

Master degree programmes

Faculty of Science

Leiden University

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MSc Mathematics

CROHO-number 66980

Leiden University offers six specialisations of an MSc programme in mathematics. Three of these correspond to research specialisations in the Leiden Mathematical Institute. The remaining three are the mathematics specialisation of the research MSc with Science-Based Business (SBB), Science Communication & Society (SCS) and Education (EDU) specialisations, which are described separately in this Appendix.

The duration of each programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Mathematics, with specification of the specialisation, if applicable. Details are provided below. All specialisations have the same Director, the same Board of Examiners, and the same Department Teaching Committee. A Board of Admissions will advise on admissions.

Candidates with a BSc degree or equivalent can apply for admission. The admission guidelines are given below for each specialisation. Individual combinations of the research programmes, with research projects from different groups, are possible in principle, depending on the decision by the Board of Examiners. The admission process may include an interview with the Board of Admissions. Foreign applicants must provide proof of proficiency in English (IELTS level ≥ 6.5). Admission is possible throughout the year, but we advise foreign students to start in September or February.

The goal of each programme is to train the student as an independent researcher, and to develop the necessary skills and proficiency to advance his/her career.

Specialisation

Algebra, Geometry and Number theory

Description

The MSc programme Algebra, Geometry and Number theory leads students to a high level of knowledge in this area. It consists of advanced courses from the field and a final research project including a master thesis and an oral presentation of it. Students with this MSc in Mathematics are admissible to a PhD programme. The programme is suited as preparation for an academic career, in particular via a subsequent PhD study, but also for a career as mathematical researcher outside the universities.

Qualifications for admission

Students from any university in The Netherlands with a BSc degree in Mathematics or with a BSc major in Mathematics will be admitted to the programme.

For all other (international) candidates, the Board of Admissions will judge the equivalence to these BSc degrees of their previous training. The choice in optional courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

Programme

For each student a programme will be tailored individually. It consists of a choice of advanced courses (at least 60 EC; at least 30 EC of these must be obtained via courses of the Dutch Master Programme in Mathematics) from algebra, algebraic and analytic number theory and algebraic and differential geometry, a research project in mathematics (at least 40 EC, including 7 EC for the thesis and an oral presentation), and a free choice of courses from any field (maximum 20 EC); required is a total of at least 120 EC.

Specialisation

Applied Mathematics

Description

The MSc programme Applied Mathematics leads students to a high level of knowledge in this area. It consists of advanced courses from the field and a final research project including a master thesis and an oral presentation of it. Students with this MSc in Mathematics are admissible to a PhD programme. The programme is particularly suited as preparation for a career as mathematical researcher in industry, government and other institutions, but also for an academic career, in particular via a subsequent PhD-study.

Qualifications for admission

Students from any university in The Netherlands with a BSc degree in Mathematics or with a BSc major in Mathematics will be admitted to the programme.

For all other (international) candidates, the Board of Admissions will judge the equivalence to these BSc degrees of their previous training. The choice in optional courses in the MSc programme may be limited by the need to adapt the programme to the present -knowledge of the candidate.

Programme

For each student a programme will be tailored individually. It consists of a choice of advanced courses (at least 60 EC; at least 30 EC of these must be obtained via courses of the Dutch Master Programme in Mathematics) on differential equations, dynamical systems, analysis of industrial problems, measure- and integration theory, probability theory, statistics, functional analysis, numerical analysis, operations research, a research project in mathematics (at least 40 EC, including 7 EC for the thesis and an oral presentation), and a free choice of courses from any field (maximum 20 EC); required is a total of at least 120 EC.

Specialisation

Statistical Science for the Life and Behavioural Sciences

Description

The MSc programme Statistical Science provides students with a thorough introduction to the general philosophy and methodology of statistical modelling and data analysis. Students gain knowledge of statistical methods and research designs as used in a broad range of empirical research, and practical skills such as statistical programming, statistical consultation, and written and oral presentation of research results. Students can specialise in applications pertaining to the Life Sciences or the Behavioural Sciences.

Qualifications for admission

Students with a wide range of bachelor degrees may apply for admission, but the bachelor's degree must include at least one introductory course and a more advanced course in statistics or probability. The candidate student should submit a letter (1 page) stating the student's motivation to apply to the program, and a Curriculum Vitae, including the courses and credits in the Bachelor program.

The courses will be taught in English, so proven proficiency in English is required for non-native English speakers (IELTS level ≥ 6.5).

The programme starts in September, in exceptional cases the Board of Admissions can decide to allow another starting date.

Programme

The nominal duration of the programme will be two years (120 ECTS). The study time may be substantially reduced for students with particular prior knowledge. The programme consists of courses and colloquia (84 EC), and an internship and writing of a Master Thesis (36 EC).

MSc Computer Science

CROHO-number 60300

The Leiden Institute of Advanced Computer Science (LIACS) is the computer science institute of Leiden University. The LIACS curriculum includes six MSc specialisations in computer science. Three of these correspond to research specialisations of LIACS, the remaining three are the computer science specialisation of the research MSc with Science-Based Business (SBB), and Science Communication & Society (SCS) and Education (EDU) specialisations which are described separately in this Appendix. In addition, LIACS offers two Master programmes in Media Technology and in ICT in Business, respectively.

The duration of each programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Computer Science, with description of the specialisation, if applicable. Details are provided below. All specialisations have the same Director, the same Board of Examiners, and the same Department Teaching Committee. A Board of Admissions will advise on admissions.

Candidates with a BSc degree in Computer Science or equivalent can apply for admission. The admission guidelines are given below for each specialisation. The admission process may include an interview with the Board of Admissions. Admission is possible throughout the year, but we advise foreign students to start in September or February. Foreign applicants must provide proof of proficiency in English (IELTS level ≥ 6.5).

The goal of each programme is to train the student as an independent researcher, and to develop the necessary skills and proficiency to advance his/her career.

Specialisation

Core Computer Technologies

Description

This MSc programme is intended to provide students with a thorough computer science background that will allow them to pursue careers in research or industrial environments. The strength of the programme is its individual approach: for each student an individually tailored programme will be designed. This programme consists of courses, research and a Master's thesis project. The research clusters are Computer Systems and Imagery and Media. Students with an MSc in Computer Science are admissible to a PhD programme.

Qualification for admission

Students from any university in The Netherlands with a BSc degree in Computer Science or with a BSc major in Computer Science will be admitted to the programme.

For all other (international) candidates, the Board of Admissions will determine the equivalence of their previous training to these BSc degrees. The choice of the specialisation courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

Programme

The programme is 120 EC in extent, and consists of specialisation courses (40 EC in total), a project (software project or project study, 20 EC), and two research projects in computer science (60 EC in total).

<i>Components</i>	Level	EC
Specialisation courses	500	42
Option: software project or project study (or specialisation courses of 20 EC)	500	18
Computer science research project	600	18
Computer science master's research project (incl. 7 EC for a thesis and an oral presentation)	600	42

Specialisation

Computer Science Theory and Advanced Technologies

Description

The MSc programme is intended to provide students with a thorough computer science background that will allow them to pursue careers in research or industrial environments. The strength of the programme is its individual approach: for each student an individually tailored programme will be designed. This programme consists of courses, research and a Master's thesis project. The research clusters are Algorithms and Foundations of Software technology. Students with an MSc in Computer Science are admissible to a PhD programme.

Qualification for admission

Students from any university in The Netherlands with a BSc degree in Computer Science or with a BSc major in Computer Science will be admitted to the programme. For all other (international) candidates, the Board of Admissions will determine the equivalence of their previous training to these BSc degrees. The choice of the specialisation courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

Programme

The programme is 120 EC in extent, and consists of specialisation courses (40 EC in total), a project (software project or project study, 20 EC), and two research projects in computer science (60 EC in total).

<i>Components</i>	Level	EC
Specialisation courses	500	42
Option: software project or project study (or specialisation courses of 20 EC)	500	18
Computer science research project	600	18
Computer science master's research project (incl. 7 EC for a thesis and an oral presentation)	600	42

Specialisation

Bioinformatics

Description

The main focus of the Bioinformatics specialisation is on *Data Analysis and Modeling*, which represents the unique expertise of the different research groups of Leiden University and the Delft University of Technology participating in this *research oriented* specialisation.

This expertise is used to address issues like data capturing, data warehousing, data analysis and data mining that have become major challenges in the field of Bioinformatics due to the tremendous complexity and abundance of quantitative data in biology and medicine. On the other hand, bioinformatics heavily contributes to the identification of new fundamental computer science principles and the development of new informatics tools. Bioinformatics offers a unique new synthetic approach for formulating hypotheses and solving problems in (molecular-) biology versus the classical reductionistic approach.

Qualifications for admission

Students from any university in The Netherlands with a BSc degree in Computer Science or with a BSc major in Computer Science will be admitted to the programme.

For all other (national and international) candidates, the Board of Admissions will judge the equivalence to these BSc degrees of their previous training.

Programme

The programme is 120 EC in extent. The programme is outlined below.

<i>Core Program</i>	Level	EC
Pattern Recognition	500	6
Databases and Data mining	500	6
Functional Genomics and Systems Biology	500	6
Molecular Computational Biology	500	6

Every student of the Bioinformatics specialisation has to complete the core program.

<i>Specialisation Courses</i>	500	20
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A choice can be made out of different specialisation courses. The specialisation courses have level 500, and range from 3 - 7 EC. The total of 20 EC is indicative and depends on the extent of the student's support program and research assignment. The selection of the specialisation courses takes place in coordination with the Bioinformatics specialisation study advisor.

Methodology	500	4
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<i>Support Program</i>	500	12
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For each student a support program will be defined by the Bioinformatics specialisation study advisor. The support program consists of courses in Life Science, Computer Science, Mathematics, or of optional courses for deficiency programs. The support program will consist of a maximum of 12 EC.

<i>Research assignment</i>	600	15
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<i>Master's research project</i> (incl. thesis and oral presentation)	600	45
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MSc ICT in Business

CROHO-number 60205

The Leiden Institute of Advanced Computer Science (LIACS) is the computer science institute of Leiden University. LIACS offers an MSc programme in ICT in Business. The duration of the programme, which is taught entirely in English, is two years (120 EC). The programme starts in September and in February. Students who complete the programme receive the degree Master of Science in ICT in Business.

Description

Rapid changes in information and communication technology (ICT) and its application over the last years have caused major changes for individuals, organizations and industries. The Internet, and information systems and communication technology in general, have radically impacted our personal and professional lives and challenged our thinking on physical, geographical and industry boundaries, on distance, speed and communication. The MSc ICT in Business programme aims at providing a deeper understanding of the issues, challenges and opportunities in this area, with a specific focus on the alignment of ICT and management. The programme builds on a solid foundation of Computer Science that students bring from their Bachelor's education, and expands this knowledge and augments it with concepts and methods from the field of management.

Qualifications for admission

Candidates with a BSc degree in Computer Science or equivalent can apply for admission. A Board of Admissions will advise on admissions. The admission process may include an interview with the Board of Admissions. Foreign applicants must provide proof of proficiency in English (IELTS \geq 6.5).

