment, as well as knowledge of territorial and demographic evolutionary dynamics related to cultural and productive systems.
7. Ability to critically read historical texts, particularly by grasping the value of historical perspective and knowledge for understanding the world we live in.
8. Knowledge of the principles of education for the respect and conservation of cultural (and environmental) heritage.

APPLICATIVE SKILLS

1. The ability to communicate and work with formalized meanings and languages. The ability to use these languages to represent and construct models of relationships between objects and events.
2. The ability to apply scientific practices for studying and understanding natural phenomena: observing, experimenting, collecting data, imagining, constructing interpretive models, predicting, revising.
3. The ability to design educational activities and pathways through an interconnected vision of scientific disciplines, in order to interpret phenomena and events in a systemic manner.
4. Knowing how to use the analytical tools of mathematics and physics for the scientific description of the world and to tackle problems in everyday life.

JUDGMENT AUTONOMY

These attitudes are developed through group discussions, teaching internship activities focused on reworking educational experiences, simulation practices, critical content presentation, and activation of reflection and problem-solving based on case discussions. The assessment of judgment autonomy is conducted through specific sections of written and oral exams, as well as the final report presented at the end of each internship year. In the evaluation of the internship, thesis, and final report, consideration will be given to the future teacher's ability to independently and reflectively elaborate. Upon completion of the educational path, the graduate will possess the following attitudes:

- Ability to self-assess their professional preparation and the effectiveness of their teaching practice.
- Willingness to renew teaching practices through openness to research, experimentation, and innovation.

COMMUNICATIVE SKILLS

The acquisition of these learning outcomes is supported by transversal paths throughout all formative activities. The assessment of these results, which may include the presentation of written papers, oral presentations, projects, and educational products, is conducted through basic and specialized training activities, laboratory and internship pathways, and within the context of understanding texts and lectures in English. Upon completion of the educational path, the graduate will possess the following skills:

- Verbal and non-verbal ability to modulate classroom communication for different purposes: to present, prepare experiences, explain concepts and theories, motivate learning, support students in difficulty, and stimulate peer interaction.
- Ability to present the objectives and nature of the teaching intervention in an organized manner, through educational and didactic planning.

LEARNING ABILITIES

The acquisition of these learning outcomes is pursued through all formative activities that allow for independent research by the student and free access to useful information for developing a cultural attitude aimed at self-formation. The monitoring and assessment of these results occurs through various types of ongoing assessments throughout the different educational activities. Upon completion of the educational path, the graduate will have developed the following attitudes and approaches in terms of learning abilities, in the perspective of lifelong learning:

- Interest in the teaching profession and the desire to improve its knowledge and practice.

- Willingness to expand basic psycho-pedagogical and methodological-didactic culture, also in relation to advancements in scientific research.
- Motivation to deepen the content and study methods of school knowledge, with ongoing updates to disciplinary repertoires.
- Openness to exploring perspectives of educational, methodological, technological, and media research conducted both nationally and internationally, with a focus on pedagogy and special education.
- Ability to self-sustain and self-regulate learning through independent bibliographic research and active participation in professional development and training opportunities.

## Methodologies

a) 14 two-hour lectures, in person, Delivered Didactics

b) Type: lectures, use of videos, readings, active teaching methodologies, experiences, suggestions for home experiments, discussion on communicating basic chemistry concepts to primary school students.

## Online and offline teaching materials

Languace of lectures: italian
Books
Additional material discussed in class
Slides shown in class
Use of websites for further information

Students who wish to spread the exam over two years must agree with the instructor on a new, updated bibliography to take the exam.

The teacher provides the following additional and alternative materials to support non-traditional students in their study and exam preparation:

- Full recording of in-person lectures;
- Copy of the slides containing material not included in the mandatory textbooks.

For **Erasmus students**, any chemistry textbook in English at the high school level, as well as texts in other languages related to the topics covered in class, may be used (to be brought on the day of the exam).

