

# *Master degree programmes*

## *Faculty of Science*

### Leiden University

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Teaching and Examination Regulations MSc programmes Appendix <ul style="list-style-type: none"><li>➤ Descriptions</li><li>➤ Qualifications for admission</li><li>➤ Condensed programmes</li></ul>
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### ***Contents***

MSc Mathematics.....	2
MSc Computer Science.....	5
MSc ICT in Business .....	9
MSc Media Technology .....	12
MSc Astronomy .....	14
MSc Physics .....	18
MSc Chemistry.....	25
MSc Bio-Pharmaceutical Sciences .....	29
MSc Biology.....	35
MSc Life Science and Technology (LS&T) – Leiden.....	40
Specialisation Science Based Business.....	43
Specialisation Science Communication & Society .....	46
Specialisation Education.....	49

# MSc Mathematics

**CROHO-number 66980**

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

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

Candidates with a BSc degree or equivalent can apply for admission. The admission guidelines are given below for each specialisation. Individual combinations of the research programmes, with research projects from different groups, are possible in principle, depending on the decision by the Board of Examiners. The admission process may include an interview with the Board of Admissions. Foreign applicants must provide proof of proficiency in English (IELTS level  $\geq 6.0$ ). Admission is possible throughout the year, but we advise foreign students to start in September or February.

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

## Specialisation

### **Algebra, Geometry and Number theory**

#### **Description**

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

#### **Qualifications for admission**

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

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

### **Programme**

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

### **Specialisation**

## **Applied Mathematics**

### **Description**

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

### **Qualifications for admission**

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

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

### **Programme**

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

### **Specialisation**

## **Statistical Science for the Life and Behavioural Sciences**

### **Description**

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

### Qualifications for admission

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

The courses will be taught in English, so proven proficiency in English is required for non-native English speakers (IELTS level  $\geq 6.0$ ).

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

### Programme

The nominal duration of the programme will be two years (120 ECTS). The study time may be substantially reduced for students with particular prior knowledge. The programme consists of courses and colloquia (84-90 EC), an internship (10 EC) and a Master Thesis (20-26 EC). The internship and Master Thesis may be combined (30-36 EC).

At least 108 EC should come from the official programme, leaving 12 EC free of choice. Students should have at least 45 EC of the 60 compulsory courses to enrol for the 'Statistical Consultancy' course and internship. Students should have obtained at least 75 EC to start their thesis research.

Compulsory courses	EC	level
Statistics, probability	9	400
Mathematics for statisticians	4	300
Statistical computation with R	3	400
Linear & generalized linear models and linear algebra	9	400
Introduction to the life and behavioural sciences	5	400
Multivariate and multidimensional data analysis	6	500
Bayesian statistics	6	500
Mixed and longitudinal modeling	6	500
Study design in the life and behavioural sciences	6	400
Statistical consulting	5	500
Advanced statistical computing	3	500
Internship	10	600
Thesis	20, 24 or 26	600
Electives	28, 24 or 22	$\geq 500$
<b>Total</b>	<b>120</b>	

### Elective courses within the programme

Survival analysis	6	500
Statistical learning theory	4	500
Psychometrics and SEM	6	500
High-dimensional data analysis	6	500
Statistical genetics	6	500

## **MSc Computer Science**

**CROHO-number 60300**

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

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

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

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.

### **Specialisation**

## **Core Computer Technologies**

### **Description**

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

### **Qualification for admission**

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

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

### **Programme**

The programme is 120 EC in extent, and consists of specialisation courses (42 EC to 60 EC in total, depending on whether a software project or project study is done by the student or not), a project (software project or project study, 18 EC), and two research projects in computer science (60 EC in total).

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

## Specialisation

### Computer Science Theory and Advanced Technologies

#### Description

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

#### Qualification for admission

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

#### Programme

The programme is 120 EC in extent, and consists of specialisation courses (42 EC to 60 EC in total depending on whether a software project or project study is done by the student or not), a project (software project or project study, 18 EC), and two research projects in computer science (60 EC in total).