Programme

The ICT in Business consists of five blocks of course-work, and a 6 months thesis project. The courses cover business foundations, ICT & Business topics, research methods and electives. Courses are typically offered in a combination of lectures, case studies, projects, company visits, and student presentations. Many activities are based on team work. At regular intervals research colloquia are offered to supplement and enrich the programme. The programme structure is as follows:

- ICT in Business topics
A set of advanced courses that focus on the interrelationship between organisational processes, management and ICT. The courses focus on Software Engineering, ICT-enabled Business Process Innovation, ICT Strategy and Planning, System's Development and Project Management and a capstone integration course.
- Business Foundations
A set of courses that provide a solid business understanding, including a management simulation and courses on marketing, finance, accounting and organisational behaviour.
- A methodology course and a research seminar
- Electives
The electives allow students to individualise their programme and accommodate special interests. Examples of electives are virtual organisations, IT Governance, cross-cultural organisations, legal aspects of ICT, and data warehousing. In addition there are possibilities to customise the programme through international exchange programmes.

- An MSc Thesis research project that often will be based on an in-company project (6 months).

Following the above, the programme consists of the components:

<i>Courses</i>	Level	EC
Kick-off: Global Business game	400	1
Software Engineering	500	6
Global Marketing	500	3
Corporate Communication	500	3
Strategy Formation & Implementation	500	5
ICT-enabled Process Innovation	500	3
Corporate Finance	500	4
Process Modelling	200	3
Behavioural Decision Making	500	3
Research Methods	500	3
System's Development and Project Management	500	6
Management Science	500	3
Managing Innovation	500	3
Organising	500	4
ICT Strategy and Planning 1	500	3
ICT Architectures	500	6
Managing People	500	3
Financial Accounting	500	4
Research Seminar 1	500	2
Research Seminar 2	500	2
Research Colloquia 1	500	2
Research Colloquia 2	500	2
Electives (3 x 3 EC)	500	9
Capstone Cases	500	3
MSc research project	600	34

Programme for candidates with working experience

A special programme is offered to professionals with at least three years of working experience. These professionals should have a BSc degree in Computer Science or equivalent to be able to participate in the following programme.

The programme is 120 EC in extent, and consists of specialisation courses (40 EC in total), a project (software project or project study, 20 EC), and two research projects in ICT in Business (60 EC in total). The choice of the specialisation courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

<i>Components</i>	Level	EC
Specialisation courses	500	40
Specialisation courses <i>or</i> software project <i>or</i> project study	500	20
ICT in Business research project	600	17
ICT in Business master's research project (incl. 7 EC for a thesis and an oral presentation)	600	43

MSc Media Technology

CROHO-number 60206

The Media Technology MSc programme is a common initiative of the computer science institute (LIACS) within the Faculty of Science, and the Academy for Creative and Performing Arts. The duration of this programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Media Technology. Details are provided below.

Candidates with a BSc degree or equivalent can apply for admission. The admission process may include an interview with the Board of Admissions. Foreign applicants must provide proof of proficiency in English (IELTS level ≥ 6.5). The programme language is English.

Description

The Media Technology programme recognises creativity as an important factor in scientific innovation. It is a place where students, artists and researchers are allowed to formulate their own scientific questions and are encouraged to translate their personal inspirations and curiosities into manageable and compact research projects. To achieve this, the curriculum focuses on creative exploration and on the understanding of science and technology. Student projects most often involve creating actual products: software, hardware, something made from sticky tape perhaps. Because we are convinced that by doing / making / creating new insights into the underlying research question are encountered. The programme encourages its students to draw from the knowledge available throughout Leiden University and the ArtScience programme of the Royal Conservatoire and the Royal Academy of Arts in The Hague.

Qualifications for admission

Students holding a BSc degree in Computer Science from Leiden University or a BSc major in Computer Science from Leiden University will directly be admitted to the programme. For all other (possibly international) candidates, the Board of Admissions will judge the equivalence of their previous training to these BSc degrees. In principle, any prior field of study is applicable. Applicants are judged with observance of specific work- and training experience with regard to Media Technology.

Substitution for Compulsory Courses

Students can qualify for substitution of certain compulsory courses (see below) within their curriculum, when they can prove already having current knowledge of the topics dealt with. Substitution should be requested via the Executive Committee, and requires agreement by the lecturer of the course at hand. To receive agreement from the lecturer, the student must participate in the first lecture and present some form of proof that the knowledge was already obtained through other ways. The lecturer may decide to honour or turn down requests for substitution, based on the material provided by the student and the evaluation of such.

The student is not relieved from obtaining the required number of EC's through other ways. For every approved substitution, students must follow another (elective) course with the same number of credits or more. The contents of this replacement course must be a logical extension to the course for which substitution was granted, and must be of the same level at least.

Substitution is never granted for a compulsory course if the student in question has failed any exam or assignment for that same course. If substitution is granted, but the student decides to follow the course nonetheless, than the substitution is retracted (becomes non-valid) when he/she fails any graded part of the course in question.

Programme

The programme is 120 EC in extent.

<i>Compulsary courses</i>	Level	EC
Visit to Ars Electronica Festival	500	1
Introduction to Programming	400	4
Human Computer Interaction	500	6
New Media & New Technologies	500	5
Creative Research	500	4
Cool Science	500	6
Perceptualisation	400	2
Sound, Space & Interaction	500	4
Web Technology	500	4
Research Seminar	500	5
Image & Vision - Embodied Vision	500	4
Hardware & Physical Computing	500	3
Meta Media	500	2
Language & Text	500	3
Essentials in Art & Music	500	2
Free choice courses	500	15
Project	500	20
Graduation Project	600	30

MSc Astronomy

CROHO-number 60200

The aim of the Leiden Observatory MSc programme is to provide students with the proficiency and skills to pursue a successful career in science, or in society with a strong background in scientific thinking and understanding. The programme offers four specialisations, each lasting two years (120 EC).

The research in astronomy specialisation focuses on major research themes including evolution of the universe, formation and evolution of galaxies, birth and death of stars, and formation and occurrence of planets near other stars. The remaining three specialisations combine the main elements of the research curriculum with topics in Science-Based Business (SBB), Science Communication & Society (SCS), and Education (EDU) which are described separately in this Appendix. Upon successful completion of the programme, students receive the degree Master of Science in Astronomy, with specification of the specialisation.

All specialisations have the same Director, the same Board of Examiners, the same Department Teaching Committee, and the same Board of Admissions. In addition, the special specialisations (SBB, SCS, and EDU) each have their own Specialisation Coordinator for the non-science part. Students with an MSc in any of these specialisations are also admitted to a PhD programme in Astronomy.

Requirements for admission

Students with a BSc in Astronomy or the equivalent from Dutch universities participating in the NOVA research school are directly admitted to the programme.

For all other national and international candidates, the Board of Admissions will evaluate whether their degree is equivalent to a BSc in Astronomy. Students with Bachelor degrees in other sciences such as Mathematics, Physics, or Chemistry can also apply for enrolment. Candidates may be required to take introductory courses covering subjects in which they are deemed to be deficient. Additional admission guidelines are given below for each of the specialisations. The admission process may include an interview with the Board of Admissions. Admission is possible throughout the year, but foreign students are advised to start the programme in September or February. Foreign applicants must provide proof of proficiency in English (IELTS \geq 6.5).

Selection of courses and Master Study Plan

For all specialisations, the selection of the course work and research projects requires prior approval by the MSc student advisor. In individual cases a course from a different programme or field of study may be elected, but only after prior written approval by the Board of Examiners. Before starting such a course, the student should discuss the choice with the MSc student advisor, and then contact the chairman of this board to obtain such approval. At the start of the Master's Programme, the student and the MSc student advisor together draw up a complete list of planned courses and projects (Master Study Plan). Changes in the Master Study Plan in the course of the programme are possible, but always require prior approval by the student advisor.

Types of courses

A variety of courses is given each year. Specifics can be found in the MSc in Astronomy Study guide, and on the Astronomy Education website. These courses are classified as follows.

Astronomy Core Courses (6 EC each).

1. Origin and Evolution of the Universe;
2. Galaxies, Structure, Dynamics and Evolution;
3. Stellar Structure and Stellar Evolution;
4. Interstellar Medium.

General Astronomy Courses (6 EC each). These vary with time. Some are only given once, others are given at irregular intervals. Examples include Star Formation, Stellar Dynamics.

Instrument-related Astronomy Courses (6 EC each). The number and schedule of these courses also varies, but regular examples are:

Detection of Light; Interferometry, Radio Astronomy, Astronomy from Space. The 4-EC course Physics of Scientific Space Instruments is also in this category, as do specifically designated courses at Delft University of Technology.

Specialist Astronomy Courses (3 EC each). These provide in-depth introductions to specialised topics such as Pulsar Physics, Databases and Data Mining, Adaptive Optics, Gravitational Lensing, Computational Astrophysics and Astrochemistry.

Non-Astronomy Courses (Various ECs). These must be selected from the courses offered by the Leiden MSc programmes in Physics, Mathematics, and Computer Sciences.

Astronomy Research Projects. The Minor (24 EC), Medium (30 EC) and Major (36 EC) Research Projects are carried out under close supervision by a member of the Scientific Staff. The Major and Minor Research Projects must be of a different nature and be supervised by different persons. The Major Research Project can be started only after the Minor Research Project is finished. The maximum duration of a Minor Research Project is eight (8) months, and that of a Major Research Project twelve (12) months. The Medium Research Project (30 EC) is carried out by to students following the SBB, SCS or EDU specialisations. Its maximum duration is ten (10) months.

Both the Medium and the Major Research Project are designated as the Master's Research Project; their total credit of 36 EC and 30 EC respectively include a 5 EC and 4 EC respectively Master's Thesis as well as a 1 EC public presentation (the Student Colloquium).

Specialisation Research in Astronomy

Description

This 2-year programme consists of advanced Astronomy courses, two research projects in Astronomy, and courses on science topics related to the field of Astronomy. It prepares the student for independent research in Astronomy.

Programme (120 EC)

The programme has the following curriculum:

<i>Year 1</i>	Level	EC
Minor Astronomy research project	500	24
Astronomy courses	400-500	24
Non-Astronomy courses	400-500	12

Year 2

Major (master's) Astronomy research project	600	36
Astronomy courses	500	12
Non-Astronomy courses	400-500	12

The Astronomy curriculum must contain the following courses:

- *Mandatory for all:* Stellar Structure and Stellar Evolution (6 EC),
- *a minimum of two* (2) other Astronomy core courses (12 EC),
- *a minimum of one* (1) instrument-related Astronomy course (6 EC)
- *a choice of* Astronomy courses of any type (12 EC)
- *both* a Minor and a Major Research Project (60 EC).

The programme may be adapted for Masters students who have not followed the Leiden Astronomy Bachelor programme. Upon recommendation by the MSc student advisor and written approval by the Board of Examiners, the Minor Research Project can be reduced to 15 EC with a simultaneous increase in the number of courses in Astronomy.

