EUROPEAN CHEMISTRY
THEMATIC NETWORK (ECTN)

Excellence in Education
Non-profit association

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Chemistry EUROBACHELOR® *Label*

EUROBACHELOR® *2018 Documentation*

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January 2019: replaces all earlier versions

Preamble

The chemistry **EUROBACHELOR®** degree framework was originally formulated by the Chemistry Subject Area Group in the project "Tuning Educational Structures in Europe" and adopted by the European Chemistry Thematic Network ECTN.

At that time, shortly after the Bologna Process had come into being, universities across Europe were being asked to introduce new shorter degree courses, commonly called Bachelor but officially known as First Cycle degrees. The purpose of the framework was to provide them with guidelines for planning the structure of such degrees.

The Bologna Process involved higher education institutions (HEIs) throughout the European Higher Education Area (EHEA), which now covers 48 countries. The EHEA has its own Qualifications Framework, according to which a first cycle qualification corresponds to 180-240 ECTS credits (3-4 years); the 180 credit degree is much more common than the 240 credit degree, so that the **EUROBACHELOR®** profile is based on 180 ECTS credits.

The European Commission has devised its own Qualifications Framework for Lifelong Learning, according to which a Bachelor degree corresponds to Level 6. To complete the picture, ISCED 2011 (the UNESCO classification) also locates Bachelor degrees at level 6.

Those institutions which decide to use 240 credits obviously exceed the **EUROBACHELOR®** criteria as defined below; they can of course use the **EUROBACHELOR®** framework and define the remaining 60 credits according to their own principles (e.g. the Bachelor Thesis may well carry more credits, or there may be an extended supervised industrial placement).

The primary aim of the **EUROBACHELOR®** qualification is to provide a first cycle degree which will be recognised by other European institutions as being of a standard which will provide automatic right of access (though not right of admission, which is the prerogative of the receiving institution) to chemistry Master programmes.

In view of the existence and acceptance of the Lisbon Recognition Convention of 1997 it may seem unnecessary to formulate such an aim, but in practice recognition is still a very uneven and uncertain process. It seems worthwhile to cite Article VI.1 of the Convention:

"To the extent that a recognition decision is based on the knowledge and skills certified by the higher education qualification, each Party shall recognise the higher education qualifications conferred in another Party, unless a substantial difference can be shown between the qualification for which recognition is sought and the corresponding qualification in the Party in which recognition is sought".

Since 2004, the European Chemistry Thematic Network ECTN has offered universities the possibility of applying for a "EUROBACHELOR® Label". ECTN, which now works with several partners on administering and awarding this Label and its pendant the EUROMASTER® Label (ASIIN/Germany, ANECA/Spain, Promozione Attività e Servizi PAS_SCI/Italy and AKKORK/Russia), has always seen its Labels as a desirable "add-on" to any certification (accreditation or evaluation) required by national bodies working within ENQA.

Employability

According to the Bologna declaration "The degree awarded after the first cycle shall also be relevant to the European labour market as an appropriate level of qualification". This statement has led to discussion in many countries regarding employability of first cycle degree holders, particularly in those countries which had previously had only long five-year first degrees.
Although subject knowledge is one criterion for employability, other competences and skills gained during the degree course are vital outcomes of an academic training for general employability. These can be divided into generic and subject-related competences and skills, and what follows refers to both chemistry-related outcomes and generic competences.

General Aims and Objectives

In the course of their degree programme, Eurobachelors should develop a realisation of the importance of chemistry in the world around us and of its possibilities for helping to solve problems for which mankind needs to develop solutions if it is to survive.
It is thus vital that teachers do not stress only the academic side of the subject, but also present material relevant to topics such as

- Chemistry and industry
- Chemistry and the environment
- The economic importance of chemistry
- Chemistry and energy, climate change and food production
- Chemistry and biology
- Chemistry and medicine
- Social aspects of chemistry

Learning Outcomes

It must be made clear at the outset that each institution providing Eurobachelor degree programmes in chemistry is completely free to decide on the content, nature and organisation of its courses or modules. Chemistry degree programmes offered by individual institutions may thus differ considerably in detail. They must however be constructed using a series of common goals.

