

# Master programme of the Faculty of Science Leiden University

- Descriptions
- Qualifications for admission
- Condensed programmes

Onderwijs en Examenregeling Masteropleiding Bijlage
--

## Contents

Mathematics .....	2 - 5
Computer Science .....	6 - 10
ICT in Business .....	11 -12
Media Technology .....	13
Astronomy .....	14 - 18
Physics.....	19 - 24
NanoScience .....	26
Chemistry .....	27 - 32
Life Science and Technology .....	33 - 37
Bio-Pharmaceutical Sciences .....	38 - 44
Biology .....	45 - 54

# MSc Mathematics

Crohonummer 66980

Leiden University offers five tracks of an MSc programme in mathematics. Two of these correspond to research specialisations in the Leiden Mathematical Institute. The remaining three are the mathematics track of the research MSc with Science-Based Business (SBB), and the Communication and Education specializations.

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 specialization, if applicable. Details are provided below. All tracks have the same Director, the same Exam Committee, and the same Programme Committee. An Admission Committee will advise on admissions.

Candidates with a BSc degree or equivalent can apply for admission. The admission guidelines are given below for each specialization. Individual combinations of the research programmes, with research projects from different groups, are possible in principle, depending on the decision by the Exam Committee. The admission process may include an interview with the Admission Committee. Foreign applicants must provide proof of proficiency in English (IELTS level  $\geq 6.5$ ). Admission is possible throughout the year, but we advise foreign students to start in September or February. Further information is available on the website <http://www.math.leidenuniv.nl/>

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.

## Track

### 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 Admission Committee 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.

## Track

### 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 Admission Committee 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.

## Track

### Mathematics and Science-Based Business

#### Description

The MSc programme Mathematics and Science-Based Business (SBB) prepares students for a career in science-related business and administration and for innovation and enterprise from a mathematical perspective. In addition to knowledge in mathematics, students obtain competence with respect to organisations, people in organisations, and establishment and management of processes. Students with an MSc in Mathematics and Science-Based Business are also admissible to a PhD programme.

In order to get an SBB Master annotation, a minimal programme consisting of the course SBB Fundamentals and the SBB training period must be completed (see below). The course SBB Fundamentals can also be taken in the “free choice” part of the research MSc programmes “Algebra, Geometry and Number theory” and “Applied Mathematics”.

#### Qualifications for admission

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

For all other (international) candidates, the Admission Committee 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

##### *Mathematics*

The Mathematics component of the Science-based Business (SBB) specialization 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 (see below).

### *Science-Based Business*

The Business-related part of the complete SBB programme consists of 40 to 60 EC of the following components.

<i>Mandatory:</i>	level	EC
SBB Fundamentals	400	17
SBB Internship	500	23-34
<i>Optional:</i>		
Orientation on Technopreneurship: Entrepreneurial Management	400	5
Orientation on Technopreneurship: Business Planning	400	5
SBB electives	500-600	0-20
Extension of the mathematic component		0-20

See for more information on Science-Based Business the following website:  
<http://www.sbb.leidenuniv.nl/>.

## **Track Mathematics and Communication**

### **Description**

The MSc programme Mathematics and Communication concerns science communication in a broad sense. The programme prepares students for a career in popularization 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 an MSc in Mathematics and Communication are admissible to a PhD programme in Mathematics or in Science Communication.

### **Qualifications for admission**

Students from any Dutch university with a BSc degree or major in Mathematics will be admitted to the programme. For all other (international) candidates, the Admission Committee 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 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 (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.

#### *Communication*

The Communication component consists of the following:

<i>Mandatory:</i>	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 mathematics 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 coordinator of Mathematics.

## Track

# Mathematics and Education

## Description

The MSc programme Mathematics and Education prepares students for a career in teaching Mathematics. The programme includes a 60-EC Mathematics research programme. Students with a MSc in Mathematics and Education are also admissible to a PhD programme.

## Qualifications for admission

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

For all other (international) candidates, the Admission Committee will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a major in Mathematics will be considered. It is strongly recommended that the BSc programme has included the 10-EC-course Learning, Presentation and Communication, offered by the Leiden School of Education (ICLON), or an equivalent course. Applicants must provide proof of proficiency in Dutch.

## Programme

### *Mathematics (60 EC)*

The research component of the Mathematics and Education specialization 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.

### *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 School of Education (ICLON) and consists of the following components:

	level	EC
Teaching Methodology	500	10
Professional functioning	300	12
Specialisation	600	8
School training	400	30

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.

# MSc Computer Science

Crohonummer 60300

The Leiden Institute of Advanced Computer Science (LIACS) is the computer science institute of Leiden University. The LIACS curriculum includes six MSc tracks in computer science. Three of these correspond to research specialisations of LIACS, the remaining three are the computer science track of the research MSc with Science-Based Business (SBB), and the Communication and Education specializations. In addition, LIACS offers two Master programmes in Mediatechnology 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 tracks have the same Director, the same Exam Committee, and the same Programme Committee. An Admission Committee 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 specialization. The admission process may include an interview with the Admission Committee. 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  $\geq 6.5$ ).

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.

## Track

### 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 Admission Committee 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	40
Option: software project or project study	500	20
Computer science research project	600	17
Computer science master's research project (incl. 7 EC for a thesis and an oral presentation)	600	43

## Track

# 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 Admission Committee 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	40
Option: software project or project study	500	20
Computer science research project	600	17
Computer science master's research project (incl. 7 EC for a thesis and an oral presentation)	600	43

## Track

# Bioinformatics

### Description

The main focus of the Bioinformatics track will be 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 track. This expertise is used to address issues like data capturing, data warehousing and data mining that have become major issues for biotechnologists and biological scientists due to sudden growth in quantitative data in biology. On the other hand, bioinformatics heavily contributes to the identification of new informatics principles and the development of new informatics tools. Bioinformatics offers a new synthetic approach for formulating hypotheses and solving problems in biology and bio chemistry 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 (international) candidates, the Admission Committee 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

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

<i>Core programme</i>	level	EC
Data analysis / Pattern Recognition	500	6
Databases / Data mining	500	6
Microscopy / Modeling and Visualization	500	6

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

<i>Specialization Courses</i>	500	24
-------------------------------	-----	----

A choice can be made out of different specialization courses. The specialization courses have level 500, and range from 3 - 7 EC. The total of 24 EC is indicative and depends on the extent of the student's support program and research assignment. The selection of the specialization courses takes place in coordination with the Bioinformatics track study advisor. More details can be found at the web-site of the institute.

<i>Support Program (Minor (Deficiency) courses)</i>	(100-300)	16-18
---	-----------	-------

For each student a support program will be defined by the Bioinformatics track study advisor. The support program consists of courses in Life Science, Computer Science, Mathematics, or of optional courses for deficiency programs. More details can be found at the web-site of the institute. The support program will consist of a maximum of 18 EC.

<i>Research assignment</i>	600	15-17
----------------------------	-----	-------

<i>Master's research project in computer science, (incl. 7 EC for a thesis and an oral presentation)</i>	600	45
--	-----	----

## Track

### Computer Science and Science-Based Business

#### Description

The MSc programme Computer Science and Science-Based Business prepares students for a career in science-related business and administration and for innovation and enterprise from a computer science perspective. In addition to knowledge in computer science, students obtain competence with respect to organisations, people in organisations, and establishment and management of processes. Students with an MSc in Computer Science and Science-Based Business are admissible to a PhD programme.

In order to get an SBB Master annotation, a minimal programme consisting of the course SBB Fundamentals and the SBB training period must be completed (see below). The course SBB Fundamentals can also be taken in the "specialisation" part of the research MSc programmes "Core Computer Technologies" and "Computer Science Theory and Advanced Technologies".

#### 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 (international) candidates, the Admission Committee will determine the equivalence of their previous training to these BSc degrees.

## Programme

### *Computer Science*

The computer science component of the Science-based Business (SBB) specialization 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.

### *Science-Based Business*

The Business-related part of the complete SBB programme consists of 40 to 60 EC of the following components.

<i>Mandatory:</i>	level	EC
SBB Fundamentals	400	17
SBB Internship	500	23-34
<i>Optional:</i>		
Orientation on Technopreneurship: Entrepreneurial Management	400	5
Orientation on Technopreneurship: Business Planning	400	5
SBB electives	500-600	0-20
Extension of the Computer Science component		0-20

See for more information on Science-Based Business the following website:  
<http://www.sbb.leidenuniv.nl/>.

## **Track Computer Science and Communication**

### **Description**

The MSc programme Computer Science and Communication concerns science communication in a broad sense. The programme prepares students for a career in popularization 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 an MSc in Computer Science and Communication are admissible to a PhD programme in Computer Science or in Science Communication.

### **Qualifications for admission**

Students from any Dutch university with a BSc degree or major in Computer Science will be admitted to the programme. For all other (international) candidates, the Admission Committee 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**

#### *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.

#### *Communication*

The Communication component consists of the following components:

<i>Mandatory:</i>	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 computer science 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 coordinator of Computer Science.

## Track Computer Science and Education

### Description

The MSc programme Computer Science and Education prepares students for a career in teaching Computer Science or Mathematics. The programme includes a 60-EC Computer Science research programme. Students with a MSc in Computer Science and Education are also admissible to a PhD programme.

### Qualifications for admission

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

For all other (international) candidates, the Admission Committee will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a major in Computer Science will be considered. It is strongly recommended that the BSc programme has included the 10-EC-course Learning, Presentation and Communication, offered by the Leiden School of Education (ICLON), or an equivalent course. Applicants must provide proof of proficiency in Dutch.

### Programme

#### *Computer Science (60 EC)*

The research component of the Computer Science and Education specialization 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.

#### *Education (60 EC)*

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

	level	EC
Teaching Methodology	500	10
Professional functioning	300	12
Specialisation	600	8
School training	400	30

In their specialisation, student teachers develop their competences to innovate their practice (e.g., by developing and testing instruction on a specific topic). If the student meets the basic qualifications for the knowledge of a discipline at Dutch high schools (e.g. mathematics), this programme is adequate to obtain the so-called "eerste graads lesbevoegdheid" needed for teaching at these schools.