If possible, the students will take these additional courses in their first semester. These additional courses can be selected from the normal courses in the Master's curriculum, and from the following courses in the Bachelor's curriculum:

- Astronomical Observing Techniques;
- Radiative Processes;
- Physics of Elementary Particles.

These students may also add Astronomy courses at the cost of the non-Astronomy courses, again after consultation with the Msc student advisor and approval by the Board of Examiners.

Instrumentation stream

Within the 'Research in Astronomy' programme, students may choose to focus on the subject 'Astronomy and Instrumentation'. This stream is offered in collaboration with the Department of Applied Physics at Delft University of Technology. In addition to the general admission requirements mentioned above, students should have successfully completed the TUD Bsc course 'Systemen en Signalen' (TN4525) or its equivalent. The requirements for the two years are as follows:

	Level	EC
<i>Mandatory Courses:</i>		
Stellar Structure and Stellar Evolution	500	6
Detection of Light	500	6
<i>Choice of core/general/specialist Astronomy courses</i>	400-500	18-12
<i>Choice of instrument-related Astronomy courses</i>	400-500	6-12
<i>Choice of instrument-related Physics courses</i>	400-500	24

Minor Research Project in observational Astronomy	500	24
Major Research Project in instrumental Astronomy (Master's Project)	600	36

The major (master's) research project may involve designing, building or testing of an instrument or instrument system, or any combination of these activities. It may be carried out in any of the Leiden Astronomy or Delft applied Physics labs, or at outside organisations directly related to astronomical instrumentation.

Cosmology stream

Within the 'Research in Astronomy' curriculum, students may choose to focus on the subject 'Cosmology'. This stream is offered in collaboration with the Institute Lorentz for Theoretical Physics in the Department of Physics at Leiden University (LION). Fundamental elements are theory, data handling, and numerical simulation. In addition to the general admission requirements, students should have successfully completed the BSc course 'Physics of Elementary Particles' (or its equivalent), and should have in-depth knowledge of undergraduate courses with theoretical and mathematical emphasis, such as quantum physics, electrodynamics, statistical physics, and complex analysis. The requirements for the two years are as follows:

	Level	EC
<i>Mandatory Astronomy Courses:</i>		
Stellar Structure and Stellar Evolution	500	6
Origin and Evolution of the Universe	500	6
Large-Scale Structure and Galaxy Formation	500	6
<i>Choice of:</i>		
core/general/specialist Astronomy courses	400-500	18
<i>Mandatory Physics Courses:</i>		
Particle Physics and Early Universe	500	6
Theory of General Relativity	400	6
<i>Choice of:</i>		
Related Physics courses	400-500	12
Minor Research Project in General Astronomy	500	24
Major Research Project in Cosmology (Master's Project)	600	36

The two research projects together should cover the three fundamental elements: theory, data handling and simulations.

MSc Physics

CROHO-number 60202

Leiden University offers four specialisations of an MSc programme in physics. One is a research specialisation with various pre-defined streams. The other three are the physics specialisation of the research MSc combined with Science-Based Business (SBB), with Science Communication & Society (SCS) and with Education (EDU), which are described separately in this Appendix. The streams in the research specialisation are Experimental Physics, Theoretical Physics, Cosmology (in collaboration with the Department of Astronomy), and 'Casimir prePhD'. The latter is run within the framework of the Casimir Research School, a joint undertaking between Leiden University and Delft University of Technology.

The duration of each programme is two years (120 EC). Upon successful completion, students receive the degree Master of Science in Physics, with specification of specialisation and stream, which allows the pursuance of a PhD degree. Details are provided below. All specialisations have the same Director, the same Board of Examiners, and the same Department Teaching Committee. A Board of Admissions will advise on admissions.

Candidates with a BSc degree or equivalent can apply for admission. The admission guidelines are given below for each specialisation. The admission process may include an interview with the Board of Admissions. Foreign applicants must provide proof of proficiency in English (IELTS level ≥ 6.5). Admission is possible throughout the year, but we advise foreign students to start in September or February. For the Cosmology and 'Casimir pré-PhD' streams, the start should be in September.

The goal of each programme is to train the student as an independent researcher, and to develop the necessary skills and proficiency to advance his/her career. In all specialisations therefore, it is possible for the optional part of the programme to choose courses offered by other universities or graduate schools. The programme should have sufficient level and cohesion, and the optional part in all cases requires approval of the Board of Examiners *in advance*.

Specialisation

Research in Physics

The various streams in this specialisation distinguish themselves by a setup and core of the curriculum which emphasizes the intended perspective and goal of that stream. In all cases, the programme consists of two components, a set of courses and one or more research projects. All streams offer research training which allows the pursuance of a PhD degree as a next step, although other career options are still fully open. The 'Casimir pre-PhD' stream puts emphasis on preparing for PhD research within the Casimir Research School, and requires a strong academic record for admission.

Experimental Physics stream

Description

The Experimental Physics stream concentrates on the subjects of the different research groups in the Leiden Institute of Physics (LION). They comprise Biological and Molecular Physics; Quantum Optics and Quantum Information; and Condensed Matter Physics.

Research in the field of Biological and Molecular Physics is aimed at the interaction between light and matter, the photophysics of optically excited states of (bio)molecules, and the conformational dynamics of proteins. The objective of these studies is to establish at the molecular level the relationship between structure and function of biomolecules. The research involves a range of spectroscopical as well as single-molecule and scanning probe imaging techniques.

Research in Quantum Optics and Quantum Information concentrates on the basic knowledge and expertise in the field of modern optics in general, in particular as it relates to the emerging field of quantum information. A student will gain experience in a variety of experimental techniques and application of light sources and optical instrumentation, in situations in which quantum coherence and entanglement is created and applied.

Research in Condensed Matter Physics concerns the study of the fundamental properties of solids, on length scales varying from macroscopic down to nanometers. It aims at acquiring understanding by investigating model systems and novel materials, with emphasis on the collective behaviour of dense interacting systems. This can be either from a statistical point of view, as in granular matter, polymers, or atomic motion and reactions at surfaces; or from an electronic and quantum point of view, as in molecular conductance, superconductivity, and magnetism. Among the experimental techniques used are (magneto)transport experiments and scanning probes (STM and AFM), down to (sub)Kelvin temperatures.

Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Physics or Astronomy, will be admitted to the programme. For all other (international) candidates, the Board of Admissions will judge the equivalence of their previous training to these BSc degrees. The choice in elective courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

Programme

The programme consists of courses and research projects totalling (minimally) 120 EC (equivalent to two years of study). It can to a high degree be tailored to individual needs and interests.

<i>Components</i>	Level	EC
Courses from the Theoretical Physics courses on offer ¹	400-500	18
Optional master courses	400-500	42-30
Physics research project 1 in a LION research group (with Master thesis and oral presentation) ²	600	36
Physics research project 2 in a research group within or outside LION (with Master thesis and oral presentation) ²	600	24-36
<i>Master courses in Physics</i>	Level	EC
Advanced Biophysics	500	6
Biomolecular Motors	500	6

¹ For a number of research subjects, the course Quantum Theory is strongly advised.

² A research project of 36 EC consists of 30 EC experimental work, a Master thesis of 5 EC, and an oral presentation of 1 EC. Smaller projects consists of the same components, proportionally scaled.

Computational Physics	400	9
Introduction to Astroparticle Physics	400	6
Physics of Scientific Space Instruments	400	4
Experimental Classical and Quantum Optics	500	6
Scanning Probe Microscopy	500	6
Single Molecule Optics	500	6
Surface Physics	500	6

For the optional Master courses, a choice can also be made from the courses in the Theoretical Physics, Cosmology, or ‘Casimir pré-PhD’ streams. Note that not each of the Master Courses in Physics is given each academic year and that also the offer of courses may change.

Theoretical Physics stream

Description

Research in the Theoretical Physics stream prepares the student for scientific research towards the PhD in a broad range of topics, such as High Energy Physics and Particle Cosmology; Theoretical Physics of Life Processes; and Condensed Matter Theory. The master will also be well-equipped for industrial research or other problem-solving tasks that demand strong analytical and computational skills.

Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Physics or Astronomy, will be admitted to the programme. For the Theoretical Physics stream, in-depth knowledge is required of undergraduate courses with theoretical and mathematical emphasis: quantum physics, electrodynamics, statistical physics, and complex analysis.

For all other (international) candidates, the Board of Admissions will judge the equivalence of their previous training to these BSc degrees. The choice in elective courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

Programme

<i>Components</i>	Level	EC
Quantum Theory	400	9
Topics in Theoretical Physics	500	9
2 courses from the Theoretical Physics courses on offer	400-500	18
Optional master courses ¹	400-600	24
Physics research project in Theoretical Physics	600	45
Master’s thesis (10 EC) and oral presentation (5 EC)	600	15
 <i>Master courses in Theoretical Physics</i>	 Level	 EC
Black Holes and Gravitational Waves	500	3
Effective Field Theory	500	3
Theoretical Cosmology	500	3
Quantum Field Theory	500	6
Quantum Optics and Quantum Information	500	9
Quantum Theory	400	9
Statistical Physics	400	9

¹ A maximum of one master course can be taken anywhere at Leiden University.

Theory of Condensed Matter	500	9
Theory of General Relativity	500	6
Topics in Theoretical Physics ¹	500	9

For the optional Master courses, a choice can also be made from the courses in the Physics, Cosmology, or ‘Casimir pre-PhD’ streams; or from courses in the M.Sc. program Mathematics. Note that not each of the Master Courses in Theoretical Physics is given each academic year and that also the offer of courses may change.

Cosmology stream

Description

The Cosmology stream is positioned at the interface between Theoretical Physics and Observational Astronomy. The core element of the specialization are theory, data handling, and numerical simulations. It prepares the student for scientific research towards the PhD in a range of topics, but the master will also be well-equipped for industrial research or other problem-solving tasks that demand strong analytical and computational skills.

Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Physics or Astronomy, will be admitted to the programme. Similar to the Theoretical Physics stream, in-depth knowledge is required of undergraduate courses with theoretical and mathematical emphasis: quantum physics, electrodynamics, statistical physics, and complex analysis. Also prerequisite is the Leiden Bachelor course on Physics of Elementary Particles, or a clear equivalent. The Bachelor course Relativistic Electrodynamics is strongly advised. For all other (international) candidates, the Board of Admissions will judge the equivalence of their previous training to these BSc degrees. The choice in elective courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

Programme

<i>Components</i>	Level	EC
Theory of General Relativity	400	6
Origin, Structure and Evolution of the Universe	400	6
Quantum Theory	400	9
Effective Field Theory	500	3
Particle Physics and the Early Universe	500	6
Observational Cosmology	400	3
choice of Black Holes and Gravitational Waves / Theoretical Cosmology	500	3
Choice of Computational Astrophysics / Data Mining	500	3
Optional master courses ²	400-500	21
Research project in Cosmology 1	500	24
Research project in Cosmology 2 (Master project)	500	36

¹ The content of the course Topics in Theoretical Physics varies from year to year, the course has an interactive format in the sense that weekly meetings consist of presentations by the participating students.

