

CH101 - Chemistry

Module Overview and General Aims

- ECTS: 15 credits
- Course Instances: 1BPC1 - BSc Biopharmaceutical Chemistry (core)
1BS1 - BSc Undenominated (optional)
1EV1 - BSc Environmental Science (optional)
1PHY1 - BSc Physics (optional)
1OS1 - Occasional Science (optional)
1OS9 - Occasional Science Teaching Council (optional)
- Coordinator: Dr. Luca Ronconi (luca.ronconi@universityofgalway.ie)
- Academic Staff Involved: Dr. David Cheung, Dr. Laura Cunningham, Dr. Luca Ronconi

This Module lays a broad foundation in chemistry for undenominated science students, as well as students who have an option of continuing to study chemistry in subsequent years. Some of these students will study chemistry to degree level and pursue careers as chemists. The Module assumes no prior knowledge of chemistry, although a significant minority of students would have an NFQ Level 5 (*i.e.* Leaving Certificate) qualification in chemistry.

The aim is to provide the learner with the knowledge, skills and competences associated with molecular and physico-chemical approaches to the study of matter and of chemical change. The Module is designed to develop an understanding of how chemicals function in “real world” applications and how chemistry integrates with human, social and environmental issues. Students will also develop the knowledge, skills and competences appropriate for effective and safe work in a chemistry laboratory.

Module Delivery

The Module runs over both Semesters I and II (23 weeks overall, 11 in Semester I/12 in Semester II). The theory course is delivered in 69 lectures (normally 3 one-hour lectures per week, 33 in Semester I/36 in Semester II) and 18 tutorials (normally 1 one-hour tutorial per week, 9 in Semester I/9 in Semester II).

The indicative timetable is reported below.

Academic Year 2024/2025 (Semester I)											
Week beginning	16-Sep	23-Sep	30-Sep	7-Oct	14-Oct	21-Oct	28-Oct	4-Nov	11-Nov	18-Nov	25-Nov
Week n.	1	2	3	4	5	6	7	8	9	10	11
Lectures & Tutorials (CH101)											
Mon 10-11am (O'Flaherty)	LR	LR	LR	LR	LR	LR	Bank Holiday	DC	DC	DC	DC
Tue 12-1pm (Kirwan)	LR	LR	LR	LR	LR	LR	LR	DC	DC	DC	DC
Thu 12-1pm (O'Flaherty)	LR	LR	LR	LR	LR	LR	LR	DC	DC	DC	DC
Thu 2-3pm (tutorial) (O'Flaherty)		LR	LR	LR	LR	LR	LR		DC	DC	DC
Fri 1-2pm (tutorial) (D'Arcy Thompson)		LR	LR	LR	LR	LR	LR		DC	DC	DC
Practicals (CH101/CH120 (1BGG1 & 1MR1 only)/CH130/CP102)											
Mon 2-4.30pm			Practical 1	Practical 2	Practical 3	Practical 4	Bank Holiday (moved to 25 th Nov)	Practical 6	Practical 7	Practical 8	Practical 5 (Mon group only)
Tue 3-5.30pm			Practical 1	Practical 2	Practical 3	Practical 4	Practical 5	Practical 6	Practical 7	Practical 8	
Wed 2-4.30pm			Practical 1	Practical 2	Practical 3	Practical 4	Practical 5	Practical 6	Practical 7	Practical 8	
Thu 3-5.30pm			Practical 1	Practical 2	Practical 3	Practical 4	Practical 5	Practical 6	Practical 7	Practical 8	
Fri 2-4.30pm			Practical 1	Practical 2	Practical 3	Practical 4	Practical 5	Practical 6	Practical 7	Practical 8	