# MSc ICT in Business

Crohonummer 60205

The Leiden Institute of Advanced Computer Science (LIACS) is the computer science institute of Leiden University. LIACS, in partnership with the Leiden University School of Management (LUSM) and RSM Erasmus University (Rotterdam), 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; there are limited possibilities for a start at another moment. 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 in 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. An Admission Committee will advise on admissions. The admission process may include an interview with the Admission Committee. Foreign applicants must provide proof of proficiency in English.

## Programme

The M.Sc. programme in ICT in Business consists of six modules, and a 6 months thesis project. The courses cover business foundations, core ICT & Business topics and electives, and are normally 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 program.

The programme structure is as follows:

- Core courses: ICT in Business  
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, ICT Infrastructure 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. These courses are offered in co-operation with RSM Erasmus University (but take place in Leiden) and the exact details and names of these courses are yet to be finalised.
- Electives  
The electives allow students to individualise their programme and accommodate special interests. Examples of electives are operations management, 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.
- A methodology course and a research seminar
- 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:

Courses	Level	EC
Management Simulation	400	1
Software Engineering	500	7

Marketing	500	6
ICT-enabled Process Innovation	500	7
Accounting	500	6
System's Development and Project Management	500	7
International Management	500	6
ICT Strategy and Planning	500	7
Finance	500	6
Electives (3 x 3 EC)	500	9
Methodology	500	3
Research Seminar	500	4
Research Colloquia	500	4
ICT Infrastructure	500	7
Capstone Cases	500	7
MSc research project	600	33

As the co-operation agreement with RSM Erasmus University is currently being finalised the Business Foundations part of the programme (Global Marketing, Financial Accounting, Corporate Finance and International Management) will likely undergo changes for the 2007-2009 programme.

# MSc Media Technology

Crohonummer 60206

The Media Technology MSc programme is a common initiative of the computer science institute (LIACS) within the Faculty of Science, and the Faculty of 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 Admission Committee. Foreign applicants must provide proof of proficiency in English (IELTS level  $\geq 6.5$ ). The programme language is English.

## Description

The Media Technology programme recognizes 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 encouraged to translate 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 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 Admission Committee 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.

**Programme** The programme is 120 EC in extent.

Subject	Level	EC
Visit to Ars Electronica Festival	500	1
Introduction to Programming	400	3
Human Computer Interaction	500	7
Multi Media Systems	500	7
Creative Research	500	4
Cool Science	500	7
Sense Interference <i>OR</i> Perceptualization	400	2
Sound, Space & Interaction	500	4
Web Technology	500	4
Research Seminar	500	4
Image & Vision - Embodied Vision	500	4
Hardware & Physical Computing	500	3
Meta Media	500	2
Language & Text	500	3
Workshop I	500	1
Workshop II	500	1
Free choice courses	500	13
Project	500	20
Graduation Project	600	30

# MSc Astronomy

Crohonummer 60200

Leiden Observatory, the oldest university astronomy department in the world, offers four tracks of an MSc programme in astronomy. The research track focuses on two major research themes, (i) formation and evolution of galaxies, and (ii) birth and death of stars. The remaining three are the astronomy track of the research MSc with Science-Based Business (SBB), and the Communication and Education specializations.

The duration of each programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Astronomy, with specification of the specialization, if applicable. Details are provided below. All tracks have the same Director, the same Exam Committee, and the same Programme Committee. An Admission Committee will advise on admissions.

Candidates with a BSc degree or equivalent can apply for admission. The admission guidelines are given below for each specialization. The admission process may include an interview with the Admission Committee. 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  $\geq 6.5$ ).

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.

## Track

### Research in Astronomy

#### Description

This 2-year programme consists of advanced astronomy courses, two research projects in astronomy, and courses outside of astronomy. It prepares the student for independent research in astronomy.

#### Qualifications for admission

Students with a BSc in Astronomy or equivalent from universities who participate in the NOVA research school will be admitted to the programme.

For all other (international) candidates, the Admission Committee will evaluate whether their degree is equivalent to the BSc in Astronomy Degree. Students with Bachelors degrees in other sciences such as mathematics, physics, or chemistry can also apply for enrollment. However, they may be required to take introductory courses in astronomy before they can be accepted.

#### Programme (120 EC)

Students are required to consult the MSc student advisor on the viability of their proposed MSc programme selection, or changes therein, before embarking on it.

<i>year 1</i>	level	EC
minor astronomy research project	600	24
astronomy courses	400/500	24
non-astronomy courses	400/500	12
<i>year 2</i>		
Major (master's) astronomy research project (including a 5 EC thesis and 1 EC for a colloquium)	600	36
astronomy courses	500	12
non-astronomy courses	400/500	12

The astronomy courses can be chosen from the different courses offered every year. The course Stellar Evolution is compulsory for all.

The non-astronomy courses are chosen from the Leiden MSc programmes in Physics, Mathematics and Computer Science. The selection 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 contact the chairman of this board to obtain such approval.

The research projects will be supervised by a staff member. The two projects should be of a different nature and be supervised by a different person.

The programme will be adapted for Masters students who have not followed the entire Astronomy Bachelors programme. The first research project can be reduced to 15 EC, and the number of courses in astronomy will be increased. The students will take these additional courses in the first semester, if possible. These additional courses can be selected from the normal courses in the Masters curriculum, and from the following courses in the Bachelors curriculum: Stars, Radiative Processes, Galaxies and Cosmology. These students may also add astronomy courses at the cost of the non-astronomy courses, after approval of the student advisor and exam committee.

Starting this year, there will be a possibility to specialize, within the track 'Research in Astronomy' in the subject 'Astronomy and Instrumentation'. This specialization is offered in collaboration with the department of applied physics at Delft Technical University. The requirements for the two years are as follows:

	Level	EC
Astronomy course Stellar Evolution	500	6
Choice of general astronomy courses	400/500	12
Choice of instrument-related astronomy courses	400/500	12-18
Choice of instrument-related physics courses	400/500	30-24
Minor research project in observational astronomy	600	24
Major (Master's) research project in instrumental astronomy	600	36

All elements of the programme require prior approval by the MSc student advisor.

The instrument-related astronomy courses include Detection of light, Space-based astronomy, Astronomical observing techniques 2, and others. The instrument-related physics courses include Physics of space science instruments (UL), as well as Advanced digital image processing (TUD), Physics of semiconductor nanodevices (TUD), Mesoscopic physics (TUD), or other courses agreed to beforehand. The major research project may involve designing building and testing 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.

## Track

# Astronomy and Science-Based Business

### Description

The MSc programme Astronomy and Science-Based Business prepares students for a career in science-related business and administration and for innovation and enterprise from a physical/astronomical perspective. In addition to knowledge in astronomy and physics, students obtain competence with respect to organisations, people in organisations, and establishment and management of processes. Students with an MSc in Astronomy and Science-Based Business are also admissible to a PhD programme.

In order to get a SBB Master annotation, a minimal programme consisting of the course SBB Fundamentals and the SBB training period must be completed (see below). The course SBB Fundamentals can also be taken in the “free choice” part of the research MSc programme “Astronomy”.

### Qualifications for admission

Students with a BSc in Astronomy from universities who participate in the NOVA research school or with a BSc major in Astronomy will be admitted to the programme.

For all other (international) candidates, the Admission Committee will judge the equivalence to these BSc degrees of their previous training.

### Programme (120 EC)

Students are required to consult the MSc student advisor on the viability of their proposed MSc programme selection, or changes therein, before embarking on it.

#### *Astronomy (60-80 EC)*

The astronomy component of the Science-based Business (SBB) specialization consists of a research project of 30 EC (incl. 4 EC for a thesis and 1 EC oral presentation) in one of the research groups of the Leiden Observatory, and 30 EC of courses to be selected in correspondence with the research topic. The latter courses include non-astronomy courses with 8-14 EC. The non-astronomy courses are chosen from the Leiden MSc programmes in Physics, Mathematics and Computer Science. The selection 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 contact the chairman of this board to obtain such approval.

#### *Science-Based Business (60-40 EC)*

The Business-related part of the complete SBB programme consists of 40 to 60 EC of the following components:

<i>Mandatory:</i>	level	EC
SBB Fundamentals	400	17
SBB Internship	500	23-34
<i>Choice of:</i>		
Orientation on Technopreneurship: Entrepreneurial Management	400	5
Orientation on Technopreneurship: Business Planning	400	5
SBB electives	500-600	0-20
Extension of the astronomy component	400/500	0-20

See for more information on Science-Based Business the following website:  
<http://www.sbb.leidenuniv.nl/>.

## Track

# Astronomy and Communication

### Description

The MSc programme Astronomy and Communication concerns science communication in a broad sense. The programme prepares students for a career in popularization 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 an MSc in Astronomy and Communication are admissible to a PhD programme in Astronomy or in Science Communication.

### Qualifications for admission

Students from any Dutch university with a BSc degree or major in Astronomy will be admitted to the programme. For all other (international) candidates, the Admission Committee 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 (120 EC)

Students are required to consult the MSc student advisor on the viability of their proposed MSc programme selection, or changes therein, before embarking on it.

#### *Astronomy*

The research component consists of a project in astronomy of 30 EC (incl 4 EC for a thesis and 1 EC for an oral presentation) in one of the research groups of the institute, and 30 EC of courses to be selected in correspondence with the research topic. The latter includes non-astronomy courses with 8 -14 EC. The non-astronomy courses are chosen from the Leiden MSc programmes in Physics, Mathematics and Computer Science. The selection 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 contact the chairman of this board to obtain such approval.

#### *Communication*

The Communication component consists of the following components:

##### *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 astronomy 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 coordinator of Astronomy.

## Track

# Astronomy and Education

### Description

The MSc programme Astronomy and Education prepares students for a career in teaching Physics. The programme includes a 60-EC Astronomy research programme. Students with a MSc in Astronomy and Education are also admissible to a PhD programme.

### Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Astronomy will be admitted to the programme.

For all other (international) candidates, the Admission Committee will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a major in Astronomy will be considered. It is strongly recommended that the BSc programme has included the 10-EC-course Learning, Presentation and Communication, offered by the Leiden School of Education (ICLON), or an equivalent course. Applicants must provide proof of proficiency in Dutch.

