

# Master programme of the Faculty of Science Leiden University

2008-09

- Descriptions
- Qualifications for admission
- Condensed programmes

Onderwijs en Examenregeling Masteropleiding Bijlage
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# 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 specialisations.

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

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

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

## 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 Board of Admissions will judge the equivalence to these BSc degrees of their previous training. The choice in optional courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

#### **Programme**

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

## 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 Board of Admissions will judge the equivalence to these BSc degrees of their previous training. The choice in optional courses in the MSc programme may be limited by the need to adapt the programme to the present -knowledge of the candidate.

### Programme

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

## 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 Board of Admissions will judge the equivalence to these BSc degrees of their previous training. The choice in optional courses in the MSc programme may be limited by the need to adapt the programme to the present-knowledge of the candidate.

### Programme

#### *Mathematics*

The Mathematics component of the Science-based Business (SBB) specialisation consists of a research project in mathematics of 40 EC (incl 7 EC for the thesis and an oral presentation) in one of the research groups of the Leiden Mathematical Institute, 20 EC of courses to be selected in

correspondence with the research topic, and a mathematical project connected with the SBB training period (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

## **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 popularisation of science, for example, as a science communicator, a science policymaker or a public relations officer, or for a career as a scientist with a communicating mindset. Students with 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 Board of Admissions will judge the equivalence to these BSc degrees of their previous training. Preferably, the BSc programme has included the 10-EC-course Learning, Presentation and Communication, offered by the Leiden School of Education (ICLON), or equivalent courses. Applicants must provide proof of proficiency in Dutch.

### **Programme**

#### *Mathematics*

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

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

#### *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
Educational Theory	300	5
Supervision of Professional Development	400	7
Teaching Methodology	500	10
Specialisation	600	8
Teaching Practice		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 specialisations. 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 Board of Examiners, and the same Department Teaching Committee. A Board of Admissions will advise on admissions.

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

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 Board of Admissions will determine the equivalence of their previous training to these BSc degrees. The choice of the specialisation courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

#### Programme

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

<i>Components</i>	level	EC
Specialisation courses	500	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 Board of Admissions will determine the equivalence of their previous training to these BSc degrees. The choice of the specialisation courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

### Programme

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

<i>Components</i>	level	EC
Specialisation courses	500	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 is on *Data Analysis and Modeling*, which represents the unique expertise of the different research groups of Leiden University and the Delft University of Technology participating in this track. This expertise is used to address issues like data capturing, data warehousing, data analysis and data mining that have become major challenges in the field of Bioinformatics due to sudden the complexity and abundance of quantitative data in biology and medicine. On the other hand, bioinformatics heavily contributes to the identification of new fundamental computer science principles and the development of new informatics tools. Bioinformatics offers a unique new synthetic approach for formulating hypotheses and solving problems in (molecular-) biology versus the classical reductionistic approach.

### Qualifications for admission

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

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

### Programme

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

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

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

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

Methodology	500	4
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<i>Support Program</i>	100 – 500	12
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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. The support program will consist of a maximum of 12 EC.

<i>Research assignment</i>	600	15
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<i>Master's research project</i> (incl. thesis and oral presentation)	600	45
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## 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 Board of Admissions 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) specialisation consists of a research project in computer science of 40 EC (incl. 7 EC for the thesis and an oral presentation) in one of the research groups of LIACS, and 20 EC of level-500 courses to be selected in correspondence with the research topic. The choices for courses and research project will be made in consultation with a supervisor.

##### *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 popularisation of science, for example, as a science communicator, a science policymaker or a public relations officer, or for a career as a scientist with a communicating mindset. Students with 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 Board of Admissions will judge the equivalence to these BSc degrees of their previous training. Preferably, the BSc programme has included the 10-EC-course Learning, Presentation and Communication, offered by the Leiden Graduate School of Education (ICLON), or equivalent courses. Applicants must provide proof of proficiency in Dutch.

### Programme

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

#### *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
Educational Theory	300	5
Supervision of Professional Development	400	7
Teaching Methodology	500	10
Specialisation	600	8
Teaching Practice		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, organisations 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.