² A maximum of one master course can be taken anywhere at Leiden University.

Note: the two research projects together have to cover the three components mentioned above, namely theory, data handling and numerical simulations.¹

<i>Master courses for Cosmology</i>	Level	EC
Galaxies: Structures, dynamics, evolution	400	6
Gravitational Lensing	400	3
Introduction to Astroparticle Physics	400	6
Numerical Simulations in Astrophysics	400	1-3 ²
Physics of Gamma Ray Bursts	400	3
Physics of Scientific Space Instruments	400	4
Quantum Field Theory	500	6
Star formation	400	3
Topics in Theoretical Physics	500	9

For the optional Master courses, a choice can also be made from the courses in the Physics, Theoretical Physics, or ‘Casimir pre-PhD’ streams; or from courses in the M.Sc. program Mathematics. Note that not each of the Master Courses in Cosmology is given each academic year and that also the offer of courses may change.

‘Casimir pre-PhD’ stream

Description

The ‘Casimir pre-PhD’ stream is offered under the auspices of the Casimir Research School, a joint undertaking of the Leiden Institute of Physics (LION), and various departments at Delft University of Technology. It prepares the student for scientific research in a Ph.D. position within the Casimir Research School, or elsewhere, and therefore puts strong emphasis on working in a research environment, in particular within the themes of the Research School. These are *Molecular Biophysics*, *Physics of nanostructures*, *Quantum Matter and Functional Materials*, *Quantum Information and quantum optics*, *Universe physics; theory and instrumentation*, and *Dynamic Complex Systems*.

The programme follows a strict schedule, in which the first year is devoted to laying a theoretical basis, and the second year to research and study projects, including the writing of a research proposal. The study projects are a special characteristic of the programme, specifically aiming at broadening the research perspective of the student. Conditions exist for admission into the stream, as well as for admission into the second year.

¹ Dispensation can be granted by the Exam Committee if a student can demonstrate competence in a component acquired outside the M.Sc. programme.

² Numerical simulations in Astrophysics can be done as modules of 1 EC each up to a total of 3.

Qualifications for admission

All admission is through selection by an admission committee. Students from any university in the Netherlands with a BSc degree in Physics or Astronomy can apply directly for admission. Their academic record needs to show good grades for undergraduate courses, in particular for quantum physics, electrodynamics, statistical physics, and complex analysis. Moreover, the time needed to obtain the BSc degree should, apart from extraordinary circumstances, not have exceeded four years.

For all other (international) candidates, separate admission to the Physics Master needs to be obtained through the University Board of Admissions. The University Board judges the equivalence of previous training to Dutch BSc degrees. The application to the 'Casimir pré-PhD' stream can be made in parallel, but a positive outcome is subject to admission by the University Board.

In the second year of the programme, students will be given the opportunity to attend a Summer School at the start of the year. Admission to the second year is on the condition that the courses of the first year (60 EC) have been successfully completed. Students who are not admitted to the second year can continue in one of the other streams of the Physics Master.

Programme

<i>Components</i>	Level	EC
Quantum Theory	400	9
Statistical Physics	400	9
1 course from the list 'Foundational'	400-500	6
2 courses from the list 'Topical'	400-500	12
1 course from the list 'Methods'	400-500	6
Optional Master courses in Physics	400-500	18
Research project in Physics (with Master thesis and oral presentation)	500	36
Study projects and Writing Research Proposal	500	24

Research project and study projects are also guided by a strict timeline. The Research project starts in September and finishes in Februari. The two study projects (8 EC each) are to be carried out in different groups, and in a different group than where the Research project took place, and have to be carried out between March and the end of May. Writing a research proposal is the last item in the programme. For a limited number of students within this track, a PhD position will be guaranteed. Details can be found on the website of the Casimir Research School.

<i>Foundational courses</i>	Level	EC	
Effective Field Theory	500	3	(L)
Quantum Field Theory	500	6	(L)
Quantum Optics and Quantum Information	500	9	(L)
Theory of Condensed Matter	500	9	(L)
Theory of General Relativity	400	6	(L)
Topics of Theoretical Physics	500	9	(L)

<i>Topical Courses</i>	Level	EC	
Advanced Biophysics	500	6	(L)
Biophysics	400	6	(D)
Introduction to Astroparticle Physics	400	6	(L)

Experimental Classical and Quantum Optics	500	6	(L)
Mesoscopic physics	400	6	(D)
Molecular Electronics	500	6	(D)
Physics of semiconductor devices	400	6	(D)
Quantum Information Processing	500	6	(D)
Single Molecule Optics	500	6	(L)
Surface Physics	500	6	(L)
<i>Methods</i>	Level	EC	
Computational Physics	400	6	(L or D)
Nanotechnology	400	6	(D)
Physics of Scientific Space Instruments	400	4	(L)
Scanning Probe Microscopy	500	6	(L)

Courses given in Leiden are denoted (L), courses given in Delft are denoted (D). Electives can be chosen from the full list, irrespective of the location. Note that not each of the Master Courses is given each academic year and that also the offer of courses may change.

MSc Chemistry

CROHO-number 66857

The Leiden Institute of Chemistry (LIC) forms the basis for research and collaborations of the Leiden chemistry and life sciences groups. The three major research areas in the LIC are *Biological Chemistry*, *Physical & Theoretical Chemistry* and *Design & Synthesis*. The LIC offers four specialisations of an MSc programme, each with a focus on one of these major research areas. The four specialisations are: the Research in Chemistry (CHEM), Science-Based Business (SBB), Science Communication & Society (SCS) and Education (EDU). Aim of each programme is to train the student as an independent researcher, and to develop the necessary skills and proficiency to advance his/her career. Students with an MSc degree in Chemistry are admissible to a PhD programme. The duration of each specialisation is two years (120 EC); a general overview of the content of the four specialisations is given in Table 1. Students who complete the programme receive the degree Master of Science in Chemistry, with specification of the specialisation and specialisation. All specialisations have the same Director, the same Board of Examiners and the same Department Teaching Committee.

Table 1: Overview of the programmes of the four MSc Chemistry specialisations

Specialisation	CHEM	EDU	SCS	SBB
Internship	60	30	30	30
Compulsory courses in specialisation	18	12	12	12
Compulsory courses outside specialisation	6	6+6	6+6	6+6
Essay & Colloquium	6	-	-	-
Free electives ¹	30	36 / 6 ²	26	26
EDU/SCS/SBB components	-	30 / 60 ²	40	40
Total	120	120	120	120

Admission procedure

Students from any university in The Netherlands with a BSc degree in Chemistry or with a BSc Major in Chemistry will be admitted to the programme. All other (international) candidates, such as students with a degree related to Chemistry, HBO Bachelors and foreign students have to apply for admission. As a guideline, the HBO-diploma has to be obtained within four years and with an average final mark above 7.5

The Board of Admissions will judge the qualifications of the applicant on the basis of the curriculum and grades of his/her previous training. The admission process may include an interview with the Board of Admissions. Foreign applicants must provide proof of proficiency in English (IELTS level ≥ 6.5). The applicants for the EDU and SCS specialisations must provide proof of proficiency in Dutch. Admission is possible throughout the year, but we advise (foreign) students to start in September or February.

¹ The choice in the free electives is restricted to the boundaries specified here. A maximum of 20 EC can be used for extension of the internships.

² if the student has taken a minor Education (tweedegraadsbevoegdheid) of 30 EC in the BSc study, only 30 EC are necessary in the MSc study to obtain the "eerstegraadsbevoegdheid"; then 30 EC free electives are added to the Chemistry programme.

Description of the research areas

In the research area *Biological Chemistry* students are trained in understanding and application of the chemistry of biomacromolecules. After successful completion of the programme, the students have extensive knowledge at the molecular level of structure and interactions of biomacromolecules, and master the skills to obtain this knowledge. Furthermore, they have insight in biochemical processes at the cellular level and at the level of the organism. They can communicate with cell biologists and biotechnologists in a multidisciplinary (and, if appropriate, industrial) team.

In the research area *Physical & Theoretical Chemistry* students are trained to describe nature in a quantitative way, with a focus on “understanding” rather than on “making”. Depending on the subject of choice, ranging from a quantum-mechanical description of chemical reactions to “mimicking” the origin of life, the students gain extensive knowledge of experimental research, theoretical research and/or computer calculations.

In the research area *Design & Synthesis* students acquire general insight in the structure and reactivity of molecules. Depending on the choice of internship the student gains advanced knowledge of the design, synthesis and properties of new organic or inorganic molecules, of the course of biological processes, or the development and investigation of new sustainable catalytic processes and reactions.

Description of the specialisations

The specialisations Science Based Business, Science Communication & Society and Education are described separately in this Appendix.

Specialisation – Research in Chemistry (CHEM)

The research specialisation offers the student the opportunity to spend two full years on training and specialisation to become an independent and creative researcher. The MSc students will become a member and colleague in one of the research groups in the LIC. The student will develop her/his individual MSc programme together with the mentor. The majority of the students with an MSc in Chemistry research will continue their career in a PhD position.

Programmes of the specialisations

The programmes of the specialisations Science Based Business, Science Communication & Society and Education are described separately in this Appendix.

Specialisation – Research in Chemistry (CHEM)

The Research in Chemistry programme (CHEM) consists of three parts: the research internship (60 EC), the compulsory courses (30 EC) and the elective courses (30 EC). A general overview of the programme is given in Table 1.

The (major) internship is carried out in a LIC research group in one of the research areas (*Biological Chemistry, Physical & Theoretical Chemistry, Design & Synthesis*) and includes a presentation and a written report (the master thesis). The research internship may be split into two internships: the major and minor internship. The major internship is limited to 60 EC and a minor internship must comprise at least 20 EC. The minor and major internship project may be related and this may be reflected in a combined master thesis. In consent with the mentor the minor internship can be carried out in another research area, another

institute (within the Netherlands or abroad), or in a company. Prior approval of the Board of Examiners is required for an internship outside the institute. The mentor has the final responsibility for the grading of the internship report of research not carried out in the LIC.

The compulsory theoretical component comprises of a selection of four core courses (24 EC) and a literature essay with colloquium (6 EC). Three of the courses are chosen within the research area (18 EC) and one is chosen from the core courses offered by the other research areas. A list of the core courses offered by the three research areas is given in Table 2.

The elective component consists of a free choice of theoretical courses (30 EC). Alternatively, a maximum of 20 EC can be used to extend the research internships. The mentor may limit the choice in elective courses by the need to adapt the programme to the present knowledge of the student. Students can choose their electives from the list of core courses within or outside their specialisation, the MSc courses offered in the Faculty of Science of level 400 or higher, or level 400 courses from the BSc MST and LST programmes provided that these were not part of the student's earlier studies. All other electives have to be approved by the Board of Examiners.