### Programme (120 EC)

Students are required to consult the MSc student advisor on the viability of their proposed MSc programme selection, or changes therein, before embarking on it.

#### *Astronomy (60 EC)*

The research component of the Astronomy and Education specialization consists of a project of 30 EC (incl. 4 EC for a thesis and 1 EC for an oral presentation) in one of the research groups of the institute, and 30 EC of courses to be selected in correspondence with the research topic. The latter includes non-astronomy courses with 8 -14 EC. The non-astronomy courses are chosen from the Leiden MSc programmes in Physics, Mathematics and Computer Science. The selection 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 contact the chairman of this board to obtain such approval.

#### *Education (60 EC)*

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

	level	EC
Teaching Methodology	500	10
Professional functioning	300	12
Specialisation	600	8
School training	400	30

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 physics needed for teaching at Dutch high schools.

# MSc Physics

Crohonummer 60202

Leiden University offers seven tracks of an MSc programme in physics. Four of these correspond to different research groups in the Leiden Institute of Physics (LION). The remaining three are the physics track of the research MSc with Science-Based Business (SBB), and the Communication and Education specializations.

Students can start an MSc programme in Physics at any moment during the year and the duration of each programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Physics, with specification of the specialization, if applicable. Details are provided below. All tracks have the same Director, the same Exam Committee, and the same Programme Committee. An Admission Committee will advise on admissions.

Candidates with a BSc degree or equivalent can apply for admission. The admission guidelines are given below for each specialization. The admission process may include an interview with the Admission Committee. Foreign applicants must provide proof of proficiency in English (IELTS level  $\geq 6.5$ ). Admission is possible throughout the year, but we advise foreign students to start in September or February. Further information is available on the website <http://www.physics.leidenuniv.nl>

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.

## Track

### Quantum optics and quantum information

#### Description

This programme 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. It is also possible to work on theoretical research projects. Typically, the student will participate in two ongoing projects in the field, and thereby will be trained in the basic aspects of scientific research. A participant in this programme will spend 40 EC on following courses and preparing exams. The remaining 80 EC will be spent on research work in the group, the preparation of a master's thesis, and contributions to group seminars.

#### Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Physics or Astronomy, including in-depth knowledge of optics, quantum physics and electrodynamics, will be admitted to the programme.

For all other (international) candidates, the Admission Committee will judge the equivalence to these BSc degrees of their previous training. 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 contains two research projects in physics (40 EC each), and compulsory and optional courses (40 EC in total).

<b>Compulsory components</b>	level	EC
Course on Quantum Optics and Quantum Information	500	10
Course on Quantum Theory	400	10
Physics research project 1	600	33
Thesis (5 EC) and oral presentation (2 EC)	600	7
Physics research project 2	600	33
Master's thesis (5 EC) and oral presentation (2 EC)	600	7

## Optional components

Additional courses

20 EC

These additional courses can be selected, depending on the research project, from the set of courses available in the MSc Physics Programme or related fields.

## Track

### Biological and Molecular Physics

#### Description

Research in the field of biological and molecular physics at the Leiden Institute of Physics (LION) 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. This research involves a range of advanced methods of optical and magnetic resonance spectroscopy, and the application of state-of-the-art imaging techniques such as single-molecule fluorescence microscopy and scanning-probe imaging.

Participants in this MSc programme will join the Section of Biological and Molecular Physics, and will work under close supervision on two different, consecutive research projects of 40 EC each, to broaden the scope of their education. In addition, the student will have to acquire 40 EC in various courses specified below.

#### Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Physics will be admitted to the programme.

For all other (international) candidates, the Admission Committee will judge the equivalence to this BSc degree of their previous training. Notably, students with a BSc degree in Chemistry or Biology are invited to apply. 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 projects in physics (40 EC each), and compulsory and optional courses (40 EC in total).

##### *Compulsory components*

At least one of the following two courses:

	level	EC
Quantum Theory	400	10
Biophysics	400/500	6
Physics research project 1	600	33
Thesis (5 EC) and oral presentation (2 EC)	600	7
Physics research project 2	600	33
Master's thesis (5 EC) and oral presentation (2 EC)	600	7

##### *Optional components*

Advanced Biophysics	500	6
Laser Physics	400	6
Linear and nonlinear spectroscopy	500	6
Scanning probe microscopy	500	6
Single molecule optics	500	6
Nanotechnology	400/500	6
Biomolecular Motors	400/500	6
Group Theory	400/500	6

## Track

# Theoretical Physics

### Description

The Theoretical Physics specialization in the MSc Physics programme prepares the student for scientific research towards the PhD in a broad range of topics in Theoretical Physics. The master will also be well-equipped for industrial research or other problem-solving tasks that demand strong analytical and computational skills.

A participant in this programme will spend the first year following courses (60 EC), some in an interactive format, and the second year on a research project under supervision of one of the theoretical physicists at the Leiden Institute of Physics (LION), completed by writing a master's thesis and by giving an oral presentation (total 60 EC).

### Qualifications for admission

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

For all other (international) candidates, the Admission Committee will judge the equivalence to this BSc degree of their previous training. 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 first year is devoted to compulsory courses (20 EC) and optional courses (40 EC). The second year is devoted to research (60 EC).

First year:

The *compulsory courses* are:

	level	EC
Quantum Theory	400	10
Topics in Theoretical Physics	500	10

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.

The *optional courses* consist of at least two Theoretical Physics master courses, to be selected from the set:

Theory of Condensed Matter	400/500	10
Quantum Field Theory	500	10
Advanced Quantum Field Theory	600	10
Theory of General Relativity	500	10
Quantum Optics and Quantum Information	500	10
Statistical Physics	400/500	10
Computational Physics	400/500	10

(Some courses are not provided every year.)

Other optional courses can be taken in Mathematics or (General) Physics. A maximum of one master course can be taken anywhere at Leiden University.

Second year:

Research project in theoretical physics	600	45
Master's thesis	600	10
Oral presentation	600	5

## Track

# Condensed Matter Physics

### Description

Condensed matter physics concerns the study of the fundamental properties of solids and quantum liquids at the microscopic level, and uses the acquired understanding to develop new model systems and new materials. This often requires the development of new concepts to describe the collective behaviour of dense interacting systems. A student will gain experience in condensed matter research, which in Leiden spans a wide variety of different phenomena, different materials and different techniques. Typically a student will perform two projects (about 40 EC each) in ongoing research programmes, to be trained as an independent researcher by working in one of the groups in the Condensed Matter section (see webpage <http://www.physics.leidenuniv.nl/sections/cm/welcome.htm>), but in fact the research component has considerable flexibility. Timely planning with the study advisor and the supervisor is required.

### Qualifications for admission

Students from all universities in the Netherlands with a BSc degree in Physics will be admitted to the programme.

For all other (international) candidates, the Admission Committee will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a BSc degree with a major in a related field, such as Astronomy, Chemistry or Mathematics, and a minor in Physics 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

<i>Compulsory components</i>	level	EC
Physics research project 1	600	33
Thesis (5 EC) and oral presentation (2 EC)	600	7
Physics research project 2	600	33
Master's thesis and oral presentation	600	7
At least one of the following courses		
Theory of Condensed Matter	400/500	10
Statistical Physics	400/500	10
<i>Elective courses:</i>		
Quantum Theory	400	10
Surface physics	400/500	6
Scanning probe microscopy	500	6
Superconductivity and magnetism	500	6
Nanotechnology	400/500	6

Courses can also be selected from the set of courses available in the MSc Physics Programme or related fields, to be discussed with the supervisor of the research project, and subject to approval of the Exam Committee.

## Track

# Physics and Science-Based Business

### Description

The MSc programme Physics and Science-Based Business prepares students for a career in science-related business and administration and for innovation and enterprise from a physical perspective. In addition to knowledge in physics, students obtain competence with respect to organisations, people in organisations, and establishment and management of processes. Students with a MSc in Physics and Science-Based Business are also admissible to a PhD programme.

In order to get a SBB Master annotation, a minimal programme consisting of the course SBB Fundamentals and the SBB training period must be completed (see below). The course SBB Fundamentals can also be taken in the “free choice” part of the research MSc programmes “Core Computer Technologies” and “Condensed Matter Physics”.

### Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Physics will be admitted to the programme.

For all other (international) candidates, the Admission Committee will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a major in Physics and a minor in a related field, such as Astronomy, Chemistry or Mathematics, will be considered.

### Programme

#### *Physics*

The physics component of the Science-based Business (SBB) specialization 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.

#### *Science-Based Business*

The Business-related part of the complete SBB programme consists of 40 to 60 EC of the following components.

<i>Mandatory:</i>	level	EC
SBB Fundamentals	400	17
SBB Internship	500	23-34
<i>Optional:</i>		
Orientation on Technopreneurship: Entrepreneurial Management	400	5
Orientation on Technopreneurship: Business Planning	400	5
SBB electives	500-600	0-20
Extension of the Physics component		0-20

See for more information on Science-Based Business the following website:  
<http://www.sbb.leidenuniv.nl/>.

### Track

## Physics and Communication

### Description

The MSc programme Physics and Communication concerns science communication in a broad sense. The programme prepares students for a career in popularization 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 an MSc in Physics and Communication are admissible to a PhD programme in Physics or in Science Communication.

### Qualifications for admission

Students from any Dutch university with a BSc degree or major in Physics will be admitted to the programme. For all other (international) candidates, the Admission Committee 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

### *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.

### *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 physics 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 coordinator of Physics.

## Track

## Physics and Education

### **Description**

The MSc programme Physics and Education prepares students for a career in teaching Physics. The programme includes a 60-EC Physics research programme. Students with a MSc in Physics and Education are also admissible to a PhD programme.

### **Qualifications for admission**

Students from any university in the Netherlands with a BSc degree in Physics will be admitted to the programme.

For all other (international) candidates, the Admission Committee will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a major in Physics will be considered. It is strongly recommended that the BSc programme has included the 10-EC-course Learning, Presentation and Communication, offered by the Leiden School of Education (ICLON), or an equivalent course. Applicants must provide proof of proficiency in Dutch.

## Programme

### *Physics (60 EC)*

The research component of the Physics and Education specialization 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.