## Programme and references

Indicatively, the lesson blocks will follow this scheme:

First part (18-20 hours)

- chemistry as a bridge science between the various disciplines
- the macroscopic and microscopic worlds
- measurements and sizes
- the physical transformations of matter

- from chemical transformations to atomic theory; the periodic table of the elements
- the kinetic-molecular theory
- the moles
- the atom: particles and structure
- water chemistry and chemical bonds

Second part (4-6 hours)

- the evolution of chemical thought in history: the great discoveries and the great chemists of the past

Third part (4-6 hours)

- chemistry in the ecological transition to accelerate the energy transition towards complete climate neutrality and sustainable development with respect for resources and people, mitigate the effects of climate change and move to an energy system with lower greenhouse gas emissions and production and more sustainable energy consumption
- green chemistry and use of reagents and solvents that respect humans and the environment

The course is structured in frontal lessons.

Bibliography


1. Giuseppe Valitutti, Patriza Amadio, Marco Falasca, "Chimica. Concetti e modelli. Dalla materia all'elettrochimica. Terza Edizione, Zanichelli, 2023 (or other text on the basic notions of chemistry at secondary school level; some texts will be indicated in class; during the first lesson any reference university texts will be indicated which are not in any case compulsory).
2. Alessandro Abbotto, "Il genio quotidiano. Raccolta di racconti del quotidiano di grandi scienziati chimici e delle loro scoperte, Edises, 2023.
3. Alessandro Abbotto, Vito Capriati, “La nuova chimica del XXI secolo. Rivoluzione verde e transizione ecologica”, Edizioni Dedalo, 2023.

Other recommended bibliography:
4) Alessandro Abbotto, Idrogeno. “Tutti i colori dell’energia”, Edizioni Dedalo, 2021.
5) Primo Levi, “Il sistema periodico”, edizione per le scuole, a cura di Roberta Mori, Maria Vittoria Barbarulo, Einaudi Scuola, 2022 (ISBN 8828625678)
6) Vincenzo Balzani, Margherita Venturi, “Chimica!”, Scienza Express
7) Sara Moraca, Elisa Palazzi, "Siamo tutti Greta", Edizioni Dedalo, 2022
8) Gianfranco Pacchioni, “W la CO2”, Il Mulino
9) Eleonora Polo, “L’isola che non c’è”, Edizioni Dedalo
10) Laura Cipolla, “I quaderni della didattica. Metodi e strumenti per l’insegnamento e l’apprendimento della chimica”, EDISES.
11) Alessandro Abbotto, "La mobilità elettrica. Storia, tecnologia, futuro", Carocci Editore, 2022.
12) Alessandro Abbotto, "Perchè l'auto elettrica", Scienza Express, 2024.
13) Testo di chimica generale a livello del primo anno di università per corsi di laurea non chimici (a lezione saranno indicati alcuni testi)


## Assessment methods

**Written and oral**
The written test consists of a multiple test (closed-ended questions), aimed at ascertaining knowledge of the subject matter covered in the lessons.
The oral test (if the written test is passed) is optional, chosen by the candidate or at the request of the teacher. The

optional oral test will consist of the discussion of any critical issues in the writing and any need to verify and deepen knowledge of the topics covered in class.
The optional oral examination may result in a reduction of the grade obtained in the written test, and may also lead to a failing mark.
The final exam grade is the average of the grades obtained in the two modules. The exam grade can be officially recorded only if the final average is equal to or greater than the passing mark (18/30).
If, after the oral exam, the grade is rejected by the student (or in case of failure), the written test must be retaken, even if the previous written test had received a passing grade.
During the module, optional ongoing written tests will be offered.