Academic Year 2024/2025 (Semester II)												
Week beginning	13-Jan	20-Jan	27-Jan	3-Feb	10-Feb	17-Feb	24-Feb	3-Mar	10-Mar	17-Mar	24-Mar	31-Mar
Week n.	1	2	3	4	5	6	7	8	9	10	11	12
Lectures & Tutorials (CH101)												
Mon 10-11am (O'Flaherty)	LR	LR	LR	Bank Holiday	DC	DC	DC	DC	LC	Bank Holiday	LC	LR
Tue 12-1pm (Kirwan)	LR	LR	LR	LR	DC	DC	DC	LC	LC	LC	LC	DC
Thu 12-1pm (O'Flaherty)	LR	LR	LR	LR	DC	DC	DC	LC	LC	LC	LC	LC
Thu 2-3pm (tutorial) (D'Arcy Thompson)		LR	LR	LR		DC	DC	DC	LC	LC	LC	
Fri 1-2pm (tutorial) (D'Arcy Thompson)		LR	LR	LR		DC	DC	DC	LC	LC	LC	
Practicals (CH101/CH120 (OMB3 & 1B01 only)/CH130)												
Mon 2-4.30pm			Practical 9	Bank Holiday (moved to 27 th Jan)	Practical 10	Practical 11	Practical 12	Practical 13	Practical 14	Bank Holiday (moved to 31 st Mar)	Practical 16	Practical 15 (Mon group only)
Tue 3-5.30pm				Practical 9	Practical 10	Practical 11	Practical 12	Practical 13	Practical 14	Practical 15	Practical 16	
Wed 2-4.30pm				Practical 9	Practical 10	Practical 11	Practical 12	Practical 13	Practical 14	Practical 15	Practical 16	
Thu 3-5.30pm				Practical 9	Practical 10	Practical 11	Practical 12	Practical 13	Practical 14	Practical 15	Practical 16	
Fri 2-4.30pm				Practical 9	Practical 10	Practical 11	Practical 12	Practical 13	Practical 14	Practical 15	Practical 16	

Unless otherwise stated, all lectures and tutorials are delivered in person on campus according to the timetable provided. In order to improve the learning process and facilitate the effective interaction between students and lecturers, the same tutorial is delivered twice per week, meaning that students have the option to attend the weekly tutorials either on Thursdays (2-3pm) or Fridays (1-2pm).

As far as the practical component of the course is concerned, there are 40 hours of laboratory work split into 16 practical sessions of 2.5 hours each (1 practical per week, 8 in Semester I/8 in Semester II). Students will be notified by the College the day of practicals and allocated a bench number. Pre-practical talks, highlighting the practical and theoretical aspects of the laboratory experiments to be carried out, as well as the related health and safety information, will be held in the first year chemistry teaching laboratory prior to the actual start of the practical.

All practicals will be carried out on campus. Students are expected to perform their laboratory work on the assigned day (as a general rule, **no day swapping allowed**).

Laboratory prerequisites:

- Students **must** bring their own **white Howie laboratory coat** (for science/chemistry) and **safety glasses/goggles** (available at the SU shop). Laboratory coats and safety glasses **cannot** be hired or borrowed: should a student arrive at a practical without their own laboratory coat and/or safety glasses/goggles, they **will not** be allowed to carry out the practical and, as such, will be given an **unauthorized absence**.
- Students **must** attend the pre-practical talks: should a student miss the pre-practical talk, they **will not** be allowed to carry out the practical and, as such, will be given an **unauthorized absence**.
- The electronic version of the laboratory manual will be available on Canvas. Students **must** bring their own printout of the laboratory manual (the hardcopy will be provided to each student during the first practical session, **mobile phones/tablets/laptops strictly prohibited**): should a student arrive at a practical without their own printout of the laboratory manual, they **will not** be allowed to carry out the practical and, as such, will be given an **unauthorized absence**.