### *Education (60 EC)*

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

	level	EC
Teaching Methodology	500	10

Professional functioning	300	12
Specialisation	600	8
School training	400	30

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 physics needed for teaching at Dutch high schools.

# MSc NanoScience

Crohonummer 60618

## Description

The ability to construct tiny objects atom-by-atom and molecule-by-molecule forms one of the exciting prospects of the emerging research field of NanoScience. This highly cross-disciplinary research area, which is expected to play a crucial role in future scientific discoveries and new technologies, combines a number of key elements from modern physics and chemistry, materials science and molecular biology.

Leiden University and Delft University of Technology have been pioneers in the field of NanoScience, and now join forces to offer students their renowned expertise in a unique, two-year MSc programme in NanoScience. The programme is especially aimed at students who are eager to transcend the traditional borders between scientific disciplines.

The aim of this programme is to educate the student in both science and technology of nanometer-scale phenomena. Students will benefit from the academic climate and infrastructure of both universities by taking courses from and participating in the research activities of the foremost experts in NanoScience.

The MSc programme in NanoScience is attractive to those students who wish to gain the skills and experience required to join the new generation of researchers in NanoScience. Being at the crossroads of a broad range of research fields, it provides students with an excellent opportunity to discover the most appealing aspects. It opens the door to a career in industry and is a stepping-stone for those graduates with the ambition and aspiration to pursue a PhD degree. The programme is starting preferably in September.

## Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Physics will be admitted to the programme.

For all other (international) candidates, the Admission Committee will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a minor in Physics and a BSc in biochemistry, chemistry, molecular biology or materials science are encouraged to apply. 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 (120 EC)

The programme consists of course modules (60 EC), an industrial training period (12 EC) and a Master thesis research project (48 EC).

### *Introductory courses*

Introduction Quantum Mechanics, and/or  
Introduction in Biochemistry, and/or Introduction Statistical Thermodynamics 0 - 6 EC

### *Core courses*

Nanotechnologies 6 EC  
Biophysics and/or Supramolecular Chemistry 6 - 12 EC  
Mesoscopic Physics and/or  
Molecular Electronics 6 - 18 EC

### *Elective courses*

Electives 18 - 42 EC\*

The total EC weight of the introductory-, core- and the electives courses should be 60 EC.

### *Practical work*

Industrial Training Period 12 EC  
Master's research project 48 EC  
(including the thesis (5 EC) and an oral presentation (2 EC))

# MSc Chemistry

Crohonummer 66857

The Leiden Institute of Chemistry ([LIC](#)) is the basis for research and collaborations of the Leiden chemistry groups. LIC offers seven tracks of an MSc program in chemistry. Three of these correspond to major research themes in LIC. Another three are the chemistry track of the research MSc combined with Science-Based Business ([SBB](#)), or the Communication and Education specializations. A seventh track concentrates on Industrial Ecology, a joint program of Leiden University, Delft University of Technology and Erasmus University.

The duration of each program is two years (120 EC). Students who complete the program receive the degree Master of Science in Chemistry, with specification of the specialization, if applicable. Details are provided below. All tracks have the same Director, the same Exam Committee, and the same Program Committee. An Admission Committee will advise on admissions and all programs will be made in consent with an advisor and must be submitted for approval to the Exam Committee before the start of the program.

Candidates with a BSc degree or equivalent can apply for admission. The admission guidelines are given below for each specialization. The admission process may include an interview with the Admission Committee. Foreign applicants must provide proof of proficiency in English (IELTS level  $\geq 6.5$ ). Admission is possible throughout the year, but we advise foreign students to start in September or February. The programme in Industrial Ecology is starting preferably in September. Further information is available on the website <http://wwwchem.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.

## Qualifications for admission

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. 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. For all other (international) candidates, such as students with a degree related to Chemistry, HBO Bachelors and foreign students, the Admission Committee will judge the equivalence to these BSc degrees of their previous training.

## Track

### Biological Chemistry

#### Description

In the Master programme 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. The programme is internationally oriented, and students are stimulated to take courses abroad.

#### Programme

The program contains two research periods (35 and 21 EC) – including a written report and an oral presentation – compulsory courses and electives (64 EC). It is mandatory that the major and minor research projects are carried out in different specializations. Electives consist of a free choice of theoretical courses or an extension of the research period. Students can choose their electives within or outside their specialization. Students are allowed to choose electives from bachelor or non-chemistry courses if allowed by the exam committee.

<i>Compulsory components</i>	
Biophysical Structure Chemistry	6 EC
Bioinformatics II	4 EC
In-vivo biomolecular interactions	4 EC
Chemistry research project 1, (incl. a thesis (2 EC) and oral presentation (1 EC))	35 EC
Chemistry research project 2 (preferably abroad), incl.report Colloquium	21 EC 6 EC
<i>Optional components</i>	
A selection of courses within specialization	6 EC
A selection of courses outside specialization	6 EC
Free choice or extension of research	32 EC

## Track

### Physical and Theoretical Chemistry

#### Description

In the Master programme Physical and Theoretical Chemistry, students are trained in a quantitative description of nature, with a focus on “understanding” rather than on “making”. Dependent 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.

#### Programme

The program contains two research periods (35 and 21 EC) – including a written report and an oral presentation – compulsory courses and electives (64 EC). It is mandatory that the major and minor research projects are carried out in different specializations. Electives consist of a free choice of theoretical courses or an extension of the research period. Students can choose their electives within or outside their specialization. Students are allowed to choose electives from bachelor or non-chemistry courses if allowed by the exam committee.

<i>Compulsory components</i>	
Advanced Soft Matter	5 EC
Modern Quantum Chemistry	6 EC
Colloid and Interface Science	6 EC
Chemistry research project 1, (incl. thesis (2 EC) and oral presentation (1 EC))	35 EC
Chemistry research project 2 (preferably abroad), including report Colloquium	21 EC 6 EC
<i>Optional components</i>	
A selection of courses within specialization	6 EC
A selection of courses outside specialization	6 EC
Free choice or extension of research	29 EC

## Track

### Design and synthesis

#### Description

After successful completion of the Master programme Design and Synthesis, students have extensive knowledge of the structure of molecules, reactivity of molecules, the course of biological processes and design and synthesis of molecules.

#### Programme

The program contains two research periods (35 and 21 EC) – including a written report and an oral presentation – compulsory courses and electives (64 EC). It is mandatory that the major and minor research projects are carried out in different specializations. Electives consist of a free choice of theoretical courses or an extension of the research period. Students can choose their electives within or outside their specialization. Students are allowed to choose electives from bachelor or non-chemistry courses if allowed by the exam committee.

#### *Compulsory components*

Advanced Organic Chemistry	11 EC
Organometallic chemistry & homogeneous catalysis	6 EC
Chemistry research project 1, (incl. thesis (2 EC) and oral presentation (1 EC))	35 EC
Chemistry research project 2, including report	21 EC
Colloquium	6 EC

#### *Optional components*

A selection of courses within specialization	6 EC
A selection of courses outside specialization	6 EC
Free choice or extension of research	29 EC

## Track

### Industrial Ecology

#### Description

The Track Industrial Ecology is the result of a cooperation agreement between the Faculty of Mathematics and Natural Sciences of Leiden University, the Faculty of Applied Sciences of Delft University of Technology, and the Faculty of Social Sciences of Erasmus University. All three universities deliver the same amount of educational effort.

The Track Industrial Ecology starts for the first time in September 2004 as a track in the MSc Programmes Chemistry (University of Leiden, Faculty of Mathematics and Natural Sciences) and Chemical Engineering (Delft University of Technology, Faculty of Applied Sciences). The Students will receive a degree in either Chemistry or Chemical Engineering with a specialisation to Industrial Ecology.

#### Qualifications for admission

Students with a bachelor's degree in any of the Natural sciences, Technical sciences and Social sciences with good results from a recognised university, and with a thorough proficiency in written and spoken English (IELTS level  $\geq 6.5$ ), can apply for admission to the two-year programme starting in September 2005. Admission is subject to the approval of the department's selection committee.

## Overview of the Programme

The MSc programme Industrial Ecology consists of the following components:

First year	Introduction Modules	13 EC
	Core Modules	35 EC
	Elective Modules	12 EC
Second year	Interdisciplinary Project Groups	12 EC
	Specialization Modules	12 EC
	Master's Thesis Research Project	36 EC
	(including the thesis (2 EC) and oral presentation (1 EC))	

Detailed information about the modules for the first year can be found on the website [www.industrialecology.nl](http://www.industrialecology.nl), or obtained from the study advisor or Programme Coordinator. The information about the second year will be announced in the course of the first year.

## Track

### Chemistry and Science-Based Business

#### Description

The MSc programme Chemistry and Science-Based Business prepares students for a career in science-related business and administration and for innovation and enterprise from a chemical perspective. In addition to knowledge in Biological Chemistry, Physical and Theoretical Chemistry or Design and Synthesis, students obtain competence with respect to organisations, people in organisations, and establishment and management of processes. Students with an MSc in Chemistry and Science-Based Business are also admissible to a PhD programme.

In order to get an SBB Master annotation, a minimal programme consisting of the course SBB Fundamentals and the SBB training period must be completed (see below). The course SBB Fundamentals can also be taken in the "free choice" part of the research MSc programmes "Biological Chemistry", "Physical and Theoretical Chemistry" and "Design and Synthesis".

#### Programme

##### *Chemistry*

The Chemistry component of the Science-based Business (SBB) specialization consists of a chemistry research project of 20 EC (incl thesis and oral presentation) in one of the research groups of LIC, and 34-54 EC of courses in Biological Chemistry, Physical and Theoretical Chemistry and/or Design and Synthesis, to be selected in correspondence with the research topic, and a general colloquium (6 EC). The choices for courses and research project will be made in concert with an advisor.

##### *Science-Based Business*

The Business-related part of the complete SBB programme consists of 40 to 60 EC of the following components.

<i>Mandatory:</i>	level	EC
SBB Fundamentals	400	17
SBB Internship	500	23-34
<i>Optional:</i>		
Orientation on Technopreneurship: Entrepreneurial Management	400	5
Orientation on Technopreneurship: Business Planning	400	5
SBB electives	500-600	0-20
Extension of the Chemistry component		0-20

See for more information on Science-Based Business the following website: <http://www.sbb.leidenuniv.nl/>.