## Track: ICT in Business

### Qualifications for admission

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

### Programme

The track 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 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).
- Electives  
The electives allow students to individualise their programme and accommodate special interests. Examples of electives are virtual organisations, IT Governance, cross-cultural organisations, legal aspects of ICT, and data warehousing. In addition there are possibilities to customise the programme through international exchange programmes.
- 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	2
Software Engineering	500	6
Marketing	500	3
Corporate Communication	500	3
Strategy Formation & Implementation	500	4
ICT-enabled Process Innovation	500	6
Corporate Finance	500	3
Behavioral Decision Making	500	3
Methodology	500	3
System's Development and Project Management	500	6
Management Science	500	3
Managing Innovation	500	3
Organising	500	4
ICT Strategy and Planning	500	6
Managing People	500	3
Financial Accounting	500	3
Research Seminar	500	4
Research Colloquia	500	4
Electives (3 x 3 EC)	500	9
Capstone Cases	500	3
Concentration Course	500	6
MSc research project	600	33

### **Track: ICT in Business Post Experience**

#### **Qualifications for admission**

Candidates with a BSc degree in Computer Science or equivalent and at least three years of working experience in the field of ICT and Business can apply for admission. A Board of Admissions will advise on admissions. The admission process may include an interview with the Board of Admissions. Foreign applicants must provide proof of proficiency in English.

#### **Programme**

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

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

# MSc Media Technology

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 Board of Admissions. 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 Conservatoire and the Royal Academy of Arts in The Hague.

## Qualifications for admission

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

**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> Perceptualisation	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
What they always wanted to tell about science	400	1
Essentials in Art & Music	500	2
Workshop I	500	1
Workshop II	500	1
Free choice courses	500	10
Project	500	20
Graduation Project	600	30

# MSc Astronomy

Crohonummer 60200

Leiden Observatory, the oldest university astronomy department in the world offers an attractive master programme. The aim of the programme is to train the student to become an independent researcher with all the necessary skills and proficiency to advance his/her career. Four tracks are offered. The research track focuses on the major research themes formation and evolution of galaxies, and birth and death of stars. The remaining three tracks combine research in astronomy with the Science-Based Business (SBB), Communication (CE), and Education (ED) specialisations.

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

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

## 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 Board of Admissions will evaluate whether their degree is equivalent to a BSc in Astronomy. Students with Bachelor degrees in other sciences such as mathematics, physics, or chemistry can also apply for enrolment. However, they may be required to take introductory courses in astronomy before they can be accepted.

## Selection of study program

For all the tracks, the selection of the course work and research projects requires prior approval by the MSc student advisor. In individual cases a course from a different programme or field of study may be elected, but only after prior written approval by the Board of Examiners. Before starting such a course, the student should contact the chairman of this board to obtain such approval.

## Track

### Research in Astronomy

#### Description

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

#### Programme (120 EC)

The programme consists of the following main elements.

<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 astronomy curriculum must contain the following courses: Stellar Structure and Stellar Evolution – 6 EC ( compulsory for all), a minimum of two courses (12 EC) from the astronomy core programme, a minimum of 1 course (6 EC) from the instrument-related astronomy programme, and a number of courses (12 EC) to complete the curriculum. The non-astronomy courses are chosen from the Leiden MSc programmes in Physics, Mathematics and Computer Science.

Two research projects, a smaller and a larger one, will be carried out under close supervision by a staff member. The two projects should be of a different nature and be supervised by a different person.

The programme may 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 Board of Examiners.

Students may choose the possibility to specialize, within the track ‘Research in Astronomy’, in the subject ‘Astronomy and Instrumentation’. This specialisation 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

The instrument-related astronomy courses include those designated as such by the Leiden Msc in Astronomy programme, whereas the instrument-related physics courses include Physics of space science instruments (UL), as well as those indicated as such by the TUD Master in Applied Physics programme 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”.

## Programme (120 EC)

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

The astronomy component of the Science-based Business (SBB) specialisation 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. These include the compulsory Stellar Structure and Stellar Evolution course, at least one course from the astronomy core programme, and 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.

### 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	C	
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

## 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 popularisation of science, for example, as a science communicator, a science policymaker or a public relations officer, or for a career as a scientist with a communicating mindset. Students with an MSc in Astronomy and Communication are admissible to a PhD programme in Astronomy or in Science Communication.