Table 2: Core courses organized by the LIC research areas *Biological Chemistry, Physical & Theoretical Chemistry* and *Design & Synthesis*

All courses are at level 500 and encompass 6 EC	yearly	organised by research area
Applied Computational Molecular Biology	yes	BC
Analysis of the three dimensional structure of proteins by diffraction and imaging methods	yes	BC
In-Vivo Biomolecular Interactions underlying diseases	yes	BC
Genome Organization and Maintenance in cancer and	yes	BC
Global Regulatory Networks in Bacteria	yes	BC
Biophysics of Proteins and Protein Interactions	yes	BC
Electrochemistry & Bioelectrochemistry	yes	FT
Modern Quantum Chemistry	yes	FT
Vibrational Spectroscopy	biannual	FT
Spin- & Photochemistry	biannual	FT
Colloids and Interfaces	biannual	FT
Advanced Multiscale Modelling	biannual	FT
Dynamics of molecule-surface reactions	biannual	FT
Quantum dynamics of chemical reactions	biannual	FT
Organometallic chemistry & homogeneous catalysis	yes	DS
Modern Organic Chemistry	yes	DS
Carbohydrate Chemistry	biannual	DS
Nucleic- and amino acids as biopolymers	biannual	DS
Reactivity in Organic Chemistry	yes	DS
The Chemistry and Physics of Solids	yes	DS

Research areas: BC, *Biological Chemistry*; FT, Physical and Theoretical Chemistry; DS, Design and Synthesis.

MSc Chemistry – specialisation Industrial Ecology

CROHO-number 66857

The scientific field Industrial Ecology focuses on the sustainable development of the industrial society, through the interaction of various scientific fields like environmental sciences, economics, policy sciences, and technology. In practice, Industrial Ecology is an interdisciplinary field, where engineers, natural scientists, and social scientists cooperate together in finding solutions for environmental problems and shaping sustainable development.

The main philosophy of the education programme is focussed on the analysis, design, and implementation of industrial activities in analogy to the ecological system and in such a way that the impact on the ecology is minimized. This implies that the word industrial is seen as the total of socio-technological systems. The word ecology is seen as the analogy to ecosystems and the aim to minimize the impact on the environment.

Qualifications for admission

Admission requirements

A bachelor degree in a the natural or social sciences is required. Candidates are expected to have:

- a GPA (Grade point average) of at least 75% of the scale maximum;
- proof of proficiency in the English language, e.g. a TOEFL score of at least 550 (paper-based test) or 213 (computer based test) or a IELTS (academic version) overall Band score of at least 6.0;
- a demonstrable interest in the field of Industrial Ecology.

Applications should include:

- a completed, current MSc application form with a recent passport photograph;
- an original TOEFL or IELTS score form;
- A curriculum vitae;
- A personal statement (in English) of the applicant's motivation to participate in the chosen MSc programme;
- Certified copies of the applicant's academic diplomas in both the original language and translations thereof in either English, French, German or Dutch;
- An original or certified copy of the full list of grades in the original language together with a certified translation of the same list of grades in either English, French, German or Dutch;
- Two original letters of reference; from academic staff members and where applicable, your current employer.

Description of the Specialisation

The MSc-specialisation Industrial Ecology consists of three parts, providing basic concepts and theories:

- *Natural Sciences of Industrial Ecology* – Ecological sustainable development, Analysis of the relation between Ecosphere and Techosphere, Environmental Sciences.

- *Technical Sciences of Industrial Ecology* – Socio-economic sustainable development, People and Profit, Design of Socio-Techological Systems (with the emphasis on technological), Design for Sustainability or Ecodesign.
- *Social Sciences of Industrial Ecology* – Socio-economic sustainable development, Implementation of Socio-Technological Systems (with the emphasis on social), Environmental Management Systems.

Programme

The Industrial Ecology programme trains students in analysis, methodology, design, and implementation of societal activities, with the aim of minimising the environmental impact of these activities while maintaining their functionality.

Industrial Ecology encompasses the study of:

- Natural resources, their renewal, their abundance and the environmental impacts of their cradle-to-grave chains;
- technologies and systems for transforming these resources into goods and services;
- consumption patterns of these goods and services;
- organisation of these processes along the entire life-cycle;
- processes of technological change;
- processes of social political change.

Overview of the programme

		Level	EC
Introduction Modules (9 EC)			
<i>IE3720</i>	Engineering Basics	300	3
<i>IE3710</i>	Introduction to Environmental Science	300	3
<i>IE3740</i>	Introduction to Social Sciences	300	3
Core Modules (54 EC)			
<i>IE4110</i>	Fundamentals of Systems, Data, Models, and Computational Thinking	500	6
<i>IE 4120</i>	System Earth	500	6
<i>IE4210</i>	Design of Sustainable Technology Systems	500	6
<i>SPM4510IE</i>	Social Systems – Policy and Management	500	6
<i>SPM4520IE</i>	Sustainable Innovation and Social Change	500	6
<i>SPM4530IE</i>	Renewable Energy Systems	500	6
<i>SPM4540IE</i>	Urban Environments and Infrastructures	500	6
<i>IE4130</i>	Analytical Methodologies and Tools	500	6
<i>IE4610</i>	General Introduction to Industrial Ecology	500	6
Elective Modules		400-500	6
Choice of module should be approved by programme management and Board of Examiners			
Master Thesis Research Project (36 EC)			
<i>IE5910</i>	Graduation Preparation Module	600	6
<i>IE5920</i>	Thesis Research Project	600	30

Interdisciplinary Project Groups (12 EC)

IE5610	Interdisciplinary Project Groups	600	12
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Specialisation Modules

400-600 12

Choice of modules should be approved by the graduation supervisor and Board of Examiners

TOTAL EC's 120

MSc Bio-Pharmaceutical Sciences

CROHO-number 60207

Students in the Center for Bio-Pharmaceutical Sciences (CBPS) of Leiden University are trained for a research career in drug research and development, not for a career as a (public) pharmacist. The CBPS offers eight specialisations of an MSc programme in Bio-Pharmaceutical Sciences (BPS). Five of these correspond to major research themes in the CBPS. The remaining three are the BPS specialisations of the research MSc with Science-Based Business (SBB), Science Communication & Society (SCS) and Education (EDU) specialisations.

The duration of each programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Bio-Pharmaceutical Sciences, with specification of the specialisation, if applicable. Details are provided below. All specialisations have the same Director, the same Board of Examiners, and the same Department Teaching Committee. A Board of Admissions will advise on admissions.

Candidates with a BSc degree or equivalent can apply for admission. The admission guidelines are given below for each specialisation. The admission process may include an interview with the Board of Admissions. Foreign applicants must provide proof of proficiency in English (IELTS level ≥ 6.5). Admission is possible throughout the year, but we advise foreign students to start in September or February. Further information is available on the website www.bfw.leidenuniv.nl

Aim of each programme is to train the student as an independent researcher, and to develop the necessary skills and proficiency to advance his/her career.

Specialisation

Medicinal Chemistry

Description

The MSc programme Medicinal Chemistry (drug design and molecular modelling) trains for junior drug researchers, and prepares students for a career in medicinal chemistry.

Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Bio-Pharmaceutical Sciences, Pharmaceutical Sciences, or Pharmacy will be admitted to the programme.

For all other (international) candidates, the Board of Admissions will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a BSc (or equivalent) in Chemistry, Life Science and Technology, as well as HBO Bachelors in Chemistry with an equivalent BSc will be considered. The choice in optional courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

Programme

The programme contains two research periods (52 and 36 EC), and compulsory and optional programme components (32 EC):

	Level	EC
Lecture series 1 (in BPS)	500	4
Lecture series 2 (in BPS)	500	4

Research project 1, in Medicinal Chemistry		
• Practical Work	600	45
• Thesis	600	5
• Oral presentation	500	2
Research project 2		
• within the Faculty of Science (preferably in another discipline of BPS), Practical Work	600	31
• or outside the Faculty of Science, Practical Work	600	31
• Thesis	600	5
Literature study plus thesis	500	7
Course Scientific Conduct	500	1
20 Lectures and Colloquia	500	1
Optional courses or traineeships	≥400 (max 12 EC <400)	15

Specialisation

Analytical Biosciences

Description

The MSc programme Analytical Biosciences (analytical chemistry focussing on hyphenated bio-analytical strategies including proteomics) trains for junior drug researchers, and prepares students for a career in analytical chemistry.

Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Bio-Pharmaceutical Sciences, Pharmaceutical Sciences, or Pharmacy will be admitted to the programme.

For all other (international) candidates, the Board of Admissions will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a BSc (or equivalent) in Chemistry, Life Science and Technology, as well as HBO Bachelors in Chemistry with an equivalent BSc will be considered. The choice in optional courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

Programme

The programme contains two research periods (52 and 36 EC), and compulsory and optional programme components (32 EC):

	Level	EC
Lecture series 1 (in BPS)	500	4
Lecture series 2 (in BPS)	500	4
Research project 1, in Analytical Biosciences		
• Practical Work	600	45
• Thesis	600	5
• Oral presentation	500	2
Research project 2		
• within the Faculty of Science (preferably in another discipline of BPS), Practical Work	600	31
• or outside the Faculty of Science, Practical Work	600	31
• Thesis	600	5
Literature study plus thesis	500	7

Course Scientific Conduct	500	1
20 Lectures and Colloquia	500	1
Optional courses or traineeships	≥400 (max 12 EC <400)	15

Specialisation Pharmacology

Description

The MSc programme Pharmacology (drug transport and disposition; pharmacokinetics/pharmacodynamics; hormones in neurosciences; clinical pharmacology) trains for junior drug researchers, and prepares students for a career in pharmacology.

Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Bio-Pharmaceutical Sciences, Pharmaceutical Sciences, or Pharmacy will be admitted to the programme. For all other (international) candidates, the Board of Admissions will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a BSc (or equivalent) in Biology or Biomedical Sciences, as well as HBO Bachelors in Biomedical Sciences with an equivalent BSc will be considered. The choice in optional courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

Programme

The programme contains two research periods (52 and 36 EC), and compulsory and optional programme components (32EC):

	Level	EC
Lecture series 1 (in BPS)	500	4
Lecture series 2 (in BPS)	500	4
Research project 1, in Pharmacology, Medical Pharmacology, or Clinical Pharmacology		
• Practical Work	600	45
• Thesis	600	5
• Oral presentation	500	2
Research project 2		
• within the Faculty of Science (preferably in another discipline of BPS), Practical Work	600	31
• or outside the Faculty of Science, Practical Work	600	31
• Thesis	600	5
Literature study plus thesis	500	7
Course Scientific Conduct	500	1
20 Lectures and Colloquia	500	1
Optional courses or traineeships	≥400 (max 12 EC <400)	15

Specialisation

Drug Delivery Technology and Biopharmaceutics

Description

The MSc programme Drug Delivery Technology and Biopharmaceutics (drug delivery and formulation research; drug target finding and gene modulation in cardiovascular disease) trains for junior drug researchers, and prepares students for a career in drug delivery technology and/or drug target finding and therapeutic gene modulation.

Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Bio-Pharmaceutical Sciences, Pharmaceutical Sciences, or Pharmacy will be admitted to the programme.