## Track

# Chemistry and Communication

### Description

The MSc programme Chemistry and Communication concerns science communication in a broad sense. The programme prepares students for a career in popularization 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 an MSc in Chemistry and Communication are admissible to a PhD programme in Chemistry or in Science Communication.

### Qualifications for admission

Students from any Dutch university with a BSc degree or major in Chemistry will be admitted to the programme. For all other (international) candidates, the Admission Committee 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

#### *Chemistry*

The research component consists of a chemistry project of 40 EC (incl 3 EC for a 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.

#### *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 chemistry 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 coordinator of Chemistry.

## Track

# Chemistry and Education

### Description

The MSc programme Chemistry and Education prepares students for a career in teaching Chemistry. The programme includes a 60-EC Chemistry research programme. Students with a MSc in Chemistry and Education are also admissible to a PhD programme.

### Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Chemistry will be admitted to the programme.

For all other (international) candidates, the Admission Committee will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a major in Chemistry will be considered. It is strongly recommended that the BSc programme has included the 10-EC-course Learning, Presentation and Communication, offered by the Leiden School of Education (ICLON), or an equivalent course. Applicants must provide proof of proficiency in Dutch.

### Programme

#### *Chemistry (60 EC)*

The research component of the Chemistry and Education specialization consists of a chemistry project of 40 EC (incl 3 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.

#### *Education (60 EC)*

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

	level	EC
Teaching Methodology	500	10
Professional functioning	300	12
Specialisation	600	8
School training	400	30

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 chemistry needed for teaching at Dutch high schools.

# MSc Life Science and Technology

Crohonummer 66286

The living cell is central in Life Science and Technology. Life Science & Technology offers five tracks of an MSc programme, resulting from the collaboration of Leiden University and the Technical University of Delft. Each of four tracks corresponds to a research area in the field of life sciences and technology. The fifth track consists of the combination of a research programme with a specialization in Science-Based Business.

The duration of each programme is two years (120 EC). Students receive the degree Master of Science in Life Science & Technology after completion of the programme, with specification of the specialization, if applicable. Details are provided below. All tracks have the same Director, the same Exam Committee, and the same Programme Committee. An Admission Committee will advise on admissions.

Candidates with an BSc degree or equivalent can apply for admission. The admission guidelines are given below for each specialization. The admission process may include an interview with the Admission Committee. Foreign applicants must provide proof of proficiency in English (IELTS level  $\geq 6.5$ ). The programmes are starting preferably in September. Further information is available on the website [www.lst.leidenuniv.nl](http://www.lst.leidenuniv.nl) or [www.lst.tudelft.nl](http://www.lst.tudelft.nl)

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

## Track

### Cell Factory

#### Description

Cell factory is the most process-oriented track of the MSc programme. It concerns cells operating as factories as well as in factories. The student focuses on gaining all information and skills necessary for the industrial application of (parts of) living organisms in the production of valuable components. Consequently, this educational programme focuses strongly on technological aspect such as fermentation technology, as well as on purification and formulation aspects of a biotechnological product on its way to the end consumer, in addition to modern molecular biology with its basis in genomics and physiology.

#### Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Life Science & Technology will be admitted to the programme.

For all other (international) candidates, the Admission Committee will judge the applications.

Applicants with a BSc or HBO degree in a related field of science will be considered. In general, the committee will compare the BSc, HBO etc. programme of the candidate with the BSc-LS&T programme. 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 a Cell factory research project (45 EC), and compulsory and optional programme components (75 EC). The programme has two variants, one of which can be chosen.

##### *Compulsory components*

(i) Profile courses	level	EC
Analysis of metabolic networks	500	5
Metabolic reprogramming	500	5
Bioprocess integration	500	5

Variant "Cells in factories"		
-Fermentation technology	500	3
-Bioseparations	500	3
-Bioconversion technology	500	3
Variant "Cells as factories"		
- Metabolic diversity	500	3
- Industrial genomics	500	3
- Molecular biotechnology	500	3
(ii) General courses		
- Ethics and technology	400	6
- Literature study (colloquium)	600	4
- Design project	400	11
- Company traineeship	400	13 -18
(iii) Researchproject in Cell Factory incl.4 EC for the thesis and an oral presentation	600	45
<i>Optional courses</i>		17-12

Note that sum of EC for the Company traineeship and the Optional courses must equal 30 EC.

## Track

### Cell Diagnostics

#### Description

This programme focuses on development and implementation of methods, techniques and instruments in order to obtain the maximum of information about the living cell. This applies to all organizational levels, from molecule through subcellular structure to the whole cell, in vitro and in situ. In addition to acquiring new fundamental knowledge, the development of new medicines is one of the most important applications. Cell diagnostics is absolutely a bio-instrumentational track in which the definition 'Biorecognition' - the detailed specificity of binding, interaction and biocatalysis through biomolecules -is central. A well-grounded knowledge of biological systems is essential in protein chemistry and protein technology, cell biology, immunobiology, bio -organic and bio-anorganic chemistry. In addition, the student is introduced to new developments in physics, spectroscopy, electron microscopy, (micro)electronics, micro array techniques, image processing and image interpretation as well as in bio-informatics.

#### Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Life Science & Technology will be admitted to the programme.

For all other (international) candidates, the Admission Committee will judge the applications. Applicants with a BSc or HBO degree in a related field of science will be considered. In general, the committee will compare the BSc, HBO etc. programme of the candidate with the BSc-LS&T programme. 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 a research project (45 EC), and compulsory and optional programme components (75 EC).

### *Compulsory components*

(i) Profile courses (24 EC from the following courses)	level	EC
Microbiology of man, animals, food and environment	500	3
Modern drug development technology	500	3
Advanced bioinformatics	500	4
Biophysics	500	6
Metals in biology and medicine	500	3
Proteomics: capita selecta	500	3
New course to be determined	500	3
 (ii) General courses		
- Ethics and technology	400	6
- Literature study (colloquium)	600	4
- Design project	400	11
- Company traineeship	400	13-18
(iii) Researchproject in Cell Diagnostics incl.4 EC for the thesis and an oral presentation	600	45

### *Optional courses*

17-12

Note that sum of EC for the Company traineeship and the Optional courses must equal 30 EC.

## **Track**

### **Functional Genomics**

#### **Description**

This programme is characterised by the in-depth study of molecular genetics and cell biology with emphasis on those processes which play a role in regulation of information transport in the cell. In addition, the student gains insight and skills in modern analysis (genomics, proteomics, single cell/single molecule spectroscopy) and recombinant DNA/PCR technologies. A thorough understanding of Bioinformatics is essential in view of the complexity and enormity of the data sets which are generated.

#### **Qualifications for admission**

Students from any university in the Netherlands with a BSc degree in Life Science & Technology will be admitted to the programme.

For all other (international) candidates, the Admission Committee will judge the applications. Applicants with a BSc or HBO degree in a related field of science will be considered. In general, the committee will compare the BSc, HBO etc. programme of the candidate with the BSc-LS&T programme. 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 a research project (46 EC), and compulsory and optional programme components (74 EC).

### *Compulsory components*

(i) Profile courses	level	EC
- Bioinformatics 2	500	4
- Bioinformatics 3	500	4
- Transcriptome & proteome analysis	500	5
- Biophysical structure determination	500	6
- Gene expression	500	5
 (ii) General courses		
- Ethics and technology	400	6
- Literature study (colloquium)	600	4

- Design project	400	11
- Company traineeship	400	13-18
(iii) Research project in Functional Genomics incl. 4 EC for the thesis and an oral presentation	600	45
<i>Optional courses</i>		17-12

Note that sum of EC for the Company traineeship and the Optional courses must equal 30 EC.

## Track Living Matter

### Description

This programme concerns the identification of molecular structures and mechanisms and research of the physical principles underlying cellular organisation. This is the most fundamental track, literally focused on the 'Science of Life'. Students will learn to understand living processes in terms of models, rules, laws and theories. Currently, a fundamental, theoretical description of the majority of biological processes is unknown. In order to arrive at a meaningful understanding of nature, it is important to discover regularities or laws in nature. This approach is evident in the Systems Biology where biological processes are described in model form without knowledge of the underlying theory. Graduates with the Living Matter profile will have accumulated in-depth knowledge stretching from physics and chemistry through mathematics and informatics to molecular biology. Whilst mathematical skills are important for a more quantitative description, the emphasis in these modules lies more on the application rather than the precise definition of mathematical rules. The interdisciplinary nature of the Living Matter profile means that both theoretical and experimental internship positions are possible in both Leiden University and TU Delft within a large number of research groups, in particular chemistry, biochemistry, biophysics, theoretical biology, mathematics and informatics.

### Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Life Science & Technology will be admitted to the programme.

For all other (international) candidates, the Admission Committee will judge the applications. Applicants with a BSc or HBO degree in a related field of science will be considered. In general, the committee will compare the BSc, HBO etc. programme of the candidate with the BSc-LS&T programme. 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 a research project (46 EC), and compulsory and optional programme components (74 EC).

#### *Compulsory components*

(i) Profile courses (besides Mathematical modeling 18 EC from the other courses)

	level	EC
- Systems Biology	500	6
- Dynamic energy budgets	500	4
- Mathematical modelling in development and evolutionary biology	500	6
- Bioinformatics 2	500	4
- Bioinformatics 3	500	4
- Biophysical structure determination	500	6

(ii) General courses

- Ethics and technology	400	6
- Literature study (colloquium)	600	4

- Design project	400	11
- Company traineeship	400	13-18
(iii) Research project in Functional Genomics incl. 4 EC for the thesis and an oral presentation	600	45
<i>Optional courses</i>		17-12

Note that sum of EC for the Company traineeship and the Optional courses must equal 30 EC.

## Track

# Life Science & Technology and Science-Based Business

## Description

This MSc programme prepares students for a career in science-related business and administration and for innovation and enterprise from an LS&T perspective. In addition to knowledge obtained from one of the above mentioned programmes, students obtain competence with respect to organisation, people in organisations and establishment and management of processes.