#### **Qualifications for admission**

In addition to the general qualifications (see introduction) the BSc programme preferably 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)

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. These include the compulsory Stellar Structure and Stellar Evolution course, at least one course from the astronomy core programme, and non-astronomy courses with 8 -14 EC. The non-astronomy courses are chosen from the Leiden MSc programmes in Physics, Mathematics and Computer Science.

### *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 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. 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. Students with a MSc in Astronomy and Education are also admissible to a PhD programme.

### **Qualifications for admission**

In addition to the general qualifications (see introduction), it is strongly recommended that the BSc programme 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)**

#### *Astronomy (60 EC)*

The research component of the Astronomy and Education specialisation 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. These include the compulsory Stellar Structure and Stellar Evolution course, at least one course from the astronomy core programme, and 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
Educational Theory	300	5
Supervision of Professional Development	400	7
Teaching Methodology	500	10
Specialisation	600	8
Teaching Practice		30

# MSc Physics

Crohonummer 60202

Leiden University offers five tracks of an MSc programme in physics. Two are research tracks with experimental physics and theoretical physics as specialisations. The other three are the physics track of the research MSc combined with Science-Based Business (SBB), with Communication and with Education.

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 specialisation. Details are provided below. All tracks have the same Director, the same Board of Examiners, and the same Department Teaching Committee. A Board of Admissions will advise on admissions.

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

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

## Track

### Research in Experimental Physics

#### Description

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

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

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

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

### Qualifications for admission

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

### Programme

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

Components	level	EC
2 courses from the Theoretical Physics courses on offer*	400-600	20
Optional master courses in Physics	400-600	20-40
Physics research project 1 in a LION research group (with Master thesis and oral presentation) **	600	40
Physics research project 2 in a research group within or outside LION (with Master thesis and oral presentation)**	600	20-40

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

\*\* A research project of 40 EC consists of 33 EC experimental work, a Master thesis of 5 EC, and an oral presentation of 2 EC. Smaller projects consists of the same components, proportionally scaled.

Master courses in Physics	Level	EC
Advanced Biophysics	500	6
Biomolecular Motors	400/500	6
Biophysics	400/500	6
Computational Physics	400/500	10
Introduction to Astro-Particle Physics	400/500	6
Nanotechnology	400/500	6
Physics of Scientific Space Instruments	400	4
Scanning Probe Microscopy	500	6
Single Molecule Optics	500	6
Superconductivity and Magnetism	500	6
Surface Physics	400/500	6

Note that not every course is given each academic year and that also the offer of courses may change.

## Track

# Research in Theoretical Physics

### Description

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

### Qualifications for admission

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

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

### Programme

Components	level	EC
Quantum Theory	400	10
Topics in Theoretical Physics	500	10
2 courses from the Theoretical Physics courses on offer	400-600	20
Optional master courses from Theoretical Physics, Mathematics or Physics. A maximum of one master course can be taken anywhere at Leiden University.	400-600	20
Physics research project in Theoretical Physics	600	45
Master's thesis (10 EC) and oral presentation (5 EC)	600	15

Master courses in Theoretical Physics	Level	EC
Advanced Quantum Field Theory	600	10
Quantum Field Theory	500	10
Quantum Optics and Quantum Information	500	10
Quantum Theory	400	10
Statistical Physics	400/500	10
Theory of Condensed Matter	400/500	10
Theory of General Relativity	500	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.

Note that not every course is given each academic year and that also the offer of courses may change (with the exception of the compulsory courses for the specialisation Theoretical Physics).

## 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 Board of Admissions 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) specialisation consists of a research project of 33 EC in one of the research groups of the Leiden Institute of Physics (LION) and a master’s thesis and an oral presentation (5+2=7 EC), together with 20 EC of courses to be selected in correspondence with the research topic.

#### *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

## 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 popularisation of science, for example, as a science communicator, a science policymaker or a public relations officer, or for a career as a scientist with a communicating mindset. Students with 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 Board of Admissions will judge the equivalence to these BSc degrees of their previous training. Preferably, the BSc programme has

included the 10-EC-course Learning, Presentation and Communication, offered by the Leiden Graduate School of Education (ICLON), or equivalent courses. Applicants must provide proof of proficiency in Dutch.