Course Outline & Learning Outcomes

- Atoms and the Periodic Table: basic atomic theory, electron configuration and periodic properties
- Chemical Bonding: from atoms to molecules, chemical formulas and molecular shape
- Quantitative Chemistry: mole, percent composition and concentration
- Thermodynamics: enthalpy and entropy, spontaneous change and chemical equilibrium
- Reactions in Aqueous Solutions: acids and bases, redox reactions, solubility and titrations
- States of Matter: intermolecular forces, gases, liquids and solids
- Kinetics: activation energy, reaction rates and mechanisms
- The Molecules of Life: carbon-based compounds and their reactivity

On successful completion of the Module, the learner will be able to:

- LO1 show an understanding of fundamental atomic structure and rationalize the properties of the elements and their compounds based on electron configuration and periodic trends;
- LO2 draw representations of the bonding and geometry of simple molecules and ions;
- LO3 predict chemical formulas of compounds using valence considerations and the knowledge of simple and complex cations and anions;
- LO4 solve quantitative problems involving chemical equilibrium and chemical kinetics, to include thermochemistry, entropy, Gibbs free energy, the direction of spontaneous change, and the effect of temperature on the rate of reactions;
- LO5 solve quantitative chemistry problems and demonstrate reasoning clearly and completely as applied to mass- and mole-type calculations, acid-base, redox and precipitation reactions in aqueous solutions;
- LO6 use models of structure at the atomic/molecular level, including intermolecular forces, to explain the physical properties of matter;
- LO7 predict and explain the expected chemical and physical behavior of simple organic compounds based on their functional groups and geometry, to include conformation and stereochemistry;
- LO8 show an understanding of nucleophiles, electrophiles, electronegativity, and delocalization/resonance;
- LO9 draw mechanisms of selected fundamental organic reactions, to include substitution, elimination and addition reactions, and predict their outcome;
- LO10 develop skills in problem solving, critical thinking and analytical reasoning as applied to scientific problems;
- LO11 appreciate the central role and societal relevance of chemistry and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals and environmental impact, as well as key issues facing our society in energy, health and medicine.

On successful completion of the associated practical work in the laboratory, the learner will be able to:

- LO12 analyze salts for the presence of common cations and anions, and simple organic substances for the presence of common functional groups;
- LO13 use appropriate laboratory techniques and equipment to synthesize, separate and purify chemical compounds;
- LO14 use titrimetry and physico-chemical techniques for quantitative analysis and to determine physico-chemical properties;

LO15 implement safe work practices in a chemistry laboratory, to include awareness of common hazards and appropriate safety precautions;

LO16 carry out scientific experiments, accurately record and analyze the results of such experiments, and report to a scientifically acceptable standard on laboratory work.

Textbook and Reference Material

- P. Flowers, K. Theopold, R. Langley, E.J. Neth, W.R. Robinson, *Chemistry: Atoms First 2e*, OpenStax™, 2019 (web version last updated in June 2024 downloadable for free at <https://openstax.org/details/books/chemistry-atoms-first-2e/>).
- First Year Chemistry Laboratory Manual (downloadable from Canvas, hardcopy to be provided).
- Lecture notes, slides and literature papers (provided in due course on Canvas).

Module Assessment & Marking

The Module will be assessed over the two Semesters as follows.

- Continuous Assessment (CA, overall worth 40% of the final grade):
 - Mandatory attendance to 16 laboratory sessions (1 practical per week, 8 in Semester I/8 in Semester II) and submission of a written report on the laboratory work each week (worth 30%)
 - 18 weekly online homework (9 in Semester I/9 in Semester II) on topics dealt with during lectures/tutorials (worth 10%)
- Two formal two-hour duration written examinations at the end of each Semester on the theory course (overall worth 60% of the final grade):
 - Paper-1 ⇒ multiple choice question (MCQ) examination at the end of Semester I (worth 30%)
 - Paper-2 ⇒ multiple choice question (MCQ) examination at the end of Semester II (worth 30%)

Continuous Assessment

- **Attendance** ⇒ mandatory to all pre-practical talks and subsequent laboratory sessions
A **limited number of authorized absences** (up to 3 for a 16-practical course) may be given **only** for:
 - medical reasons (upon provision of an official medical certificate: certificates received after one calendar month from the date of absence **will not be accepted**);
 - bereavement in the event of the death of an immediate family member (upon provision of the RIP.ie death notice);
 - participation to scheduled sports events involving members of any of the University of Galway sports teams (upon provision of an official absence request sent in advance by the University of Galway Sports Office).