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

## Specialisation Bioinformatics

### Description

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

### Qualifications for admission

Students from any university in The Netherlands with a BSc degree in Computer Science or with a BSc major in Computer Science will be admitted to the programme. For all other (national and international) candidates, the Board of Admissions will judge the equivalence to these BSc degrees of their previous training.

### Programme

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

<i>Core Programme</i>	Level	EC
Pattern Recognition	500	6
Databases and Data mining	500	6
Functional Genomics and Systems Biology	500	6
Computational Molecular Biology	500	6
 <i>Methodology</i>		
Methodology	500	4

Every student of the Bioinformatics specialisation has to complete the core programme and the course Methodology.

<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 - 6 EC. The total of 20 EC is indicative and depends on the extent of the student's support programme and research assignment. The selection of the specialisation courses takes place in coordination with the Bioinformatics specialisation study advisor.

<i>Support Programme</i>	500	12
For each student a support programme will be defined by the Bioinformatics specialisation study advisor. The support programme consists/tutors of courses in Life Science, Computer Science, Mathematics, or of optional courses for deficiency programmes. The support programme will consist of a maximum of 12 EC.		
<i>Research assignment</i>	600	15
<i>Master's research project</i> (incl. thesis and oral presentation)	600	45

## **MSc ICT in Business**

**CROHO-number 60205**

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

### **Description**

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

### **Qualifications for admission**

To enter the MSc programme in ICT in Business, a bachelor's degree in Computer Science or a closely related subject is required. Each application is considered individually. The Board of Admissions assesses whether the candidate's academic background and work experience can be considered to be equivalent to a bachelor's degree in Computer Science. The admission process may include an interview with the Board of Admissions. Foreign applicants must provide proof of proficiency in English (IELTS  $\geq$  6.5). Students who have a BSc in Computer Science from Leiden University are directly admissible.

### **Programme**

The ICT in Business consists of five blocks of course-work, and a 34 EC thesis project, often based on an in-company project. The courses cover business foundations, ICT & Business topics, research methods and electives. The electives allow students to individualise their programme and accommodate special interests. In addition there are possibilities to customise the programme through international exchange programmes. Courses are typically offered in a combination of lectures, case studies, projects, company visits, and student presentations. Many activities are based on team work. At regular intervals research colloquia are offered to supplement and enrich the programme.

### **Curriculum outline ICT in Business**

The curriculum depends on the student's background. Students with a Leiden University bachelor in Computer Science, specialisation "Informatica en Economie" follow an alternative curriculum (see below). All the other students follow the main curriculum.

The main curriculum consists of the following components:

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

The alternative curriculum consists of the following components:

<i>Courses year 1</i>	<i>Level</i>	<i>EC</i>
Kick-off: Global Business game	400	1
Research Methods	500	3
Software Engineering	500	6
ICT-enabled Process Innovation	500	3
Strategy Formation & Implementation	500	5
Change Management	500	3
System's Development and Project Management	500	6
Management Science	500	3
ICT Strategy and Planning	500	3
ICT Architectures	500	6
Capstone Cases	500	3
Managing Innovation	500	3
Behavioural Decision Making	500	3
Managing People	500	3
Research Colloquia	500	4
Research Seminar	500	4
Electives	500	27
MSc research project	600	34

The electives need approval by the Exam Committee before the courses can be taken.

### **Programme for candidates with working experience**

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

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

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

# MSc Media Technology

CROHO-number 60206

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

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

## Description

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

## Qualifications for admission

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

## Substitution for Compulsory Courses

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

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

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

### **Programme**

The programme is 120 EC in extent.

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

## **MSc Astronomy**

**CROHO-number 60200**

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

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

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

### **Requirements for admission**

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

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

### **Selection of courses and Master Study Plan**

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

## Types of courses

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

*Astronomy Core Courses* (6 EC each).

1. Origin and evolution of the Universe;
2. Galaxies, structure, dynamics and evolution;
3. Stellar structure and evolution;
4. Interstellar medium.

*General Astronomy Courses* (6 EC each). These vary with time. Some are only given once, others are given at regular or irregular intervals. Examples include Star Formation, Computational Astrophysics and the InterUniversity Courses (IAC).

