Appendices Bachelor's degree programme Chemistry

Appendix I Learning outcomes of the degree programme (Article 1.3)

A. Generic learning outcomes – Knowledge

A1. Bachelor's graduates have general knowledge of the foundations and history of mathematics, natural sciences and technology, in particular those of their own discipline.

A2. Bachelor's graduates have mastered the basic concepts of their own discipline (see Appendix 1 for further specification) to a certain extent and are familiar with the interrelationships of these concepts within their own discipline as well as with other disciplines.

A3. Bachelor's graduates have in-depth knowledge of several current topics within their own discipline.

A4. Bachelor's graduates are familiar with the quantitative character of the fields of mathematics and natural sciences and have an understanding of the methods used in these fields, and particularly within their own discipline, including computer-aided methods.

A5. Bachelor's graduates have sufficient knowledge and understanding of mathematics and natural sciences to successfully complete a follow-up Master's degree programme in their own discipline.

A6. Bachelor's graduates are aware of the societal, ethical and social aspects involved in the fields of mathematics and natural sciences.

B. Generic learning outcomes – Skills

B1. (Research) Bachelor's graduates are able to draw up a research question, design, plan and conduct research and report on it independently with a certain degree of supervision. Bachelor's graduates are able to evaluate the value and limitations of their research and assess its applicability outside their own field.

B2. (Designing) Bachelor's graduates are able to translate a problem, in particular a design problem, into a plan of approach and – taking into account the requirements of the client and/or technical preconditions – find a solution.

B3. (Gathering information) Bachelor's graduates are able to gather relevant information using modern means of communication and to critically interpret this information.

B4. (Collaborating) Bachelor's graduates are able to collaborate in teams (including multidisciplinary teams) on technical-scientific problems.

B5. (Communicating) Bachelor's graduates are able to communicate orally and in writing in academic and professional contexts, with both colleagues and others. They are familiar with the relevant means of communication.

B6. (Reflecting) Bachelor's graduates are able to assess their own actions and those of others in a natural sciences context, bearing in mind the social/societal and ethical aspects.

B7. (Learning skills) Bachelor's graduates are able to apply learning skills that enable them to pursue a follow-up degree and acquire knowledge in new fields with a high level of autonomy.

B8. Additional subject-specific skills are listed in Appendix 2.

Appendix 1 Degree programme-specific learning outcomes – Basic Knowledge

The Bachelor's graduate in Chemistry has:

1.1. knowledge of the most important fields of Chemistry: Inorganic, Organic, Analytical, Physical, Polymer Chemistry and Biochemistry, furthermore general knowledge of more specific field such as Theoretical Chemistry, Materials Chemistry, etc.,
1.2. knowledge of at least one multidisciplinary fields: 'Chemistry of Life', 'Smart Materials' and 'Sustainable Energy and Chemistry',
1.3. a broad general knowledge of subjects within his/her own discipline or of subjects within a different discipline,
1.4. necessary background knowledge of Mathematics and Physics,
1.5. understanding of the position and role of the discipline within science and society, and also in the international character of the discipline.

The Bachelor's graduate has become familiar with the following key elements of Chemistry:

a. The important aspects of chemical terminology, nomenclature and conventions.
b. Numerical and computational skills, including error analysis, understanding of the proper order of magnitude and correct use of units.
c. The most important types of chemical reactions and their characteristics.
d. The principles and procedures that are used in the chemical analysis and in the characterization of chemical compounds.
e. The fundamental techniques of structural analysis, including spectroscopy.
f. The properties of various states of matter and the common theories to describe them.
g. The principles of Quantum Mechanics and its applications in the description of structure and properties of atoms and molecules.
h. The principles of Thermodynamics and its applications in Chemistry.
i. The kinetics of chemical processes, catalysis and mechanical interpretation of chemical reactions.
j. The typical properties of elements and their compounds, including group relationships and trends in the periodic table.
k. The structural properties of chemical elements and their compounds.
l. The typical properties of aliphatic, aromatic, heterocyclic and organometallic compounds.
m. The nature and behavior of functional groups in molecules.
n. Important synthetic routes of organic/inorganic chemistry.
o. The relationship between bulk properties of matter and properties of individual atoms and molecules, including macromolecules (both natural and synthetic).
p. The structure and reactivity of important types of biomolecules and the chemistry of important biological processes.
q. The design of processes (also on industrial scale), taking into account flow and transfer of matter and energy.
r. Properties of chemicals and the involved environmental and safety aspects.