For all other (international) candidates, the Board of Admissions will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a BSc (or equivalent) in Biology, Biomedical Sciences, Chemistry, Life Science and Technology, as well as HBO Bachelors in Chemistry or Biomedical Sciences with an equivalent BSc will be considered. The choice in optional courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

Programme

The programme contains two research periods (52 and 36 EC), and compulsory and optional programme components (32 EC):

	Level	EC
Lecture series 1 (in BPS)	500	4
Lecture series 2 (in BPS)	500	4
Research project 1, in Drug Delivery Technology or Biopharmaceutics		
• Practical Work	600	45
• Thesis	600	5
• Oral presentation	500	2
Research project 2		
• within the Faculty of Science (preferably in another discipline of BPS), Practical Work	600	31
• or outside the Faculty of Science, Practical Work	600	31
• Thesis	600	5
Literature study plus thesis	500	7
Course Scientific Conduct	500	1
20 Lectures and Colloquia	500	1
Optional courses or traineeships	≥400 (max 12 EC <400)	15

Specialisation Toxicology

Description

The MSc programme Toxicology (cellular and molecular mechanisms of toxicity) trains for junior drug researchers, and prepares students for a career in toxicology.

Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Bio-Pharmaceutical Sciences, Pharmaceutical Sciences, or Pharmacy will be admitted to the programme.

For all other (international) candidates, the Board of Admissions will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a BSc (or equivalent) in Biomedical Sciences, Chemistry, Life Science and Technology, as well as HBO Bachelors in Chemistry or Biomedical Sciences with an equivalent BSc will be considered. The choice in optional courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

Programme

The programme contains two research periods (52 and 36 EC), and compulsory and optional programme components (32 EC):

	Level	EC
Lecture series 1 (in BPS)	500	4
Lecture series 2 (in BPS)	500	4
Research project 1, in Toxicology		
• Practical Work	600	45
• Thesis	600	5
• Oral presentation	500	2
Research project 2		
• within the Faculty of Science (preferably in another discipline of BPS), Practical Work	600	31
• or outside the Faculty of Science, Practical Work	600	31
• thesis	600	5
Literature study plus thesis	500	7
Course Scientific Conduct	500	1
20 Lectures and Colloquia	500	1
Optional courses or traineeships	≥400 (max 12 EC <400)	15

MSc Biology

CROHO-number 66860

The Institute of Biology Leiden (IBL) of the Leiden University offers an attractive and varied MSc programme. The two research specialisations '*Molecular and Cellular Biosciences (MCB)*' and '*Evolution, Biodiversity and Conservation (EBC)*' reflect the two major themes of biological research at Leiden University. A special feature of the '*Evolution, Biodiversity and Conservation (EBC)*' programme is its close link with the unique biodiversity research cluster in Leiden consisting of the Institute of Environmental Sciences (CML), the Hortus botanicus and the National Herbarium (NHN), and the National Museum of Natural History (Naturalis). In addition to the two research specialisations, three additional specialisations combine research programmes in biology with training in Science-Based Business (SBB), Science Communication & Society (SCS) or education (EDU).

The duration of the programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Biology (MSc in Biology) with specification of the specialisation, if applicable. The degree provides graduates with the academic training and research skills required to pursue a scientific or science-related career. All specialisations have the same director and the same Board of Examiners. A Board of Admissions advises on admissions. Each MSc-student is assigned a staff mentor who will advise the student on their study programme, and monitor and mentor his or her personal progress.

Admission

Students from any Dutch university with a BSc degree in Biology will be admitted to the programme without restriction, but the optional elements of the MSc programme might be used to adapt the programme to the present knowledge of the candidate. For candidates with degrees from universities abroad and candidates with a BSc in any of the other Natural Sciences, Life sciences, (bio)mathematics or Biomedical sciences and specific HBO bachelors, the Board of Admissions will judge how the previous training matches that of the Dutch BSc in Biology. Where this results in admission, this may be under the condition of specific additional coursework as part of the degree. The admission process may include an interview with the Board of Admissions. The admission guidelines for each specific specialisation are given in more detail below where they differ from these general admission qualifications. Foreign applicants must provide proof of proficiency in English (IELST ≥ 6.5 with a value ≥ 6.0 for all subscores).

Start of the programme

Students may enter the programme throughout the year. However, they are strongly encouraged to start in September when a general introduction into the master programme and compulsory theoretical courses are scheduled.

Specialisation

Evolution, Biodiversity and Conservation

Description

This internationally oriented MSc programme provides students with a broad theoretical background and research skills in the study of evolution, biodiversity and conservation. It

builds on the unique combination of biological institutes in Leiden joining forces: the Institute of Biology (IBL, UL); the Institute of Environmental Sciences (CML, UL) the National Herbarium and the National Museum of Natural History (Naturalis). Students within this specialisation can either specialize in particular research areas or develop themselves more broadly. The programme provides students with the attitude and the scientific skills to become an independent, creative and reflective academic. They will be able to function as a researcher (e.g. PhD-student) in various disciplines: ecology, evolutionary biology, animal behaviour, zoology, developmental biology and evo-devo, environmental sciences, systematics and taxonomy, conservation biology, biomedical areas and other related fields. They can also function as policy maker, consultant or advisor on issues of conservation, sustainable use of resources, land use planning and management, global development, tropical forest management, environmental change; or as curator in natural history museums - all depending on the chosen specialization. This specialisation is also extremely well suited for students from developing countries with an interest in biodiversity or conservation.

Programme (120 EC)

The programme consists of a theoretical part (32-60 EC) and one or more research projects (60-88 EC). Courses cover a broad range of relevant subjects and provide in-depth theoretical knowledge as well as training in practical skills and advanced research tools. Internationally leading scientists in fields relevant for the programme are invited for special lectures and discussion with students ('*Top lectures*'). Compulsory are the introductory '*Fundamentals*' course, two so-called '*Trends courses*', some other elements indicated below, and at least one research project. The '*Fundamentals*' is a broad-ranging 8week (12 EC) 'basics' course, consisting of 4 modules. In the first one, students will use the famous Lake Victoria system to discover how this can give rise to research questions on a great variety of topics in great many disciplines. The subsequent modules ('*Fundamentals of evolutionary change*', '*Richness of the world*' and '*Fundamentals of conservation biology*') offer a broad kaleidoscope of subjects as starting points for the later individual specializations. In addition, students can choose among several '*Trends*' courses (lasting 4 weeks) providing students with an integrated picture on specific topics. The research projects are the actual core of the MSc programme. Students will be member of a research group of their choice and work on a specific project in close collaboration with staff of one of the different institutes full time. Each project will be rounded off with writing an MSc thesis in the form of a manuscript for an international scientific journal. The research project(s) should make up at least 60 EC of the programme. Research projects can range from experimental studies on the molecular mechanisms of development or on animal behaviour to collection-based research on biodiversity or field projects in the Netherlands or elsewhere (e.g. terrestrial and marine studies in Southeast Asia). After an internal project, students are encouraged to do an external project at an affiliated institute abroad.

Compulsory:

The compulsory theoretical component consists of 32 EC and the minimum time to be spent on research projects is 60 EC.

<i>Theoretical courses:</i>	Level	EC
EBC fundamentals	400	12
Two EBC 'trends' courses	500	2x6
<i>In addition, two of the following elements are also compulsory:</i>		
Seminar	500	4
Top lectures	600	4

Book exam	500	6
Colloquium 'Spotlight Research talks'	500	4
Research projects:	600	60-88

compulsory is at least one project of 36 EC within one of the participating institutes.

Optional elements:

Students may use a total of 28 EC for the optional part of the programme which can either consist of course work (at Leiden or elsewhere), or an extra (or expanded) research project. For courses outside the LU biology programme and for all external research projects, *a priori* approval of the specialisation coordinator is required.

Note: a maximum of 12 EC of optional elements at a level < 400 are permitted.

Specialisation Molecular and Cellular Biosciences

Description

This MSc specialisation provides students with knowledge about all basic aspects of genetics and molecular and cellular biology of prokaryotes and eukaryotes. Attention is given to genetic, microbiological, cellular and physiological approaches to understand the functioning of uni- and multicellular organisms at the molecular level. Training in functional genomics, cellular imaging, transcriptomics, proteomics and metabolomics will provide essential knowledge and skills to apply these powerful techniques in the broad fields of biological and medical research. The implications of these techniques for biotechnology and the understanding of the molecular basis of development and diseases of animals and plants are highlighted. Research projects embrace a wide variety of different organisms including bacteria, yeast, fungi and the famous model species, *Arabidopsis* and zebra fish. Students are trained in general academic skills and in understanding and critically evaluating specialized scientific literature. They are equipped with the necessary practical skills to outline, plan and execute experiments. They are able to critically assess recent developments in the field. Based on this, they can discover, describe and analyse new scientific questions and design creative approaches to tackle these questions via experimentation. They will be able to use state of the art technology in at least one of the major sub disciplines genetics, microbiology, cell biology or microbial and plant biotechnology. They are able to analyze scientific data, to formulate scientific conclusions on basis of these data and they are trained to present scientific results in oral presentations and in writing.

This master specialisation is optimally suited as a basis for starting a career in experimental molecular and cellular biological or biomedical research. However, as the students will be provided the option to do a project at the interface of fundamental and applied science, this will also qualify them for positions at governmental (research) institutions, non-governmental organisations or commercial companies.

Programme (120 EC)

The programme consists of two consecutive phases with compulsory components that can be expanded with electives. The mandatory components in phase 1 in the 1st semester provide students with the theoretical and practical background in molecular and cell biology research needed in phase 2. Phase 1 needs therefore to be finished successfully, before the student can start with phase 2.

In phase 2, students are further trained in critically reading and writing about recent scientific literature ranging from a general perspective to a chosen specialization. This includes at least one, extensive research project including an MSc thesis and a colloquium. Specializations are: genetics and microbiology, plant stress and metabolites, plant developmental genetics, microbial- or plant biotechnology. and animal cells and disease, The areas covered are gene technology, genomics, cell biology, cell physiology, microbiology and biotechnology. A major and compulsory part of the master training is actively taking part in a running research project, preferably one research project of at least 9 months (54 EC), or two research projects each with a minimum duration of 6 months (36 EC). The compulsory research project(s), or at least one of them, is done in one of the IBL departments: Molecular Developmental Genetics, Molecular Microbiology, Molecular Cell Biology, or Plant Cell Physiology. A research project within one of the 'Life Science' research groups of the Leiden Institute of Chemistry (LIC), at the Leiden-Amsterdam Centre of Drug Research (LACDR) or at the Leiden University Medical Centre (LUMC) may substitute for the mandatory research project within the IBL (meaning that it may count as an internal research project). A research project can be done at the LUMC when minimally 20 EC on biomedical courses have been concluded during the bachelor programme. For all external research projects, a priori approval by the program coordinator is required.

Additional EC can be obtained by following optional courses or advanced lectures, by doing a minor research project, or by extending a research project. The element 'Colloquium course' comprises advanced lectures specialisation (flexible for 2 to 6 EC).