*Instrumentation-related Astronomy Courses* (3 or 6 EC each). The number and schedule of these courses also varies, but regular examples are “Detection of Light” (6 EC) and “Radio Astronomy” (3 EC).

The 4-EC course Physics of Scientific Space Instruments is also in this category, as are specifically designated courses at Delft University of Technology.

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

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

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

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

## Specialisation Research in Astronomy

### Description

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

### **Programme (120 EC)**

The programme has the following structure:

<i>Year 1</i>	Level	EC
Minor Astronomy research project	500	24
Astronomy courses	400-500	24
Non-Astronomy courses	400-500	12
 <i>Year 2</i>		
Major (master's) Astronomy research project	600	36
Astronomy courses	500	12
Non-Astronomy courses	400-500	12

The Astronomy curriculum must contain the following courses:

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

The course “Science-Based Business Fundamentals” may also be chosen as a non-Astronomy course.

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

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

- Astronomical observing techniques (Astronomische waarneemtechnieken);
- Radiative processes (Stralingsprocessen);
- Physics of elementary particles (Fysica van elementaire deeltjes).

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

### **“Astronomy and Instrumentation” stream**

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

The requirements for the two years are as follows:

	Level	EC
<i>Mandatory Courses:</i>		
Stellar structure and evolution	500	6
Detection of light	500	6
<i>Choice of core/general/specialist Astronomy courses</i>	400-500	18-12
<i>Choice of instrument-related Astronomy courses</i>	400-500	6-12
<i>Choice of instrument-related Physics courses</i>	400-500	24
Minor Research Project in General Astronomy	500	24
Major Research Project in Instrumental Astronomy (Master's Project)	600	36

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

### “Cosmology” stream

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

	Level	EC
<i>Mandatory Astronomy Courses:</i>		
Stellar structure and evolution	500	6
Origin and evolution of the Universe	500	6
Large-scale structure and galaxy formation	500	6
<i>Choice of:</i>		
core/general/specialist Astronomy courses	400-500	18
<i>Mandatory Physics Courses:</i>		
Particle physics and early Universe	500	6
Theory of general relativity	400	6
<i>Choice of:</i>		
Related Physics courses	400-500	12
Minor Research Project in General Astronomy	500	24
Major Research Project in Cosmology (Master's Project)	600	36

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

## **MSc Physics**

### **CROHO-number 60202**

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

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

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

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

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

### **Specialisation**

## **Research in Experimental Physics**

### **Description**

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

Research in the field of Biological and Molecular Physics is aimed at the interaction between light and matter, the photophysics of optically excited states of (bio) molecules, and the conformational dynamics of proteins. The objective of these studies is to establish at the molecular level the relationship between structure and function of biomolecules. The

research involves a range of spectroscopical as well as single-molecule and scanning probe imaging techniques.

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

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

### **Qualifications for admission**

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

### **Programme**

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

<i>Components</i>	Level	EC
Choice of Quantum Theory <i>or</i> Statistical Physics <sup>1</sup>	400	9
Courses from the Theoretical Physics courses on offer	400-500	9
Optional master courses	400-500	42-30
Physics research project 1 in a LION research group (with Master thesis and oral presentation) <sup>2</sup>	600	36
Physics research project 2 in a research group within or outside LION (with Master thesis and oral presentation)	600	24-36

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

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

<i>Master courses in Physics</i>	Level	EC
Advanced Biophysics	500	6
Biomolecular Motors	500	6
Computational Physics	400	9
Introduction to Astroparticle Physics	400	6
Physics of Scientific Space Instruments	400	4
Experimental Classical and Quantum Optics	500	6
Scanning Probe Microscopy	500	6
Single Molecule Optics	500	6
Superconductivity	400	3
Surface Physics	500	6

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

## Specialisation

### Research in Theoretical Physics

#### Description

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

#### Qualifications for admission

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

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

#### Programme

<i>Components</i>	Level	EC
Quantum Theory	400	9
Topics in Theoretical Physics <sup>1</sup>	400	9
Courses from the Theoretical Physics courses on offer	400-500	18
Optional master courses <sup>2</sup>	400-600	24
Physics research project in Theoretical Physics	600	45
Master’s thesis (10 EC) and oral presentation (5 EC)	600	15

<sup>1</sup> 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.