Appendix 2 Degree programme-specific learning outcomes – Skills

The Bachelor's graduate in Chemistry has developed the skills and competencies mentioned below.

Chemistry-related cognitive skills and competencies

The Bachelor's graduate is:

2.1. able to demonstrate and use his/her knowledge and understanding of essential facts, concepts, principles and theories related to the topics, as defined in Appendix Ia, in various situations,
2.2. able to apply knowledge and understanding to solve basic qualitative and quantitative problems,
2.3. skilled in evaluating, interpreting and combining chemical information and data,
2.4. able to recognize and implement 'good laboratory practice',
2.5. familiar with project work,
2.6. able to adopt a professional attitude regarding environmental and safety aspects and possible ethical implications in the context of research, education and industry.

Chemistry-related practical skills

The Bachelor's graduate is:

2.7. skilled in the use of standard laboratory procedures and in the use of equipment for synthetic and analytical work,
2.8. able to verify chemical properties, to observe and measure events or changes, and to systematically archive and document data,
2.9. able to interpret data, obtained from observations and measurements, and relate it to the right theories,
2.10. able to assess the risks of laboratory procedures and the use of chemicals,
2.11. skilled in the safe handling of chemicals, taking into account physical and chemical properties, including the various specific risks of use, and is also able to act adequately in emergency situations in the laboratory,
2.12. able to use IT skills appropriate to the chosen specialization.

Appendix II Follow-on Master's degree programmes (Article 1.5)

The Bachelor's degree programme will grant unconditional admission to the following Master's degree programmes at the University of Groningen:

- Chemistry
- Education and Communication in Mathematics and Natural Sciences
- Energy and Environmental Sciences

The Bachelor's specialization in Chemistry of Life will grant unconditional admission to the following Master's degree programme:

- Molecular Biology and Biotechnology.

Appendix III Majors and Minors in the degree programme (Article 2.1.2)

The programme consists of a Major and a Minor.

1) The elective part within the Major is chosen from the following three tracks:
   a) Chemistry of Life
   b) Smart Materials
   c) Sustainable Chemistry and Energy
2) The Minor may either be the Minor Chemistry 'Science for Scientists' or may be chosen from the collection of university and faculty Minors.

Appendix IV Course units in the propaedeutic phase

- **List of course units; Article 3.1.1**
- **Course units with one or more practicals; Article 3.2**
- **Form of examinations; Article 7.4**

Course unit	ECTS	Assessment method	Practical
Calculus for Chemistry and Chemical Engineering	5	Written exam, test	x
Molecules: Structure, Reactivity, and Function	5	Assignments, Written exam, practical assessment, report, test	x
Choice: ▪ From Bacteria to Plastic ▪ Physics Laboratory 1 ▪ Introduction to Mathematics	5	 ▪ Reports, oral exam, lab journal, practical assessment ▪ Written exam, practical assessment ▪ Written exam	 x x
Organic Chemistry 1	5	Written exam, test	
Practicum Synthesis and Analysis 1	5	Practical assessment, report, discussion of results	x
Physical Chemistry 1	5	Written exam, practical assessment, homework assignments	x
Biochemistry	5	Written exam, practical assignment	x
Biochemistry Practicum	5	Oral exam, Lab journal, practical assessment,	x
Spectroscopy	5	Written exam, computer assignment, test	x
Process and Product Technology	5	Written exam	
Inorganic Chemistry	5	Written exam	
First Year Symposium	5	Presentation, report , poster	x

Appendix V Course units in the post-propaedeutic phase

- **List of course units; Article 6.1**
- **Course units with one or more practicals; Article 6.2**
- **Compulsory order of examinations; Article 7.2**
- **Form of examinations; Article 7.4**