Students with a MSc in Life Science & Technology and Science-Based Business are also admissible to a PhD programme.

In order to get a SBB Master annotation, the minimal programme consisting of the course SBB Fundamentals and the SBB training period must be completed (see below). The course SBB Fundamentals can also be taken in the “free choice” part of the research MSc programmes mentioned above.

## Programme

	level	EC
Compulsory courses of the chosen profile (Cell Factory, Cell Diagnostics, Functional Genomics or Living Matter).		24
<i>Compulsory general courses:</i>		
- Ethics & technology	400	6
- Literature study	600	4
- Design project	400	11
- Research project in the chosen profile	600	35
<i>Science-based business</i>		
SBB fundamentals	400	17
SBB internship	500	23

See for more information on Science-Based Business the following website:  
<http://www.sbb.leidenuniv.nl>.

# MSc Bio-Pharmaceutical Sciences Crohonummer 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 tracks 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 tracks of the research MSc with Science-Based Business (SBB), and the Communication and Education specializations.

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 specialization, if applicable. Details are provided below. All tracks have the same Director, the same Exam Committee, and the same Programme Committee. An Admission Committee will advise on admissions.

Candidates with a BSc degree or equivalent can apply for admission. The admission guidelines are given below for each specialization. The admission process may include an interview with the Admission Committee. Foreign applicants must provide proof of proficiency in English (IELTS level  $\geq 6.5$ ). 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](http://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.

## Track

### 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 Admission Committee 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 30 or 37 EC), and compulsory and optional programme components (31 or 38 EC):

	Level	EC
Lecture series 1 (in BPS)	500	4
Lecture series 2 (in BPS)	500	4
Research project 1, in Medicinal Chemistry	600	45
• Thesis	600	5
• Oral presentation	500	2
Research project 2		
• within the Faculty of Mathematics and Natural Sciences (preferably in another discipline of BPS)	600	25
• or outside the Faculty of Mathematics and Natural Sciences	600	32
• thesis	600	5
Literature study plus thesis	500	7
Course Scientific Conduct	500	1
20 Lectures and Colloquia	500	1
Optional courses or traineeships	$\geq 400$ (max 12 ec <400)	14 or 21

## Track

# 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 Admission Committee 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 30 or 37 EC), and compulsory and optional programme components (31 or 38 EC):

	Level	EC
Lecture series 1 (in BPS)	500	4
Lecture series 2 (in BPS)	500	4
Research project 1, in Analytical Biosciences	600	45
• Thesis	600	5
• Oral presentation	500	2
Research project 2		
• within the Faculty of Mathematics and Natural Sciences (preferably in another discipline of BPS)	600	25
• or outside the Faculty of Mathematics and Natural Sciences	600	32
• 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)	14 or 21

## Track

# 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 Admission Committee 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 30 or 37 EC), and compulsory and optional programme components (31 or 38 EC):

	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	600	45
• Thesis	600	5
• Oral presentation	500	2
Research project 2		
• within the Faculty of Mathematics and Natural Sciences (preferably in another discipline of BPS)	600	25
• or outside the Faculty of Mathematics and Natural Sciences	600	32
• 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)	14 or 21

### Track

## 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 Admission Committee 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 30 or 37 EC), and compulsory and optional programme components (31 or 38 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	600	45
• Thesis	600	5

• Oral presentation	500	2
Research project 2		
• within the Faculty of Mathematics and Natural Sciences (preferably in another discipline of BPS)	600	25
• or outside the Faculty of Mathematics and Natural Sciences	600	32
• 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)	14 or 21

## Track 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 Admission Committee 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 30 or 37 EC), and compulsory and optional programme components (31 or 38 EC):

	Level	EC
Lecture series 1 (in BPS)	500	4
Lecture series 2 (in BPS)	500	4
Research project 1, in Toxicology	600	45
• Thesis	600	5
• Oral presentation	500	2
Research project 2		
• within the Faculty of Mathematics and Natural Sciences (preferably in another discipline of BPS)	600	25
• or outside the Faculty of Mathematics and Natural Sciences	600	32
• 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)	14 or 21

## Track Bio-Pharmaceutical Sciences and Science-Based Business

## Description

The MSc programme Bio-Pharmaceutical Sciences and Science-Based Business trains for junior drug researchers, who consider a career in science-related business and administration, preparing for innovation and enterprise from a bio-pharmaceutical perspective. In addition to knowledge in Bio-Pharmaceutical Sciences, students obtain competence with respect to organisations, people in organisations, and establishment and management of processes. Students with an MSc in Bio-Pharmaceutical Sciences and Science-Based Business are also admissible to a PhD programme. In order to get an SBB Master annotation, a minimal programme consisting of the course SBB Fundamentals and the SBB training period must be completed (see below). The course SBB Fundamentals can also be taken in the optional part of the research MSc programmes “Medicinal Chemistry”, “Analytical Biosciences”, “Pharmacology”, “Drug Delivery Technology and Biopharmaceutics” and “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 Admission Committee will judge the equivalence to these BSc degrees of their previous training.

## Programme

### *Bio-Pharmaceutical Sciences*

The BPS research component of the Science-Based Business (SBB) specialization 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.

### *Science-Based Business*

The Business-related part of the complete SBB programme consists of 40 to 60 EC of the following components.

<i>Mandatory:</i>	level	EC
SBB Fundamentals	400	17
SBB Internship	500	23-34
<i>Optional:</i>		
Orientation on Technopreneurship: Entrepreneurial Management	400	5
Orientation on Technopreneurship: Business Planning	400	5
SBB electives	500-600	0-20
Extension of the BPS component		0-20

See for more information on Science-Based Business the following website:  
<http://www.sbb.leidenuniv.nl/>.

## Track

## **Bio-Pharmaceutical Sciences and Communication**

### Description

The MSc programme Bio-Pharmaceutical Sciences and Communication concerns science communication in a broad sense. The programme prepares students for a career in popularization 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 an MSc in Bio-Pharmaceutical Sciences and Communication are admissible to a PhD programme in Bio-Pharmaceutical Sciences or in Science Communication.

### 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 Admission Committee 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 (120 EC)**

#### *Bio-Pharmaceutical Sciences*

The BPS research component of the Bio-Pharmaceutical Sciences and Communication specialization 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.

#### *Communication*

The Communication component consists of the following:

<i>Mandatory:</i>	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 BPS 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 coordinator of BPS.

## **Track**

# **Bio-Pharmaceutical Sciences and Education**

### **Description**

The MSc programme Bio-Pharmaceutical Sciences and Education prepares students for a career in Bio-Pharmaceutical Sciences or in teaching. The programme includes a 60-EC Bio-Pharmaceutical Sciences research programme. Students with a MSc in Bio-Pharmaceutical Sciences and Education are also admissible to a PhD programme.

### **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 Admission Committee will judge the equivalence to these BSc degrees of their previous training. It is strongly recommended that the BSc programme has included the 10-EC-course Learning, Presentation and Communication, offered by the Leiden School of Education (ICLON), or an equivalent course. Applicants must provide proof of proficiency in Dutch.

## **Programme**

*Bio-Pharmaceutical Sciences (60 EC)*

The BPS research component of the Bio-Pharmaceutical Sciences and Education specialization 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.

*Education (60 EC)*

The Education option of the MSc programme Bio-Pharmaceutical Sciences and Education is offered as a joint programme of the faculty and the Leiden School of Education (ICLON) and consists of the following components:

	level	EC
Teaching Methodology	500	10
Professional functioning	300	12
Specialisation	600	8
School training	400	30

In their specialisation, student teachers develop their competences to innovate their practice (e.g., by developing and testing instruction on a specific topic). If the student meets the basic qualifications for the knowledge of a discipline at Dutch high schools (e.g. chemistry or biology), this programme is adequate to obtain the so-called “eerste graads lesbevoegdheid” needed for teaching at these schools.

# MSc Biology

Crohonummer 66860

Leiden University offers a MSc programme in Biology of nine different tracks. Specializations range from the molecular to the population level and from fundamental to applied research. The tracks reflect the two major themes of biological research at Leiden University: Life Science and Biodiversity. All tracks are organized around specialized state-of-the-art courses and research training provided by leading research groups within an international, academic setting. Four tracks are linked with research programmes within the Institute of Biology (IBL), one is a joint programme of the IBL with the Institute of Environmental Sciences (CML) and another one is a joint programme between the Leiden branch of the National Herbarium of the Netherlands (NHN), the Hortus botanicus and the Dutch National Museum of Natural History ('Naturalis'). In the remaining three tracks, research programmes are combined with training in science-based business, communication and education, respectively.

The duration of each 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 specialization, if applicable. The MSc degree guarantees thorough training in performing academic research completed with an MSc thesis and it is founded on a firm theoretical basis that students will be able to function in an international science environment. Details are provided below. All tracks have the same Director and the same Exam Committee. An Admission Committee will advise on admissions, and all programmes will be made in concert with the track coordinator.

Most-updated information can be found on the website following the following links: [www.biologie.leidenuniv.nl](http://www.biologie.leidenuniv.nl) > Master programme. A detailed description of the theoretical elements can be found on [www.studiegids.leidenuniv.nl/index.php3?m=32&c=974](http://www.studiegids.leidenuniv.nl/index.php3?m=32&c=974).

## **Qualifications for admission**

Students from any university in the Netherlands with a BSc degree in Biology will be admitted to the programme without restriction. 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. For all other (international) candidates, such as BSc graduates from other universities, graduates with a BSc in other natural sciences, life sciences, mathematics or biomedical sciences and specific HBO Bachelors as well as for foreign students, the Admission Committee will judge the equivalence of the previous training to the Dutch BSc in Biology which may result in additional coursework. The admission process may include an interview with the Admission Committee. The admission guidelines are given below for each specific track if they differ from these general admission qualifications. Foreign applicants must provide proof of proficiency in English.

## **Start of the programme**

Students may enter the programme throughout the year. However, they are encouraged to start in either September or February when a general introduction into the master programme and theoretical courses are scheduled. Courses starting in either the first or the second semester are not identical. Often, the first semester course starts with an introduction to the specified track.