<i>Compulsory components:</i>	level	EC
<i>Phase 1:</i>		
Fundamentals of Molecular and Cellular Biosciences	400	6
Orientation on MCB research	400	4
MCB laboratory skills ¹	400	1
<i>Phase 2:</i>		
MCB research project	600	54-72 (or 2x36)
Initial oral presentation		1
Research		1.5 EC per week
Master thesis		5 (or 2 x 3)
Final oral presentation		2 (or 2 x 1)
Colloquium course "Discoveries in Bioscience"	600	2-6
Advanced MCB textbook	500	6
Ph.D. orientation course		
Condensed literature survey (introduction) ²	500/600	3
Ph.D. Research project proposal ³	600	3
<i>Electives</i>		
Additional courses, lectures, minor research project or extension research project	400/500	23 – 41

¹ This concerns a 1-week individual introductory course on general MCB laboratory practices, which should naturally precede the (first) MCB research project, and ensures that the MSc student can safely work in a molecular laboratory.

² This 2-week condensed literature survey will be finalized with writing the introduction part of the PhD research project proposal, and formulation of the research question(s) of this proposal.

³ During this 2-week period a PhD research proposal will be written according to the NWO/ALW open competition guide lines.

Note: maximally 12 EC of optional theoretical program elements of level < 400 are permitted.

Description of the Courses

Phase 1 of the MCB MSc study comprises 3 compulsory courses. The course Fundamentals of Molecular and Cellular Biosciences concerns a self study on the basic theoretical knowledge of microbiology, cellular biology, molecular genetics, immunology and plant cell physiology and the connection between these sub disciplines. This course should be finished satisfactory before any other part can start. The course Orientation on MCB research provides a state of the art overview of the scientific research in the departments participating in this MSc specialisation taken from presentations by group leaders and PhD students. The course MCB laboratory skills concentrates on general methods and techniques that are required for students to work safely in a molecular biology lab. This course is often integrated with the first week of the first research project.

Phase 2 aims at deepening the knowledge of and insights in one of the research fields of cellular biology, developmental and molecular genetics, microbiology or plant cell physiology.

Only after successful completion of the three courses in phase 1, a student can start with the research project. A colloquium course 'Discoveries in Bioscience' is being offered as an obligatory element by the MCB specialisation, which is flexible and can be followed in combination with the research project. In addition, students choose a specific advanced book, and prepare individually for a specialized theoretical exam. Available book titles are: Molecular Biology of The Cell (Alberts, Edition 4 or 5); Brock Biology of Microorganisms, (Madigan et al. 10th edition), and Plant Physiology (Tiaz and Zieger, 4th edition). For details (description, literature, exam dates and further calendar events) about the different courses during Phase 1 and 2 see: Blackboard.

MSc Life Science and Technology (LS&T) – Leiden

CROHO-number 66286

The Leiden Institute of Chemistry (LIC) forms the basis for research and collaborations of the Leiden chemistry and life sciences groups. The LIC offers four specialisations of an MSc LS&T programme: the life science research and development (RESEARCH), Science Based Business (SBB), Science Communication & Society (SCS) and Education (EDU). Aim of each programme is to train the student as an independent researcher, and to develop the necessary skills and proficiency to advance his/her career. The duration of each specialisation is two years (120 EC); a general overview of the content of the four specialisations is given in Table 1. Students who complete the programme receive the degree Master of Science in LS&T, with specification of the specialisation. All specialisations have the same director, the same Board of Examiners, and the same Department Teaching Committee.

Table 1: Overview of the programmes of the four Leiden MSc LS&T specialisations

Specialisation	RESEARCH	EDU	SCS	SBB
Internship	60	30	30	30
Compulsory courses within	18	12	12	12
Compulsory courses outside	6	12	12	12
Essay & Colloquium	6	-	-	-
Free electives ¹	30	36 / 6 ²	26	26
EDU/SCS/SBB components	-	30 / 60	40	40
Total	120	120	120	120

Admission procedure

Students from any university in the Netherlands with a BSc degree in Life Sciences & Technology will be admitted to the programme. All other (international) candidates, such as students with a degree related to Life Sciences, HBO Bachelors and foreign students have to apply for admission. As a guideline, the HBO-diploma has to be obtained within four years and with an average final mark above 7.5

The Board of Admissions will judge the qualifications of the applicant on the basis of the curriculum and grades of his/her previous training. The admission process may include an interview with the Board of Admissions. Foreign applicants must provide proof of proficiency in English (IELTS level ≥ 6.5). The applicants for the EDU and SCS specialisations must provide proof of proficiency in Dutch. Admission is possible throughout the year, but we advise (foreign) students to start in September or February.

The programme

Each student composes his/her own study programme in consent with the mentor, who is a permanent staff member of the LIC. The mentor is the supervisor of the major internship of the specialisation in one of major research areas as chosen by the student. The mentor will coach the student from the admission throughout the MSc programme. The choice in

¹ The choice in the free electives is restricted to the boundaries specified here. A maximum of 20 EC can be used for extension of the internships.

² if the student has taken a minor Education (tweedegraadsbevoegdheid) of 30 EC in the BSc study, only 30 EC are necessary in the MSc study to obtain the “eerstegraadsbevoegdheid”; then 30 EC free electives are added to the LS&T programme.

elective courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate. This study programme must be submitted for approval to the Board of Examiners at the start of the study. The intended programme may be adjusted during the course of the MSc programme. A copy of the approved programme is administrated by the study coordinator; it is used to keep specialisation of the student's progress and forms the basis for the master portfolio. The master portfolio is updated by the student on a regular basis via the research group secretariat and it is accessible to the student, the mentor and the study coordinator. The mentor discusses the progress of the student at least every half year using the results documented in the portfolio. The study coordinator will mediate when the student encounters problems in the contact with the mentor.

Description of the specialisations

The specialisations Science Based Business, Science Communication & Society and Education are described separately in this Appendix.

The students will study molecular genetics and cell biology, with an emphasis on the regulation of cell signaling. They will also learn to identify molecular structures and mechanisms and carry out research of the physical principles underlying cellular organization in health and disease. In addition, the students gain insights and skills in modern analysis and bio-imaging such as genomics, proteomics, mass spectroscopy, life cell imaging, X-ray and NMR analysis. A thorough understanding of bioinformatics is essential in view of the complexity and enormity of the data sets that are generated. Furthermore, due to the multidisciplinary character of the Cell Observatory, the students are in the position to carry out research projects in life sciences in a chemistry, physics, bioinformatics, biopharmacology, biology or biomedical setting. Next to research projects within the Cell Observatory and related research groups, our Msc students have the opportunity to carry out pre-clinical master projects in biomedical research institutes, including the LUMC, ErasmusMC and NKI.

Programmes of the specialisations

The programmes of the specialisations Science Based Business, Science Communication & Society and Education are described separately in this Appendix.

Specialisation – Life science research and development (RESEARCH)

The life science research and development programme consists of three parts: the research internship (60 EC), the compulsory courses (30 EC) and the elective courses (30 EC). A general overview of the programme is given in Table 1.

The (major) internship is carried out within the Cell Observatory or related LIC research groups. Our Msc students also have the opportunity to carry out pre-clinical master projects in biomedical research institutes, including the LUMC, ErasmusMC and NKI. The research internship includes a presentation and a written report (the master thesis). The research internship may be split into two internships: the major and minor internship. The major internship is limited to 60 EC and the minor internship must comprise at least 20 EC. The topics of the minor and major internship project may be related which may be reflected in a combined master thesis. In consent with the mentor the minor internship can be carried out in another specialisation, another institute (within the Netherlands or

abroad), or in industry. Prior approval of the Board of Examiners is required for an internship outside the institute. The mentor has the final responsibility for the grading of the minor internship report of the research not carried out in the LIC.

The compulsory theoretical component comprises a selection of four core courses (24 EC) and a literature essay with colloquium (6 EC). Three of the courses are chosen from the courses listed in Table 2 (18 EC) and one is chosen from the core courses offered by the Leiden Msc programme chemistry or within the Delft Msc programme. LS&T.

The elective component consists of a free choice of theoretical courses (30 EC). Alternatively, a maximum of 20 EC can be used to extend the research internships. The mentor may limit the choice in elective courses by the need to adapt the programme to the present knowledge of the student. Students can choose their electives from the list of core courses within or outside their specialisation, the MSc courses offered in the Science Faculty of level 400 or higher, or level 400 courses from the BSc LS&T and Bsc MS&T programmes provided that these were not part of the student's earlier studies. All other electives have to be approved by the Board of Examiners.

List of Advanced Compulsory Modules

Each course encompasses 6 EC and is a 500 level course.

- Applied Computational Molecular Biology
- Analysis of the three dimensional structure of proteins by diffraction and imaging methods
- Biophysics of Proteins and Protein Interactions
- Genome Organization and Maintenance in cancer and aging
- Global Regulatory Networks in Bacteria
- In-Vivo Biomolecular Interactions underlying diseases

Three courses have to be followed for the research specialization, two course have to followed for the other specializations.

Specialisation Science Based Business

Description

The specialisation Science Based Business (SBB) provides knowledge and skills in the area of Management, Business and Entrepreneurship. Its focus is on their application in science- and research-driven organisations. Its purpose is to broaden the horizon, to form an opinion on and prepare for a career in industry and to enhance competencies for pursuing entrepreneurial business opportunities created in research.

Qualifications for Admission

Admissible to the Specialisation SBB are all students that are admitted to a Master Programme of the Faculty of Science and the Master Programme in Biomedical Sciences of the Faculty of Medicine (LUMC) provided that the rules and regulations of the subject Master Programme do allow so.

Exemptions; Students with prior education in management, business and entrepreneurship may –depending on the contents and extent of such education- be exempted from following one or more of the Foundation and Advancement courses. These courses need to be substituted such that their master programme contains at least 40 EC of SBB courses.

Programme

Completion of the specialisation SBB requires a minimum of 40 EC courses from the courses listed in the table below, including at least either the SBB Internship or the RBB Assignment.

Minimum requirement for the SBB Internship is completing the courses SBB Fundamentals and SBB Management.

Minimum requirement for the RBB Assignment is completing the three Research Based Business foundation courses and either the course RBB New Business Development or RBB Technology Transfer.

Mathematics

The Mathematics component of the Science Based Business (SBB) specialisation consists of a research project in mathematics of 40 EC (incl. 7 EC for the thesis and an oral presentation) in one of the research groups of the Leiden Mathematical Institute, 20 EC of courses to be selected in correspondence with the research topic, and a mathematical project connected with the SBB training period.

Computer Science

The computer science component of the Science-based Business (SBB) specialisation consists of a research project in computer science of 40 EC (incl. 7 EC for the thesis and an oral presentation) in one of the research groups of LIACS, and 20 EC of level-500 courses to be selected in correspondence with the research topic. The choices for courses and research project will be made in consultation with a supervisor.

Astronomy

The Astronomy research component of the SBB specialisation consists of a Medium Research Project (30 EC) supervised by a member of the Leiden Observatory scientific staff, as well as courses to be selected in correspondence with the research topic to a minimum of 30 EC and a maximum of 50 EC. These include at least the mandatory course Stellar Structure and Stellar Evolution, one other Astronomy core course and non-Astronomy courses with 8-14 EC.