## **Programme**

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

*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
Educational Theory	300	5
Supervision of Professional Development	400	7
Teaching Methodology	500	10
Specialisation	600	8
Teaching Practice		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 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 programme 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), Communication or Education specialisations. A seventh track concentrates on Industrial Ecology, a joint programme of Leiden University, Delft University of Technology..

The duration of each programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Chemistry, with specification of the specialisation. Details are provided below. All tracks have the same Director, the same Board of Examiners, and the same Department Teaching Committee. A Board of Admissions will advise on admissions and all programmes will be made in consent with an advisor and must be submitted for approval to the Board of Examiners before the start of the programme.

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

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 Board of Admissions 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 programme contains two research periods (35 and 21 EC) – including a written report and an oral presentation for each, compulsory courses and electives (64 EC). It is mandatory that the major and minor research projects are carried out in different specialisations. 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 track.



<i>Compulsory components</i>	level	EC
Electron Microscopy of Bio-macromolecules	500	3
Introduction to Protein Crystallography	400	3
Bioinformatics II	500	4
In-vivo biomolecular interactions	500	4
Research project I, including master thesis and oral presentation	600	35
Research project II, including report and oral presentation	600	21
Colloquium	500	6
<i>Optional components</i>		
A selection of courses within specialisation	500/600	6
A selection of courses outside specialisation	500/600	6
Electives or extension of research	500/600	32
The extension of research is limited to 15 EC for research project I and/or II.		

## Track

### Physical and Theoretical Chemistry

#### Description

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

#### Programme

The programme 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 specialisations. 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 track.

<i>Compulsory components</i>	level	EC
Advanced Soft Matter	500	5
Modern Quantum Chemistry	500	6
Colloid and Interface Science	500	6
Research project I, including master thesis and oral presentation	600	35
Research project II, including report and oral presentation	600	21
Colloquium	500	6
<i>Optional components</i>		
A selection of courses within specialisation	500/600	6
A selection of courses outside specialisation	500/600	6
Electives or extension of research	500/600	29
The extension of research is limited to 15 EC for research project I and/or II.		

## Track

### Design and synthesis

#### Description

After successful completion of the Master programme Design and Synthesis, students have extensive knowledge of the structure of molecules and reactivity of molecules. Depending on the choice of research projects the students have advanced knowledge of the course of biological processes, the design, synthesis and properties of new organic or inorganic molecules or the development and investigation of new sustainable catalytic processes and reactions.

#### Programme

The programme contains two research periods (35 and 21 EC) – each 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 specialisations. 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 specialisation.

<i>Compulsory components</i>	level	EC
Advanced Organic Chemistry	500	11
Organometallic chemistry & homogeneous catalysis	500	6
Research project I, including master thesis report and oral presentation	600	35
Research project II including report and oral presentation	600	21
Colloquium	500	6
<i>Optional components</i>		
A selection of courses within specialisation	500/600	6
A selection of courses outside specialisation	500/600	6
Electives or extension of research	500/600	29
The extension of research is limited to a maximum of 15 EC for research project I and/or II.		

## Track

### 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 recognized university, and with a thorough proficiency in written and spoken English, can apply for admission to the two-year variant Industrial Ecology starting in September. Admission is subject to the approval of the department's selection committee.

#### Overview of the Programme

The programme Industrial Ecology consists of the following components:

		level	EC
First year	Introduction Modules	400	15
	Core Modules	500	39
	Elective Modules	≥400	6
Second year	Interdisciplinary Project Groups	600	12
	Specialisation Modules	≥500	12
	Master's Thesis Research Project	600	36

## Track Chemistry and Science-Based Business

### Description

This track offers the opportunity to combine training in chemistry research with education in business and entrepreneurship. It enables science students to understand the fundamentals of business management and innovation. The emphasis is on science-driven organisations and on establishing new business based on the outcomes of scientific research.

During the 2-year programme students will a) carry out a research project in one of the research groups of LIC combined with courses relevant to their research assignment and b) spend up to 1 year on management and entrepreneurship in the context of science- and research-based business. Core elements, required for an SBB Master annotation, are SBB Fundamentals and SBB Internship. The other key course is Orientation on Technopreneurship.