**The exam sessions scheduled for the Chemistry module taken in the 2025/26 academic year must be completed with an exam session for the Biology Teaching module within the same academic year. Otherwise, the exam cannot be recorded. The midterm tests held during the course require special rules, which are explained in class and on the e-learning pages.**

**Erasmus students** may request to take the oral exam in English.

**The following grading criteria are applied in relation to the following parameters:**

1. Conceptual knowledge and comprehension skills
2. Ability to apply knowledge and comprehension
3. Communication and argumentative skills
4. Learning, self-assessment, and self-regulation skills

Grade 14-17

1. Knowledge and Comprehension
   The student identifies only partially the characteristics of the concepts. The connections between concepts are fragmented and poorly supported by theoretical knowledge.
2. Ability to apply knowledge and comprehension
   The student identifies only a few relevant elements of a phenomenon, without being able to integrate them into an organic analysis.
3. Communication and Argumentative Skills
   In the oral exam, the student develops a basic argument, lacking logical articulation and characterized by numerous expositional inaccuracies.
4. Learning, self-assessment, and self-regulation skills
   The student is able to reconstruct only a few aspects of their learning and professional development.

Grade 18-22

1. Knowledge and Comprehension
   The student recognizes and presents most of the conceptual characteristics and is able to provide a relatively coherent explanation, although with some inaccuracies. The theoretical references are present but not always rigorous.
2. Ability to apply knowledge and comprehension
   The student is able to recognize a significant number of elements and provide a partial explanation, although there are some gaps in the analysis.
3. Communication and Argumentative Skills
   In the oral exam, the student constructs a basic argument, with a minimal structure but some inaccuracies.
4. Learning, self-assessment, and self-regulation skills
   The student demonstrates basic awareness of their learning process, being able to trace essential connections between formative experiences, though with some analytical imprecision.

Grade 23-27

1. Knowledge and Comprehension
   The student demonstrates a deep understanding of conceptual characteristics. In the oral exam, the explanations are well articulated and supported by appropriate use of theoretical references.
2. Ability to apply knowledge and comprehension
   The student identifies the essential elements of a phenomenon with precision. The application of knowledge is carried out with methodological rigor, though not always solid.
3. Communication and Argumentative Skills
   In the oral exam, the student develops a coherent and well-organized argument, demonstrating good command of language and a solid logical-argumentative structure. Communication is clear and effective.
4. Learning, self-assessment, and self-regulation skills
   The student analyzes their learning process in a clear and structured way, highlighting significant relationships between different developmental stages and demonstrating good critical reflection skills.

Grade 28-30

1. Knowledge and Comprehension
   The student demonstrates complete mastery of the concepts, articulating complex connections and providing exhaustive explanations. Theoretical references are used with pertinence and rigor.
2. Ability to apply knowledge and comprehension
   The student demonstrates advanced analytical ability, identifying and interpreting all key elements of a phenomenon in an exhaustive manner. The application of knowledge is carried out with methodological rigor, supported by a solid and articulated argument.
3. Communication and Argumentative Skills
   In the oral exam, the student develops a solid and articulated argument, with a rigorous logical framework and a high level of textual coherence. The discourse is fluid and well-structured.
4. Learning, self-assessment, and self-regulation skills
   The student demonstrates advanced self-reflection, providing an articulated and deep analysis of their learning and professional development. The connections between formative experiences and theoretical concepts are clear, coherent, and rigorous.

**In order to ensure transparent evaluation, the criteria adopted and shared with the students for the exam assessment are outlined below.**
Written exam: fraction of exercises completed correctly; 45 minutes, 15 questions; evaluation in thirtieths
Oral exam: further discussion of the exercises and concepts addressed in the written exam, along with knowledge of related concepts; 30-60 minutes.
The final grade, in thirtieths, takes into account both parts of the exam.

## Office hours

Always by appointment via email

## Programme validity

One academic year

## Course tutors and assistants

## Sustainable Development Goals

ZERO HUNGER | GOOD HEALTH AND WELL-BEING | QUALITY EDUCATION | GENDER EQUALITY | CLEAN WATER AND SANITATION | AFFORDABLE AND CLEAN ENERGY | DECENT WORK AND ECONOMIC GROWTH | INDUSTRY, INNOVATION AND INFRASTRUCTURE | SUSTAINABLE CITIES AND COMMUNITIES | RESPONSIBLE CONSUMPTION AND PRODUCTION | CLIMATE ACTION | LIFE BELOW WATER | LIFE ON LAND