Physics

The research component consists of a project in Physics of 33 EC in one of the research

groups of the institute and a master's thesis and an oral presentation (5+2=7 EC), together with 20 EC of courses to be selected in correspondence with the research topic.

Chemistry

The Chemistry component of the Science Based Business (SBB) specialisation consists of a research project in chemistry of 30 EC in one of the major research areas, 12 EC of courses within and 12 EC outside the chosen research area. The programma comprises 26 EC of free electives; an extension of the research project is restricted to 20 EC and no more than 20 EC can be used for SBB courses.

Bio-Pharmaceutical Sciences

The BPS research component of the Science-Based Business (SBB) specialisation consists of a research project of 50 EC in one of the research groups of CBPS, including 5 EC for a thesis and 2 EC for an oral presentation, two lecture series of 4 EC each, the course Scientific Conduct of 1 EC and attendance of at least 20 colloquia or seminars (1 EC). The choices for lecture series and research project will be made in concert with an advisor.

Biology

The Biology component of the Science-based Business (SBB) specialisation consists of a biology research project of 36-40 EC (including 4 EC for an MSc thesis and 1 EC for a colloquium) and 20-24 EC of advanced theory (courses, lectures and a mandatory seminar) to be selected in relation to the research topic. The research project will be in one of the research groups of the Institute of Biology (IBL), Institute of Environmental Sciences (CML), National Herbarium of the Netherlands (NHN) or 'Naturalis'. The individual study programme consisting of choices of courses and the research project will be made in concert with and approved *a priori* by the track coordinator of the biology part of the programme.

Life Science & Technology

The LST component of the Science Based Business (SBB) specialisation consists of a research project in chemistry of 30 EC, 12 EC of courses within LS&T programma and 12 EC of courses offered by Chemistry or the Delft LST programme. The programma comprises 26 EC of free electives; an extension of the research project is restricted to 20 EC and no more than 20 EC can be used for SBB courses.

<i>Specialisation Science Based Business: Courses</i>		
<i>Foundation:</i>	Level	EC
- SBB Fundamentals	400	15
- Research Based Business Opportunities	400	5
- Research Based Business Ventures	400	5
- Research Based Business Planning	400	5
<i>Advancement:</i>		
- RBB New Business Development	500	3
- RBB Technology Transfer	500	3
- SBB Management	500	3
- Learning from Silicon Valley: Innovation, Entrepreneurship & Successful Cluster Development	500	10
- SBB Essay	500	3-7
- SBB Elective	400-600	3-15
<i>Finishing:</i>		
- SBB Internship	600	22-35
- RBB Assignment	600	22-35

Specialisation Science Communication & Society

Description

The specialisation Science Communication & Society concerns science communication in a broad sense. The programme prepares students for a career in popularisation of science, for example, as a science communicator, a science policymaker or a public relations officer, or for a career as a scientist with a communicating mindset. Students with a MSc specialisation Science Communication & Society are admissible to a PhD programme in their MSc research or in Science Communication.

Qualifications for admission

Students should be admitted to a MSc programme within the Faculty of Science. For all other (international) candidates, the Board of Admissions will judge the equivalence to these BSc degrees of their previous training. Preferably, the BSc programme has included the 10-EC-course Learning, Presentation and Communication, offered by the Leiden Graduate School of Education (ICLON), or equivalent courses. Applicants must provide proof of proficiency in Dutch.

Programme

Mathematics

The research component consists of a project in mathematics of 40 EC (including a master thesis and an oral presentation) in one of the research groups of the institute, and 20 EC of courses to be selected in correspondence with the research topic.

Computer Science

The research component consists of a project in computer science of 40 EC (incl. 7 EC for the thesis and an oral presentation) in one of the research groups of the institute, and 20 EC of courses to be selected in correspondence with the research topic.

Astronomy

The Astronomy research component of the SCS specialisation consists of a Medium Research Project (30 EC) supervised by a member of the Leiden Observatory scientific staff, as well as courses to be selected in correspondence with the research topic to a minimum of 30 EC and a maximum of 50 EC. These include at least the mandatory course Stellar Structure and Stellar Evolution, one other Astronomy core course and non-Astronomy courses with 8-14 EC.

Physics

The physics component of the Science-based Business (SBB) specialisation consists of a research project of 33 EC in one of the research groups of the Leiden Institute of Physics (LION) and a master's thesis and an oral presentation (5+2=7 EC), together with 20 EC of courses to be selected in correspondence with the research topic.

Chemistry

The Chemistry component of the Science Communication & Society (SCS) specialisation consists of a research project in chemistry of 30 EC in one of the major research areas, 12 EC of courses within and 12 EC outside the chosen research area. The programme comprises 26 EC of free electives; an extension of the research project is restricted to 20 EC and no more than 20 EC can be used for SCS courses.

Bio-Pharmaceutical Sciences

The BPS research component of the Bio-Pharmaceutical Sciences and Communication specialisation consists of a research project of 50 EC in one of the research groups of CBPS, including 5 EC for a thesis and 2 EC for an oral presentation, two lecture series of 4 EC

each, the course Scientific Conduct of 1 EC and attendance of at least 20 colloquia or seminars (1 EC). The choices for lecture series and research project will be made in concert with an advisor.

Biology

The research component consists of a biology research project of 36-40 EC (including 4 EC for an MSc thesis and 1 EC for a colloquium) and 20-24 EC of advanced theory (courses, lectures and a mandatory seminar) complementing the research topic. The research project should take place in one of the research groups of the Institute of Biology (IBL), Institute of Environmental Sciences (CML) or National Herbarium of the Netherlands (NHN). All theory is minimally on level 400. The choices for theory and research project will be made together with the track coordinator of the biology part of the programme.

Life Science & Technology

The LS&T component of the Science Communication & Society (SCS) specialisation consists of a research project in LS&T of 30 EC in one of the major research areas, 12 EC of courses within LS&T programma and 12 EC of courses offered by Chemistry or the Delft LST programme. The programma comprises 26 EC of free electives; an extension of the research project is restricted to 20 EC and no more than 20 EC can be used for SCS courses.

Communication

The Communication component consists of the following:

Mandatory:

	Level	EC
- Fundamentals of Science Communication and Society	400/500	17
- Training period	500/600	23-34

The training period can be in the field of Journalism, Museology or New Media and includes a written report, and an oral presentation.

Choice of:

- Extension of the MSc specialisation component		0-20
- Courses in Communication	≥400	0-8
- Communication Master thesis	500/600	5
- Communication research project correlated to the Master thesis	500/600	4

The choice of the training period, master thesis, and elective courses should be approved beforehand by the track coordinator and the Msc programme coordinator.

Specialisation Education

Description

The MSc specialisation Education prepares students for a career in teaching in their own research specialisation. In their specialisation, student teachers develop competences to improve and innovate their practice (e.g., by developing and testing instruction on a specific topic). This programme leads up to the so-called “eerstegraads-lesbevoegdheid” in physics needed for teaching at Dutch high schools.

Students with a MSc specialisation in Education are also admissible to a PhD programme in their MSc research specialisation.

Qualifications for admission

Students should be admitted to a MSc programme within the Faculty of Science.

For all other (international) candidates, the Board of Admissions will judge the equivalence to this BSc degree of their previous training.

Applicants must provide proof of proficiency in Dutch.

Programme

The specialisation Education (EDU) consists of 60 EC in one of the MSc programmes of the faculty as listed below and 60 EC in Education.

When the student has passed the minor Education (30 EC) during the BSc programme, the compulsory education component is reduced with 30 EC. The remaining 30 EC can be used for both the education specialisation or the MSc programme. For LS&T and Chemistry the electives are restricted to the MSc programme.

Computer Science (60 EC)

The research component of the Computer Science and Education specialisation consists of a project in computer science of 40 EC (incl. 7 EC for the thesis and an oral presentation) in one of the research groups of the institute, and 20 EC of courses to be selected in correspondence with the research topic.

Mathematics (60 EC)

The research component of the Mathematics and Education specialisation consists of a project in mathematics of 40 EC (incl. 7 EC for the thesis and an oral presentation) in one of the research groups of the institute, and 20 EC of courses to be selected in correspondence with the research topic.

Astronomy (60 EC)

The Astronomy research component of the EDU specialisation consists of a Medium Research Project (30 EC), as well as courses to be selected in correspondence with the research topic to a total of 30 EC. These include at least the mandatory course Stellar Structure and Stellar Evolution, one other Astronomy core course and non-Astronomy courses with 12 EC.

Physics (60 EC)

The research component of the Physics and Education specialisation consists of a physics project of 33 EC in one of the research groups of the institute and a master's thesis and an oral presentation (5+2=7 EC), together with 20 EC of courses to be selected in correspondence with the research topic.

Chemistry (60 EC)

The Chemistry component of the EDU specialisation consists of a research project in Chemistry of 30 EC in one of the major research areas, 12 EC of courses within and 12 EC outside the chosen research area. The programme comprises 6 EC of free elective.

Bio-Pharmaceutical Sciences (60 EC)

The BPS research component of the Bio-Pharmaceutical Sciences and Education specialisation consists of a research project of 50 EC in one of the research groups of CBPS, including 5 EC for a thesis and 2 EC for an oral presentation, two lecture series of 4 EC each, the course Scientific Conduct of 1 EC and attendance of at least 20 colloquia or seminars (1 EC). The choices for lecture series and research project will be made in concert with an advisor.

Biology (60 EC)

The research component of the Biology and Education specialisation consists of a biology research project of 36-40 EC (including 4 EC for a thesis and 1 EC for a colloquium) and 20-24 EC of advanced theory (courses, lectures and a mandatory seminar) to be selected in correspondence with the research topic. The research project is in one of the research groups of the Institute of Biology (IBL), Institute of Environmental Sciences (CML) or National Herbarium of the Netherlands (NHN). All theory is minimally on level 400. The programme will be established in concert with the study advisor, track coordinator and has to be approved by the Board of Examiners.

Life Science & Technology (60 EC)

The LS&T component of the Education specialisation consists of a research project in LS&T of 30 EC in one of the major research areas, 12 EC of courses within LS&T programma and 12 EC of courses offered by Chemistry or the Delft LST programme. The programma comprises 6 EC of free electives.

Education (60 EC)

The Education option of the MSc programme Mathematics and Education is offered as a joint programme of the faculty and the Leiden University School of Teaching (ICLON) and consists of the following components:

	Level	EC
Educational Theory	300	5
Supervision of Professional Development 1	400	4
Supervision of Professional Development 2	400	3
Teaching Methodology 1	500	5
Teaching Methodology 2	500	5
Specialisation	600	8
Teaching Practice 1		15
Teaching Practice 2		15

In their specialisation, student teachers develop their competences to innovate their practice (e.g., by developing and testing instruction on a specific topic). This programme is adequate to obtain the so-called “eerste graads lesbevoegdheid” in mathematics needed for teaching at Dutch high schools