The SBB-programme is geared towards pursuing future career opportunities, both in academia and in industry. About 40% of the former SBB-students have gone on to do a PhD, where most of the others found employment in industry as consultant or in a managerial position

### Programme

#### *Chemistry (60 – 80 EC)*

The Chemistry component of the Science-Based Business (SBB) track consists of a research project of 20 EC in one of the research groups of LIC, including a master's thesis and an oral presentation, 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 (40 – 60 EC)*

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

	level	EC
<i>Mandatory:</i>		
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

## 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 popularisation of science, for example, as a science communicator, a science policymaker or a public relations officer, or for a career as a scientist with a communicating mindset. Students with 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 Board of Admissions will judge the equivalence to these BSc degrees of their previous training. Preferably, the BSc programme has included the 10-EC-course Learning, Presentation and Communication, offered by the Leiden

Graduate School of Education (ICLON), or equivalent courses. Applicants must provide proof of proficiency in Dutch.

### **Programme**

#### *Chemistry (60 – 80 EC)*

The research component consists of a project in Chemistry 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 (40 - 60 EC)*

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 programme.

Students with a MSc in Chemistry and Education are also admissible to a PhD programme.

#### **Programme**

##### *Chemistry (60 EC)*

The research component of the Chemistry and Education specialisation consists of a research project of 20 EC in one of the research groups of LIC, including a master's thesis and an oral presentation and 34 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.

##### *Education (60 EC)*

The Education part of the MSc programme Chemistry and Education is offered by the Leiden University Graduate School of Teaching (ICLON) and consists of the following components:

	level	EC
Educational Theory	300	5
Supervision of Professional Development	400	7
Teaching Methodology	500	10
Specialisation	600	8
Teaching Practice		30

This programme is adequate to obtain the so-called “eerste-graads lesbevoegdheid” needed for teaching at Dutch high schools.

NB. For students attending the Chemistry and Education track it is strongly recommended that the BSc programme has included the 10-EC-course Learning, Presentation and Communication, offered by the Leiden University Graduate School of Teaching (ICLON), or an equivalent course. The applicants for this track must also provide proof of proficiency in Dutch.

# 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 specialisations.

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

Candidates with a BSc degree or equivalent can apply for admission. The admission guidelines are given below for each specialisation. The admission process may include an interview with the Board of Admissions. Foreign applicants must provide proof of proficiency in English (IELTS level  $\geq$  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 Board of Admissions will judge the equivalence to this BSc degree of their previous training. Notably, applicants with a BSc (or equivalent) in Chemistry, Life Science and Technology, as well as HBO Bachelors in Chemistry with an equivalent BSc will be considered. The choice in optional courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate.

#### Programme

The programme contains two research periods (52 and 36 EC), and compulsory and optional programme components (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	31
• or outside the Faculty of Mathematics and Natural Sciences	600	31
• thesis	600	5
Literature study plus thesis	500	7
Course Scientific Conduct	500	1
20 Lectures and Colloquia	500	1
Optional courses or traineeships	$\geq$ 400 (max 12 ec <400)	15

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

### Programme

The programme contains two research periods (52 and 36 EC), and compulsory and optional programme components (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	31
• or outside the Faculty of Mathematics and Natural Sciences	600	31
• thesis	600	5
Literature study plus thesis	500	7
Course Scientific Conduct	500	1
20 Lectures and Colloquia	500	1
Optional courses or traineeships	≥400 (max 12 ec <400)	15

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

### Programme

The programme contains two research periods (52 and 36 EC), and compulsory and optional programme components (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	31
• or outside the Faculty of Mathematics and Natural Sciences	600	31
• thesis	600	5
Literature study plus thesis	500	7
Course Scientific Conduct	500	1
20 Lectures and Colloquia	500	1
Optional courses or traineeships	≥400 (max 12 ec <400)	15

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

### Programme

The programme contains two research periods (52 and 36 EC), and compulsory and optional programme components (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	31
• or outside the Faculty of Mathematics and Natural Sciences	600	31
• thesis	600	5
Literature study plus thesis	500	7
Course Scientific Conduct	500	1
20 Lectures and Colloquia	500	1
Optional courses or traineeships	≥400 (max 12 ec <400)	15