The goals of a first cycle study programme can be described by the Budapest Descriptors developed by the Chemistry Subject Area Group working in the project "Tuning Educational Structures in Europe". They are as follows:

First cycle degrees in chemistry are awarded to students who have shown themselves by appropriate assessment to:

- have a good grounding in the core areas of chemistry: inorganic, organic, physical, biological and analytical chemistry; and in addition the necessary background in mathematics and physics;
- have basic knowledge in several other more specialised areas of chemistry[1]
- have built up practical skills in chemistry during laboratory courses, at least in inorganic, organic and physical chemistry, in which they have worked individually or in groups as appropriate to the area;
- have developed generic skills in the context of chemistry which are applicable in many other contexts;
- have attained a standard of knowledge and competence which will give them access to second cycle course units or degree programmes.

Such graduates will:

- have the ability to gather and interpret relevant scientific data and make judgements that include reflection on relevant scientific and ethical issues;
- have the ability to communicate information, ideas, problems and solutions to informed audiences;
- have competences which fit them for entry-level graduate employment in the general workplace, including the chemical industry;
- have developed those learning skills that are necessary for them to undertake further study with a sufficient degree of autonomy.

It should be noted that this Descriptor implies an obligation of the HEI issuing the individual Bachelor degree to offer a course which is capable of meeting these goals. It also implies an obligation to the graduate, to potential employers, and to society as a whole.

Outcomes: Background

The above Descriptor formulates learning outcomes for the programme as a whole. Naturally each course or module will have its own learning outcomes, and these will need to be formulated clearly and revised at intervals in the light of advances in chemical science.

[1] Such as computational chemistry, materials chemistry, macromolecular chemistry, radiochemistry

Outcomes: Subject Knowledge and Understanding[2]

Curricula of degree courses are developed and defined by institutions in the light of the profile which they wish their course to have. There can not be such a thing as a „Eurobachelor Curriculum“. It is however suggested that all programmes ensure that students become conversant with the following main aspects of chemistry:

The main types of chemical reaction and their main characteristics.
Methods of chemical analysis (both qualitative and quantitative) and the characterisation of chemical compounds.
Spectroscopy, x-ray diffraction and other principal techniques of structural investigation.
The principles of quantum mechanics and their application to the description of the structure and properties of atoms and molecules.
The principles of thermodynamics and their applications to chemistry.
The kinetics of chemical change, including catalysis; the mechanistic interpretation of chemical reactions.
The characteristic properties of elements and their compounds, including group relationships and trends within the Periodic Table.
The structural features of chemical elements and their compounds, including stereochemistry.
The chemistry of organic and organometallic compounds.
The nature and behaviour of functional groups in organic molecules.
Major synthetic pathways in organic chemistry.
The relation between bulk properties and the properties of individual atoms and molecules, including macromolecules (both natural and man-made), polymers and other related materials.
The structure and reactivity of important classes of biomolecules and the chemistry of important biological processes.

Outcomes: Abilities and Skills

At **EUROBACHELOR®** level, students are expected to develop a wide range of different abilities and skills.
These may be divided into three broad categories:

- Chemistry-related intellectual abilities and skills
- Chemistry-related practical skills
- Generic skills, developed as part of the teaching and learning of chemistry but also applicable in many other contexts

The abilities and skills which students are expected to develop during their **EUROBACHELOR®** degree programme in chemistry are listed below.

[2] In the year 2000, the United Kingdom Quality Assurance Agency (QAA) published a “benchmark statement” which provided a starting point for the initial **EUROBACHELOR®** discussions and some parts of which were incorporated in a modified form in the following sections.

Chemistry-related cognitive abilities and skills
Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to the subject areas involved in the degree programme.
Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of a familiar nature.
Ability to evaluate, interpret and synthesise chemical information and data.
Skills in theoretical and computational chemistry.
Skills in presenting scientific material and arguments in writing and orally, to an informed audience.
Information technology and data-processing skills, relating to chemical information and data.
Skills involved in carrying out and reporting on a research project, the outcomes of which should be potentially publishable.