Course unit	ECTS	Assessment method	Practical	Prerequisites
Material Properties 1	5	Written exam		
Organic Chemistry 2	5	Written exam, homework assignments		
Practicum Synthesis 2	5	Practical assessment, reports,	x	
Physical Chemistry 2	5	Written exam, practical assessment	x	
Linear Algebra for Chemistry and Chemical Engineering	5	Written exam, practical assessment	x	
Quantum chemistry	5	Written exam, practical assessment, report	x	
Science, Ethics, Technology and Society	5	Written exam, performance, essay, presentation,	x	
Macromolecular Chemistry	5	Written exam, tests, presentation	x	
Practicum Macromolecular Chemistry	5	Practical assessment, reports, oral exam	x	
Track: • Smart Materials • Sustainable Chemistry and Energy • Chemistry of Life	25	See individual tables	See individual tables	See individual tables
Track practical Choice: • Chemical Biology • Organic and Molecular Inorganic Chemistry • Polymer Chemistry • Materials Design, experiment	5	Practical assessment, report, discussion of results, presentation, oral exam	x	- 'Practical synthesis and analysis 1' or 'Practicum Chemie voor Levenswetenschappen' 'Practical Macromolecular Chemistry' -
Bachelor's Research Project	15	Performance, presentation, report	x	Passed 150 ECTS of the Bachelor's degree programme of Chemistry
Minor	30	See the programme-specific appendices IV and V of the Teaching and Examination Regulations.	See the programme specific appendices IV and V of the Teaching and Examination Regulations.	See the programme-specific appendices IV and V of the Teaching and Examination Regulations.

Chemistry of Life

Course unit	ECTS	Assessment method	Practical	Prerequisites
Bio-energetics and Metabolism	5	Written exam, test		
Recombinant DNA and Biotechnology	5	Written exam		
Chemical Biology	5	Written exam	x	
(Bio)-catalysis	5	Written exam, presentation	x	
Cellular Chemistry	5	Written exam	x	

Smart Materials

Course unit	ECTS	Assessment method	Practical	Prerequisites
Soft Molecular Materials	5	Written exam		
Material Properties 2	5	Written exam		
Molecular Design	5	Written exam, practical assessment, essay	x	
Materials Design: Theoretical Methods	5	Written exam, practical assessment, report	x	
Trends in Polymer Science	5	Written exam		

Sustainable Chemistry and Energy

Course unit	ECTS	Assessment method	Practical	Prerequisites
Bioenergy and Bioresources	5	Written exam, test		
Electrochemistry and Energy	5	Written exam, practical assessment	x	
Green Chemistry and Technology	5	Written exam		
(Bio)-catalysis	5	Written exam, presentation	x	
Physical Organic and Photo-Chemistry	5	Written exam		

The course units 'Bio-energetics and Metabolism' and 'Bioenergy and Bioresources' have a large overlap, therefore only one of both course units may be included in an individual's programme.

Minor Chemistry 'Science for Scientists'

The Minor comprises 30 ECTS and is a coherent and deepening package of course units.

Course unit	ECTS	Assessment method	Practical	Prerequisites
Medicinal Chemistry I	5	Written exam, computer practical assessment, report	x	
Medicinal Chemistry II	5	Written exam, computer practical assessment, participation excursion	x	
Biomaterials 2	5	Written exam		
Structural Probes for Solid Materials	5	Written exam, computer practical assessment	x	
Organic and Molecular Electronics	5	Written exam		
Solar Cells	5	Written exam, presentation, report	x	
Electives, courses from Bachelor's programmes Chemistry, Chemical Engineering, Biology, Life Science and Technology, Farmacie, (Applied) Physics, Astronomy, (Applied) Mathematics, Industrial Engineering and Management, which are to be individually approved by the Exam Committee.	0-30	See the programme-specific appendices IV and V of the Teaching and Examination Regulations.	See the programme-specific appendices IV and V of the Teaching and Examination Regulations.	See the programme-specific appendices IV and V of the Teaching and Examination Regulations.

Appendix VIII Admission to the post-propaedeutic phase

The following candidates will be admitted to the post-propaedeutic phase:

- Holders of a propaedeutic certificate of the degree programmes in Chemistry or Chemical Engineering

Appendix IX Contact Hours in the propaedeutic phase

Bachelor year 1	
Type of contact	**Number of contact hours per year**
Lectures	250
Tutorials	230
Practical	330
Computer practical	90
Study support/Mentor groups	8
Internship support and guidance	-
Exams	52
Misc. contact hours	-