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

### Programme

The programme contains two research periods (52 and 36 EC), and compulsory and optional programme components (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	31
• or outside the Faculty of Mathematics and Natural Sciences	600	31
• thesis	600	5
Literature study plus thesis	500	7
Course Scientific Conduct	500	1
20 Lectures and Colloquia	500	1
Optional courses or traineeships	≥400 (max 12 ec <400)	15

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

#### *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

### 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 popularisation of science, for example, as a science communicator, a science policymaker or a public relations officer, or for a career as a scientist with a communicating mindset. Students with 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 Board of Admissions will judge the equivalence to these BSc degrees of their previous training. Preferably, the BSc programme has included the 10-EC-course Learning, Presentation and Communication, offered by the Leiden Graduate School of Education (ICLON), or equivalent courses. Applicants must provide proof of proficiency in Dutch.

## Programme (120 EC)

### *Bio-Pharmaceutical Sciences*

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

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

### *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
Educational Theory	300	5
Supervision of Professional Development	400	7
Teaching Methodology	500	10
Specialisation	600	8
Teaching Practice		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(specialisations). Specialisations range from the molecular to the population level and from fundamental to more strategically-orientated research. The tracks reflect the two major themes of biological research at Leiden University: 'Life Science' and 'Biodiversity and Evolution'. All tracks are organized around specialized state-of-the-art courses organized by specialized staff, closely related to their expertise, and emphasized 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 the programme is two years (120 EC) and each track consists of compulsory components and electives. Electives might be chosen from the biology programmes or from other biology-related programmes offered by Dutch or foreign universities. In individual cases a course on a subject not related to biology may be elected. Electives outside the biology programme require *prior* written approval by the Board of Examiners.

Students who complete the programme receive the degree Master of Science in Biology (MSc in Biology), with specification of the specialisation, 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 Board of Examiners. A Board of Admissions will advise on admissions, and all programmes will be made in concert with the track coordinator.

## 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, (bio)mathematics or biomedical sciences and specific HBO bachelors as well as for foreign students, the Board of Admissions 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 Board of Admissions. 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 (IELST  $\geq 6.5$  with a value  $\geq 6.0$  for all subscores).

## 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 compulsory theoretical courses are scheduled. Courses starting in either the first or the second semester are often not identical.

## 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 research 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 'Laboratory Animal Science', that offers the qualification for experimental handling of laboratory 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 animal biology. 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 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 "Laboratory Animal Science" (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 <i>(Scientific Writing Skills, Statistics, Modeling)</i>	400	10
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	24 - 42
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Note: maximally 12 EC of optional theoretical programme elements of 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 specialisations 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 Board of Admissions 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, including 'General Research Skills', and the course 'Collections and Research' and profile course 2. Some additional courses can be chosen from a number of specialized courses, e.g. 'Economic Botany', 'Advanced topics in Phylogeny Reconstruction', 'Ethnobotanical Knowledge Systems', 'Paleobotany'. In some cases, the course 'Basic Molecular Biological Techniques' 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	400	10
<i>(Scientific Writing Skills, Statistics, Modeling)</i>		
Collections and Research	400	1
Specialized courses	400/500	11
Profile course 2 Biodiversity in Time and Space:		
Advanced BTS textbook	500	6
Seminar	500	4
Biology major research project	600	48 – 58
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 - 16
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Note: maximally 12 EC of optional programme elements of 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 compulsory profile course 1 includes the following elements: statistics, English scientific writing, modelling, genetics and a general overview of (theoretical) evolutionary ecology. 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 ( <i>Scientific Writing Skills, Statistics, Modeling</i> )	400	10
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                      15 - 33

Note: maximally 12 EC of optional theoretical programme elements of 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, cellular imaging, transcriptomics, proteomics and metabolomics will provide essential knowledge and skills to apply these powerful techniques in the broad fields of biological and medical research. The implication of these techniques for biotechnology and the understanding of the molecular basis 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 able to analyze scientific data, to formulate scientific conclusions on basis of these data and they are trained to present scientific results in oral presentations and in writing.

This master 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 ranging from a general perspective towards a chosen specialisation. Specialisations include 'Animal cells and disease', 'Developmental genetics', 'Microbes and disease' and 'Biotechnology'. 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. A research project within one of the 'Life Science' research groups of the Leiden Institute of Chemistry (LIC) 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). A research project can be done also at the Leiden University Medical Centre (LUMC) and it may count as an internal research project 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 required.