Chemistry-related practical skills
Ability to determine possible hazards and carry out risk assessments involving the use of chemical substances and laboratory procedures.
Ability to plan and organize laboratory work and procedures.
Ability to handle chemicals safely, taking into account their physical and chemical properties, their toxicity and any other specific hazards involved in their use.
Skills required for carrying out laboratory experiments and using the instrumentation which may be required in the course of synthetic and analytical work.
Skills in the monitoring, by observation and measurement, of chemical properties, events or changes, and the systematic and reliable recording and documentation thereof.
Ability to interpret data derived from their laboratory observations and measurements in terms of their significance and relate them to the relevant theory.

Generic skills
Communication skills, covering both written and oral communication, in English and an official local language.
Skills in scientific writing and the presentation of data and experimental results.
Problem-solving skills.
Numeracy and calculation skills.
Research and analytical skills.
Information location and retrieval skills.
Information technology skills relevant to scientific information and its presentation.
Interpersonal skills, team-working.
Planning and time management.

Learning skills needed for undertaking further personal and professional development.

Organisation of Content

It is highly recommended that the **Eurobachelor®** degree course material should be presented in a modular form, whereby modules should correspond to at least 5 credits. The use of 10- or 15-credit modules can certainly be envisaged, a Bachelor Thesis or equivalent probably requiring 15 credits. Thus a degree course (180 credits) should not contain more than 34 modules, but will almost certainly contain less. It must be remembered that 34 modules require more than 10 examinations per year.

Apart from the Bachelor Thesis, which will be the last module in the course to be completed, it appears logical to define modules as being compulsory, semi-optional (where a student is required to select one or more modules from a limited range), and elective (where the student may choose one or modules from a normally much wider range).
While institutions should be encouraged to break down the traditional barriers between the chemical sub-disciplines, we realise that this process will not always be rapid. Thus we retain the traditional classification in what follows.

Compulsory chemistry modules will deal with:

- Analytical chemistry, inorganic chemistry, organic chemistry, physical chemistry, biological chemistry.

Semi-optional modules will deal with:

- Computational chemistry, chemical technology, macromolecular chemistry, biochemistry, biophysics.

Non-chemical modules will deal with mathematics, physics and biology. It can be expected that there will be compulsory mathematics and physics modules.
Practical courses may be organised as separate modules or as integrated modules. Both alternatives have advantages and disadvantages: if they are organised as separate modules, the practical content of the degree course will be more transparent. Integrated modules offer better possibilities for synchronising theory and practice.
Modules corresponding to a total of at least 150 credits (including the Bachelor Thesis) should deal with chemistry, physics, biology or mathematics.
Projects leading to the Bachelor Thesis could well involve teamwork, as this is an important aspect of employability which is often neglected in traditional chemistry degree courses.
Students should be informed in advance of the expected learning outcomes for each module.

Distribution of credits

Each individual institution will of course make its own decision as to the distribution of credits between compulsory, semi-optional and elective modules. It will however be necessary to define a "core" in the form of a recommended minimum number of credits for the main sub-disciplines as well as for mathematics and physics. This "core" should neither be too large nor too small, and a volume of 50% of the total number of credits, i.e. 90 out of 180, seems a good compromise in view of the different philosophies present in Europe. These 90 credits will cover the following areas:

- General chemistry
- Analytical chemistry
- Inorganic chemistry
- Organic chemistry
- Physical chemistry
- Biological chemistry
- Physics
- Mathematics

In other words, the 90 credits form the “core” of the degree course.

As far as semi-optional modules in chemistry are concerned, it is recommended that the student should study at least three additional chemical sub-disciplines, depending on the structure of the department: examples are biology, theoretical/computational chemistry, chemical technology, macromolecular chemistry. Each of these should correspond to at least 5 credits.

Additional semi-optional and elective modules will certainly be favoured in many institutions: these can be chemistry modules, but may also be taken from any other subjects defined by the appropriate Regulations. The course load should be organised in such a manner that the student distributes these modules evenly across the 3 years.

Language modules (stand-alone or integrated) will often be semi-optional, as the Eurobachelor should be proficient in a second European language as well as his/her mother tongue.