## **Track**

### **Animal Biology**

#### **Description**

This MSc track provides students with knowledge about organism-level processes in a range of animal species. Emphasis will be on developing critical skills and judgment necessary for planning and executing experiments, and for analyzing data. The subject areas covered include physiology, neurobiology, evolution and development (evo-devo), morphology, behavioural biology, (molecular) developmental biology, including normal and abnormal development, and human diseases. Students will learn scientific methods and selected laboratory techniques by carrying out an in-

depth research project in one of the participating groups: Integrative Zoology, Behavioural Biology, Evolutionary Biology or Molecular Cellular Biology.

This course will form an ideal foundation for students who want to pursue a career in zoological or biomedical research. Students will also be given the opportunity to gain a certificate in animal care. This qualification is required for the handling of experimental animals. Vertebrates, in particular fish and birds, are emphasised as main model systems.

### Programme (120 EC)

The programme consists of compulsory components and electives. Mandatory are both profile courses to cover the methodological and theoretical aspects, a seminar, and at least one, extensive research project including an MSc thesis and a colloquium.

The mandatory introductory profile courses include guided self-study in the basic underlying facts and principles of experimental animal sciences. In some cases, the course 'Basic Statistics' is compulsory. Compulsory is, preferably one research project of at least 9 months (54 EC), or two research projects each of at least 6 months (36 EC). The compulsory MSc thesis research project, or at least one of them, is in any of the research groups of Integrative Zoology, Behavioural Biology, Evolutionary Biology or Molecular Cellular Biology. In some cases and after approval by the track coordinator, it is possible that a medically-orientated research project is performed at the Leiden University Medical Centre (LUMC). For students following the 'Animal Biology' track, a research project at the LUMC may count as an internal research project if minimally 20 EC on Biomedical courses have been concluded during the bachelor programme. For all research projects, *a priori* approval by the track coordinator is obliged. The course "Animal care" (4 EC) is strongly recommended as an additional course.

Additional EC can be obtained by following optional courses or advanced lecture series, by doing a minor research project or by extending a research project.

<i>Compulsory:</i>	level	EC
Profile course 1 Animal Biology		
General Research Skills for Animal Biology ( <i>Scientific Writing Skills, Bio-statistics</i> )	400	6
Theory of Animal Biology	500	8
Profile course 2 Animal Biology		
Advanced Animal Biology textbook	500	6
Seminar	500	4
Biology research project	600	54 - 72 (or 2x36)

The research project includes a Master's thesis and a colloquium (5+2 EC for a long and 4+1 EC for the short research project)

### *Optional:*

Elective courses, lectures, minor research project or extension research project	400/500	42 – 24
--	---------	---------

Note: maximally 12 EC of optional theoretical programme elements of a level < 400 are permitted

## Track

### Biodiversity in Time and Space

#### Description

This integrated track is the unique combination of the National Herbarium Netherlands (NHN), the Dutch National Museum of Natural History ('Naturalis'), the Hortus botanicus, collections of the Institute of Biology (IBL) and specializations in the field of evolutionary patterns, zoological, botanical and mycological biodiversity studies.

The prime aim of this MSc track is to provide the students with a broad theoretical background to comparative research in biodiversity (i.e. theory, methodology and practice of systematics and taxonomic biodiversity studies). The students will obtain in depth knowledge about the various research tools (descriptive, observation, experimental, computer algorithmic) and will apply this during a minor and a major research project utilizing state-of-the-art equipment and under two different supervisors.

Several specialized programs can be chosen: plant diversity (mainly NHN-based), animal diversity (mainly 'Naturalis' and IBL-based), marine diversity (both 'Naturalis' and NHN) or fungal diversity (mainly NHN-based).

Key fields of study for research projects include: Alpha-taxonomy; phylogeny reconstruction; morphological character analyses; molecular systematics and total evidence analyses; historical biogeography; quantitative spatial pattern analysis, range modelling and GIS applications; multi-media identification tools and biodiversity assessments.

### Qualifications for admission

The track is open for students with at least a BSc degree in biology or forestry. This track is also excellently suited for students from 2<sup>nd</sup> and 3<sup>rd</sup> world countries. Besides the necessary academic diplomas, important criteria for the latter applicants can be that they already hold positions that are connected with the field of research, or have shown to have been active in this field of research, i.e. have professional credits. For all other (inter)national candidates, the Admission Committee will judge the equivalence to these BSc degrees of their previous training. The choice in elective courses in the MSc track may be limited by the need to adapt the programme to the fore-knowledge of the candidate.

### Programme (120 EC)

The programme consists of compulsory components and electives. Mandatory are both profile courses, to cover the methodological and theoretical aspects, a seminar, and two research projects including an MSc thesis and a colloquium.

The first semester, as envisaged, comprises profile course 1 and profile course 2. The specialized courses are being decided upon yet. In some cases, the course 'Basic Statistics' is compulsory. Compulsory is one major research project of at least 8 months (48 EC) and a minor research project of at least 4 months (24 EC). The major research project is performed within either of the research groups of NHN or 'Naturalis'. The minor research project can be performed within either research group of NHN, 'Naturalis' or IBL or outside Leiden University. For all research projects, a *priori* approval by the track coordinator is obliged.

If appropriate, additional EC can be obtained by following optional courses or advanced lecture series, a second seminar or a literature review might be written.

<i>Compulsory:</i>	level	EC
Profile course 1 Biodiversity in Time and Space:		
General research skills for Biodiversity Research ( <i>Scientific Writing Skills, Bio-statistics, Methods and Models</i> )	400	9
Specialized courses	400/500	12
Profile course 2 Biodiversity in Time and Space:		
Advanced BTS textbook	500	6
Seminar	500	4
Biology major research project	600	48 – 59
Biology minor research project	500	24 – 30

Both research projects include a Master's thesis and a colloquium (5+2 EC for the major and 3+1 for the minor project).

### *Optional:*

Elective courses, seminar or literature review	400/500	0 - 17
--	---------	--------

Note: maximally 12 EC of optional programme elements of a level < 400 are permitted.

## Track

### Evolutionary and Ecological Sciences

#### Description

This MSc track provides students with a general understanding of the research field of Evolutionary and Ecological Sciences, including the latest scientific developments. The students will be able to analyze scientific literature and recognize relevant and interesting scientific problems on the basis

of scientific and social developments and practical situations. The students will be able to translate these problems into scientifically testable hypotheses and to design an adequate research strategy. They will be able to formulate problems in the form of mathematical formulas or simulation models in such a way that these problems are accessible for analysis. They are able to analyze scientific data and formulate scientific conclusions on the basis of these data. They will be able to deliver adequate oral and written presentations of their research projects.

With this Master track completed, the students are well equipped to start a PhD-project in one or more of the following disciplines: evolutionary biology, (plant- and animal) ecology, behavioural biology, and theoretical biology or to function in a position in which evaluation or commission of research projects is an important element.

### Programme (120 EC)

The programme consists of compulsory and optional components. Mandatory are both profile courses, to cover the methodological and theoretical aspects, a seminar, and at least one, extensive research project including an MSc thesis and a colloquium.

The mandatory profile course 1 includes the following elements: statistics, English scientific writing, modelling, genetics and a general overview of (theoretical) evolutionary ecology. In some cases, the course 'Basic Statistics' is compulsory. The mandatory profile course 2 is individual deepening of knowledge. Compulsory is one research project of at least 9 months (54 EC) or two research projects each of at least 6 months (36 EC). The compulsory research project, or at least one of them, is in one of the IBL research groups on Plant Ecology, Animal Ecology, Theoretical Biology, Evolutionary Biology or Behavioural Biology. In some cases and after approval by the track coordinator, it is possible that the compulsory research project is carried out at a research institute outside the IBL under responsible supervision of a teacher participating in the Evolutionary and Ecological Sciences track.

Additional EC can be obtained by following optional courses or advanced lecture series, by doing a minor research project, by extending a research project or a literature review might be written.

<i>Compulsory:</i>	level	EC
Profile course 1 Evolutionary and Ecological Sciences:		
General research skills for Biodiversity Research <i>(Scientific Writing Skills, Bio-statistics, Methods and Models)</i>	400	9
Theoretical overview evolutionary ecology	500	13
Profile course 2 Evolutionary and Ecological Sciences:		
Advanced EES textbook	500	6
Seminar	500	4
Biology research project(s)	600	54 – 72 (or 2x

36)

The research project includes a Master's thesis and a colloquium (5+2 EC for a long and 4+1 EC for the short research project)

### *Optional:*

Elective courses, lectures, minor research project, extension research project or literature review	400/500	16 - 34
--	---------	---------

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

## Track

### Molecular and Cellular Biology

#### Description

This MSc track 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, transcriptomics, proteomics and metabolomics will provides essential knowledge and skills to apply these powerful techniques in the broad fields of biological and medical research. The implication of these techniques for

biotechnology and the understanding of development and diseases of animals and plants are highlighted.

Students are trained in general academic skills and to understand and critically evaluate 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 trained to present scientific results in oral presentations and in writing.

This master track is optimally suited as a basis for starting a career in experimental molecular-biological or biomedical research. 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 commercial companies.

### Programme (120 EC)

The programme consists of compulsory components and electives. Mandatory are both profile courses, to cover the theoretical aspects, a seminar, and at least one, extensive research project including an MSc thesis and a colloquium.

In the profile courses, students are trained in critical reading and writing about recent scientific literature. A major part of the master training is actively taking part in a running research project. Compulsory is, 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 in either of the research groups of Molecular Developmental Genetics, Molecular Microbiology, Molecular Cell Biology, Plant Cell Physiology or other departments of the Faculty of Sciences or LUMC (Leiden University Medical Centre). For students following this track, a research project within one of the LIC 'Life Science' research groups or at the Leiden-Amsterdam Centre of Drug Research (LACDR) may substitute for the mandatory research project within the IBL (meaning that it may count as an internal research project). Even so, a research project at the LUMC may substitute for this when minimally 20 EC on biomedical courses have been concluded during the bachelor programme. For all research projects, *a priori* approval by the track coordinator is obliged.

Emphasis will be put on model organisms such as zebra fish, *Arabidopsis*, yeast, and on the filamentous fungus *Aspergillus niger* and *Pseudomonas* species or on their interactions.