Emphasis will be put on model organisms such as zebrafish, *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. The optional element 'Colloquium course' comprises advanced lectures and is highly recommended for student enrolled in the MCB track (flexible for 2, 3 or 4 EC).

<i>Compulsory:</i>	level	EC
Profile course 1 Molecular and Cellular Biology:		
- Theoretical overview 'Molecular & Cellular biology' and orientation on MCB research	400	9
- MCB Specialisation	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
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Note: maximally 12 EC of optional theoretical programme elements of 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. Master students should be able to analyse scientific literature and recognize scientific questions, they 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 realisation of these applications. The students should be able to communicate scientific results in the oral and written form, including poster presentations. The students should develop into independent researchers who 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 Board of Admissions 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. The course “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 series 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, taking the obligatory components in consideration, and it should be approved by the Board of Examiners prior to the start.

<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)

<i>Optional:</i>		
Elective courses, lectures, seminars, minor research project or literature review	400/500	2 – 34

Note: maximally 12 EC of optional programme elements of 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, a seminar (preferably “Biodiversity and 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. The first part ('General Research Skills') is focussed on scientific writing, statistics and modelling. The second part ('Principles of Conservation Biology') deals with the knowledge and skills needed as a background for environmental biological research. The third part ('Biodiversity and Society') concentrates on the social, cultural and economic backgrounds of nature conservation. Profile course 2 offers deepening of knowledge in a specific topic. In the recommended seminar 'Sustainability and Biodiversity' organized by the CML, the concepts of biodiversity and sustainability are analyzed from different perspectives (e.g. scientific, social, economical) and the role of biodiversity within sustainable development is discussed. 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 required. Additional time might be spent on optional courses, advanced lectures, seminars, a literature review or extra research project time. Alternative suggestions might be considered and should be discussed with the coordinator who should approve on them before the actual start.

<i>Compulsory:</i>	level	EC
Profile course 1 Sustainability and Biodiversity:		
– General Research Skills ( <i>Scientific Writing Skills, Statistics, Modeling</i> )	400	10
– Principles of Conservation Biology	400	4
– Biodiversity and Society	500	3
Profile course 2 Sustainability and Biodiversity:		
Advanced S&B textbook	500	6
Seminar, preferably "Biodiversity and 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
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Note: maximally 12 EC on optional theoretical program elements of 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 Board of Admissions will

judge the equivalence of the previous training to the Dutch BSc in Biology which may result in additional coursework.

## **Programme**

### *Biology*

The Biology component of the Science-based Business (SBB) specialisation consists of a biology research project of 36-40 EC (including 4 EC for an MSc thesis and 1 EC for a colloquium) and 20-24 EC of advanced theory (courses, lectures and a mandatory seminar) to be selected in 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), National Herbarium of the Netherlands (NHN) or 'Naturalis'. The choices for courses and research project will be made in concert with an advisor and should be approved by the Board of Examiners prior to the start.

### *Science-Based Business*

The Business-related part of the complete SBB programme consists of 41 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

Note: maximally 12 EC on theoretical programme elements of 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 popularisation of science (especially biological sciences), 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 Board of Admissions will judge the equivalence of their previous training to these BSc degrees. 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 at least at level NT3 ("Dutch as a second language") but preferable at the level of native speaker.

## **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:

<i>Mandatory:</i>	level	EC
- Fundamentals of Science Communication and Society	400/500	17
- Training period	500/600	24-34

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		0-19
- 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 Board of Admissions 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 specialisation consists of a biology research project of 36-40 EC (including 4 EC for a thesis and 1 EC for a colloquium) and 20-24 EC of advanced theory (courses, lectures and a mandatory seminar) to be selected in correspondence with the research topic. The research project is in one of the research groups of the Institute of Biology (IBL), Institute of Environmental Sciences (CML) or National Herbarium of the Netherlands (NHN). All theory is minimally on level 400. The 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
Educational Theory	300	5
Supervision of Professional Development	400	7
Teaching Methodology	500	10
Specialisation	600	8
Teaching Practice		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.