Requests for authorized absences will be evaluated on a case-by-case basis. After 3 authorized absences have been granted, any additional absence will be deemed as unauthorized **regardless of the reason**.

- **Laboratory reports** ⇒ reports of the laboratory work submitted each week through Canvas
Templates of the laboratory reports are included in the laboratory manual. Downloadable templates of the laboratory reports (as Word documents) will be available in due course on Canvas.

Attending the laboratory only is **not** enough to get credits: practicals must be completed satisfactorily and complete laboratory reports must be submitted weekly through Canvas by the relevant deadline (to

be communicated in due course). Each report will be marked out of 10. A **“zero” will be given for late or no submission, as well as for any unauthorized absence.**

- **Online homework** ⇒ weekly assignments to be worked out online over the two semesters
- A total of 18 online homework will be assigned on a weekly basis over the two semesters and will need to be completed and submitted through Canvas by the relevant deadline (to be communicated in due course). Each homework will be marked out of 10 and will comprise of short-answer questions, numerical problems and multiple-choice questions. A **“zero” will be given for late or no submission.**

Written Examination

Past exam papers are available on Canvas and in the Exam Papers Archive (https://regexam.nuigalway.ie/regexam/paper_index_search_main_menu.asp) of the James Hardiman Library. Note that, according to the policy in place at the School of Biological and Chemical Sciences, past Paper-1 MCQ-type examinations and past repeat Paper-1 and Paper-2 exam papers are **not** made available.

- **Paper-1 ⇒ MCQ-type examination at the end of Semester I**
- The written examination of two-hour duration will be marked out of 45 and the overall grade will be returned as % mark. It will consist of 45 MCQs (marking scheme: +1 for each correct answer, 0 for each unattempted question, 0 for each incorrect answer) and students are required to answer **all** MCQs.
- **Paper-2 ⇒ Advanced MCQ-type examination at the end of Semester II**
- The written examination of two-hour duration will be marked out of 90 and the overall grade will be returned as % mark. It will consist of a variable number of MCQs allocated to three sections as follows:
- Section A: Reactions in aqueous solutions (Dr. Luca Ronconi)
 - Section B: States of matter and chemical kinetics (Dr. David Cheung)
 - Section C: Molecules of life (Dr. Laura Cunningham)
- Each section will carry **30 marks** distributed as shown in the exam paper. Students are required to answer **all** MCQs from **all** three sections (**no internal choice**).

Further details about the format of the exam papers will be provided in due course.

Marking

Marks of laboratory reports and online homework will be made available on Canvas in due course.

Results of Paper-1 examination will be returned on Canvas as provisional grades (**not** as % mark) as follows:

- grade A: 70-100%
- grade B: 60-69%
- grade C: 50-59%
- grade D: 40-49%
- grade E+: 35-39%
- grade E-: 30-34%
- grade F: 0-29%

Students will be communicated the aggregate mark for the Module once the overall examination process is complete (that is, after the Paper-2 examination has been marked and all grades have been approved by the College).

A student will have **passed** if the mark in the CA component is at least 35% (that is, 14 out of 40) **and** the aggregate mark for the Module is at least 40%.

A student will be deemed **incomplete** if the mark in the CA component is less than 35%. Should this be the case they **will not** be able to progress **regardless** of the performance in the written examination for the Module in the 1st sitting. Consequently, the student **will not be allowed** to re-sit either, and will have to **re-register** for the Module the following year and **re-engage in all parts** of the Module again.

A student will have **failed** the 1st sitting where the mark in the CA component is at least 35% but the aggregate mark for the Module is less than 40%. Should this be the case, the student will have to repeat the written examination in the 2nd sitting with a view to improving the overall Module mark, retaining the CA mark from the 1st sitting. Should the student underperform also in the 2nd sitting (that is, by obtaining an aggregate mark for the Module lower than 40%), they will have **failed** the 2nd sitting and will have to **re-register** for the Module the following year and **re-engage in all parts** of the Module again.