Additional EC can be obtained by following optional courses or advanced lectures, by doing a minor research project or by extending a research project.

<i>Compulsory:</i>	level	EC	
Profile course 1 Molecular and Cellular Biology:			
- Theoretical overview mol. & cellular biology	400	9	
- Orientation on MCB research	400	2	
- Proof of practical skills	400	1	
Profile course 2 Molecular and Cellular Biology:			
- Advanced MCB textbook	500	6	
- Condensed literature survey (thesis)	500	1	
- Ph.D. Research project proposal	500	2	
Seminar	500	4	
Biology research project	600	54 – 72	(or 2x

36)

The research project includes a Master's thesis and a colloquium (5+2 EC for a long and 4+1 EC for the short research project)

### *Optional:*

Elective courses, lectures, minor research project or extension research project	400/500	23 – 41
--	---------	---------

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

## Track

# Natural Products

### Description

The major aim of this MSc track is to provide the students with a broad theoretical background to multidisciplinary research in natural products and plant cell biotechnology, to obtain in depth knowledge about the various experimental tools, and the application of these during a research project utilizing state-of-the-art equipment. The students should be able to collect scientific information and assess this in terms of possible applications, and identify and develop strategies to overcome potential scientific bottlenecks for realization of these applications. The students should be able to communicate scientific results in the oral and written form, including posters. The students should develop into independent researchers which are able to continue for a PhD programme, or take the responsibility for projects in an industrial or institutional research environment.

### Qualifications for admission

The track is open for students with at least a BSc degree in biology, forestry, (bio)chemistry, pharmacy or medicine. Special target groups for this MSc track are students from 2<sup>nd</sup> and 3<sup>rd</sup> world countries. Besides the necessary academic diplomas, important criteria for the latter applicants can be that they already hold positions that are connected with the field of research, or have shown to have been active in this field of research, i.e. have professional credits. For all other (inter)national candidates, the Admission Committee will judge the equivalence to these BSc degrees of their previous training. The choice in elective courses in the MSc track may be limited by the need to adapt the programme to the fore-knowledge of the candidate.

### Programme (120 EC)

The programme consists of compulsory components and electives and is built of two parts. Mandatory is the profile course, to cover the theoretical aspects, a seminar and at least one, extensive research project including an MSc thesis and a colloquium.

The first part of the programme is a series of short courses (together indicated as the profile course) of at least 28 EC, and a maximum of 42 EC, depending on the level of the student. In some cases, the course 'Basic Molecular Biological Techniques' is compulsory. Methods for phytochemical screening and testing of biological activity of plant extracts will be dealt with, as well as the isolation and identification of natural products, including structure elucidation. It will provide knowledge about chemotaxonomy and the role of secondary metabolism. Basic knowledge on plant cell culture as a tool for biosynthetic studies and plant cell biotechnology is included in the programme. "Natural products" is dealing with aspects of the production and quality control of drugs from natural origin. The use of chromatographic methods is an important aspect of this. It will also include courses on drug discovery. "Plant Cell Biotechnology" as a method for studying biosynthesis and for the production of secondary metabolites. Strategies to improve production such as metabolic engineering will be dealt with. Also plant tissue culture as method for micro propagation will be learned.

The second part concerns participation in the research of the department. The research project should last 9-12 months (54-72 EC). In addition, the student should participate in an international scientific meeting and present a poster on his/her research. A seminar should be followed as well.

Additional EC can be obtained by following optional courses, advanced lectures or seminars. It is also possible to earn EC credits by writing a literature review or by doing a minor research project (minimally 24 EC). Based on the information on the educational background of the applicant, a tailor-made programme will be made. The individual study programme will be discussed with the student by the track coordinator and should be approved by the board of examiners.

<i>Compulsory:</i>	level	EC
Profile course Natural Products	400/500	28 - 42
<i>To choose from</i>		
Biosynthesis secondary metabolites	400	2
Bioprospecting	400	4

Natural products I	400	4
Natural products II	500	9
Metabolomics	400	4
Plant cell biotechnology	500	4
Chromatography course	500	4
Structure elucidation	500	4
Science communication	500	2
Additional suggested courses offered by the Master programme Biology		
Seminar	500	4
Biology research project	600	54 – 72

The research project includes a Master's thesis (5 EC) and a colloquium (2 EC)

*Optional:*

Elective courses, lectures, seminars, minor research project or literature review	400/500	2 – 34
---	---------	--------

Note: maximally 12 EC of optional programme elements of a level < 400 are permitted.

**Track**

**Sustainability and Biodiversity**

**Description**

This MSc track offers knowledge of and insight in the conservation and management of biodiversity from a local to a global scale. By using 'sustainability' as a guiding principle, the programme not only takes into account ecological but also economical and social aspects of biodiversity and conservation. The programme provides students with an academic attitude by stimulating reflective, independent and creative thinking. It prepares students for a PhD programme and/or for research positions at universities, research institutes, government organisations and consult agencies.

**Programme (120 EC)**

The programme consists of compulsory components and electives. Mandatory are two profile courses, to cover the methodological and theoretical aspects, one of the two CML-seminar ("Biodiversity" or "Sustainability"), and two extensive research projects, both including an MSc thesis and a colloquium.

In the first profile course, students are trained in basic knowledge and skills required for environmental research. In some case, the course 'Basic Statistics' is compulsory. Profile course 2 offers deepening of knowledge in a specialized topic. Both seminars are re-occurring every two years, alternating "Biodiversity" in one year and "Sustainability" the next year. One of them is mandatory, the other is optional. Compulsory are two research projects each with a minimum duration of 24 EC and total duration for both of at least 72 EC. At least one of the research projects should be carried out within CML. The other can also be in the IBL research groups on Plant Ecology, Animal Ecology, Theoretical Biology, Evolutionary Biology or Behavioural Biology, at the NHN, or at 'Naturalis'. Also, external internships are possible. For all projects carried out outside of CML, *a priori* approval by the track coordinator, and responsible supervision of a teacher of CML is obliged.

Additional time might be spent on courses, advanced lectures, seminars, a literature review or extra research project time to be performed outside the Institute of Environmental Sciences (CML). Alternative suggestions might be considered and should be discussed with the coordinator who should approve on them before the actual start. Optional courses provided by CML are planned for marine biodiversity conservation and management (4 EC), spatial modelling (4 EC), and sustainable wildlife management (6 EC).

<i>Compulsory:</i>	level	EC
Profile course 1 Sustainability and Biodiversity:		
General research skills for Biodiversity Research ( <i>Scientific Writing Skills, Bio-statistics, Methods and Models</i> )	400	9

Environmental Processes	500	10
Biodiversity and Society	500	3
Profile course 2 Sustainability and Biodiversity:		
Advanced S&B textbook	500	6
Seminar		
"Biodiversity" or "Sustainability"	500	4
Two research projects, total	600	72

Both the research projects includes a Master's thesis and a colloquium (5+2 EC for a long and 4+1 EC for the short research project)

*Optional:*

Elective courses, lectures, seminars, minor research project, extension research project or literature review	400/500	16
--	---------	----

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

**Track**

**Biology and Science-Based Business**

**Description**

This Msc programme Biology and Science-Based Business prepares students for a career in science-related business and administration, and for innovation and enterprise from a biological perspective. In addition to knowledge in biology, students obtain competence with respect to organisations, people in organisations, and establishment and management of processes. Students with an MSc in Biology and Science-Based Business are also admissible to a PhD programme.

In order to get a SBB Master annotation, a minimal programme consisting of the course SBB Fundamentals and the SBB training period must be completed (see below). The course SBB Fundamentals can also be taken in the optional part of the research MSc programmes in Biology.

**Qualifications for admission**

Students from any university in the Netherlands with a BSc degree in Biological Sciences will be admitted to the programme.

For other (international) candidates, such as BSc graduates from other natural sciences, life sciences and biomedical sciences as well as specific HBO Bachelors, the Admission Committee will judge the equivalence to these BSc degrees of their previous training.

**Programme**

*Biology*

The Biology component of the Science-based Business (SBB) specialization 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 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). The choices for courses and research project will be made in concert with an advisor.

*Science-Based Business*

The Business-related part of the complete SBB programme consists of 40 to 60 EC of the following components.

*Mandatory:*

	level	EC
SBB Fundamentals	400	17
SBB Internship	500	24-34

*Optional:*

Orientation on Technopreneurship: Entrepreneurial Management	400	5
Orientation on Technopreneurship: Business Planning	400	5

SBB electives	500-600	0-19
Extension of the Biology component		0-19

See for more information on Science-Based Business the following website:  
<http://www.sbb.leidenuniv.nl/>

Note: maximally 12 EC on theoretical programme elements of a level < 400 are permitted within the total programme.

## Track Biology and Communication

### Description

The MSc programme Biology and Communication concerns science communication in a broad sense. The programme prepares students for a career in popularization 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 an MSc in 'Biology and Communication' are admissible to a PhD programme in Biology or in Science Communication.

### Qualifications for admission

Students from any Dutch university with a BSc degree or major in Biology will be admitted to the programme. For all other (international) candidates, the Admission Committee 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

#### *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) 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 choices for theory and research project will be made in concert with an advisor.

#### *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 biology 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 coordinator of biology.

## Track Biology and Education

### Description

The MSc programme Biology and Education prepares students for a career in teaching Biology. The programme includes a 60-EC Biology research programme. Students with a MSc in Biology and Education are also admissible to a PhD programme.

### Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Biology will be admitted to the programme.

For all other (international) candidates, the Admission Committee will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a major in Biology will be considered. It is strongly recommended that the BSc programme has included the 10-EC-course Learning, Presentation and Communication, offered by the Leiden School of Education (ICLON), or an equivalent course. Applicants must provide proof of proficiency in Dutch.

### Programme

#### *Biology (60 EC)*

The research component of the Biology and Education specialization 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 choices for courses and research project will be made in concert with an advisor.

#### *Education (60 EC)*

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

	level	EC
Teaching Methodology	500	10
Professional functioning	300	12
Specialisation	600	8
School training	400	30

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 biology needed for teaching at Dutch high schools.