In summary, of the 180 credits available

- 90 credits are allocated to the core
- around 15 credits to the bachelor thesis,
- at least 15 credits to the semi-optional modules, and
- up to 60 credits are freely allocable by the institution.

ECTS and Student Workload

A European average for the total (expected) student workload per year generally lies between 1500 and 1800 hours; this figure refers to full-time students in a standard academic programme. One ECTS credit thus corresponds to 25-30 hours of work. The number of teaching weeks varies widely, from around 25 to just over 40. However, generally European institutions seem to expect their students to do degree-relevant work during 36-40 weeks per year.
Thus it is important to have clear guidelines on student workload distribution. These should always include definition of pre-examination study periods and examination periods separate from the teaching period, as these periods form an integral part of the total workload.
When defining workload for the different teaching/learning elements of a chemistry degree course it must be taken into account that, for example, the total workload connected with a 1-hour lecture is different than that corresponding to 1 hour of practical work. Factors thus have to be introduced when workload is being estimated.
Initial institutional estimates of workload for the average student will of course not necessarily be correct; thus there must be a clear mechanism for continuous student feedback on actual workload and the use of this feedback to correct the structure of programmes where necessary

Methods of Teaching and Learning

Chemistry is an "unusual" subject in that the student not only has to learn, comprehend and apply factual material but also spends a large proportion of his/her studies on practical courses with "hands-on" experiments, i.e. there are important elements of "handicraft" involved.

Practical courses must continue to play an important role in university chemical education in spite of financial constraints imposed by the situation of individual institutions.
There should also be an element of research involved in a **Eurobachelor®** course; thus the Bachelor Thesis referred to above is a highly recommended feature of the **Eurobachelor®**. It is important not only for those going on to do higher degrees, but also for those leaving the system with a first degree, for whom it is vital that they have personal first-hand experience of what research is about.
An industrial placement may be considered a valid alternative to a Bachelor Thesis; such placements should be organised in such a way that their outcomes are clearly documented, defended in the common way and that they can be given credits.
Lectures should be supported by multimedia teaching techniques wherever possible and also by problem-solving classes. These offer an ideal platform for teaching in smaller groups, and institutions are advised to consider the introduction of tutorial systems.

Learning

We can help the student to learn and develop his/her capacity for learning by providing him or her with a constant flow of small learning tasks, for example in the form of regular problem-solving classes where it is necessary to give in answers by datelines clearly defined in advance. It is obviously vital to have regular contacts between the teachers involved in the modules being taught to a class in any one semester to avoid overloading the student. Teaching committees with student participation seem to be an obvious measure here.

Assessment procedures and performance criteria

The assessment of student performance will be based on a combination of the following:

- Written examinations
- Oral examinations
- Laboratory reports
- Problem-solving exercises
- Oral presentations
- The Bachelor Thesis

Additional factors which may be taken into account when assessing student performance may be derived from:

- Literature surveys and evaluations
- Essay assignments
- Collaborative work
- Preparation and displays of posters reporting thesis work

Since **Eurobachelor®** programmes are credit-based, assessment should be carried out with examinations at the end of each term or semester. It should be noted that the use of ECTS does not automatically preclude the use of "comprehensive examinations" at the end of the degree course; if these are used they must however also be included in the credit distribution process!

Written examinations will probably predominate over oral examinations, for objectivity reasons; these also allow a "second opinion" in the case of disagreement between examiner and student.
Examinations should not be overlong; 2-3 hour examinations will probably be the norm.
Examination questions should be problem-based as far as possible; though essay-type questions may be appropriate in some cases, questions involving the regurgitation of material "digested" by rote learning should be avoided as far as possible.
Questions should be designed to cover the following aspects:

- The knowledge base
- Conceptual understanding
- Problem-solving ability
- Experimental and related skills
- Transferable skills

Examination papers should be marked anonymously and the student should be provided with feedback wherever possible in the form of "model answers".

The Diploma Supplement

All chemistry **Eurobachelors** must be provided with a Diploma Supplement in English and if required in the language of the degree-awarding institution.