<sup>2</sup> A maximum of one master course of maximally 9 EC can be taken anywhere at Leiden University.

<i>Master courses in Theoretical Physics</i>	Level	EC
Black Holes and Gravitational Waves	500	3
Effective Field Theory	500	3
Theoretical Cosmology	500	3
Quantum Field Theory	500	6
Quantum Theory	400	9
Statistical Physics	400	9
Theory of Condensed Matter	500	9
Theory of General Relativity	400	6
Topics in Theoretical Physics <sup>1</sup>	400	9

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

## Specialisation Cosmology

### Description

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

### Qualifications for admission

Students from any university in the Netherlands with a BSc degree in Physics or Astronomy will be admitted to the programme. Similar to the Theoretical Physics stream, in-depth knowledge is required of undergraduate courses with theoretical and mathematical emphasis: quantum physics, electrodynamics, statistical physics, and complex analysis. Also prerequisite is the Leiden Bachelor course on Physics of Elementary Particles, or a clear equivalent. The Bachelor course Relativistic Electrodynamics is strongly advised.

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

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<sup>1</sup> 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.

**Programme**

<i>Components</i>	Level	EC
Large Scale Structure and Galaxy Formation	500	6
Theory of General Relativity	400	6
Origin and Evolution of the Universe	400	6
Quantum Theory	400	9
Effective Field Theory	500	3
Galaxies: Structures, dynamics, evolution	400	6
Particle Physics and the Early Universe	500	6
Observational Cosmology	400	3
Choice of Black Holes and Gravitational Waves / Theoretical Cosmology	500	3
Choice of Computational Astrophysics / Databases and Data Mining	500	3
Optional master courses <sup>1</sup>	400-500	15
Research project in Cosmology 1	500	24
Research project in Cosmology 2 (Master project)	500	36

Note: the two research projects together have to cover the three components mentioned above, namely theory, data handling and numerical simulations.<sup>2</sup>

<i>Master courses for Cosmology</i>	Level	EC
Effective Field Theory	500	3
Galaxies: Structure, dynamics, evolution	400	6
Gravitational Lensing	400	3
Introduction to Astroparticle Physics	400	6
Numerical Simulations in Astrophysics	400	1-3 <sup>3</sup>
Physics of Gamma Ray Bursts	400	3
Physics of Scientific Space Instruments	400	4
Quantum Field Theory	500	6
Star formation	400	3
Black Holes and Gravitational Waves	500	3
Theoretical Cosmology	500	3
Computational Astrophysics	500	3
Databases and Data Mining	500	3
Topics in Theoretical Physics <sup>4</sup>	500	9

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

<sup>1</sup> A maximum of one master course can be taken anywhere at Leiden University.

<sup>2</sup> Dispensation can be granted by the Exam Committee if a student can demonstrate competence in a component acquired outside the M.Sc. programme.

<sup>3</sup> Numerical simulations in Astrophysics can be done as modules of 1 EC each up to a total of 3.

<sup>4</sup> 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.

## Specialisation 'Casimir pre-PhD'

### Description

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

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

### Qualifications for admission

All admission is through selection by an admission committee.

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

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

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

### Programme

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

Research project and study projects are also guided by a strict timeline. The Research project starts in September and finishes in February. The two study projects (8 EC each) are

to be carried out in different group, and in a different group than where the Research project took place, and have to be carried out between March and the end of May. Writing a research proposal is the last item in the programme. For a limited number of students within this track, a PhD position will be guaranteed. Details can be found on the website of the Casimir Research School.

<i>Foundational courses</i>	Level	EC	
Effective Field Theory	500	3	(L)
Quantum Field Theory	500	6	(L)
Quantum Optics and Quantum Information	500	9	(L)
Theory of Condensed Matter	500	9	(L)
Theory of General Relativity	400	6	(L)
Topics of Theoretical Physics	500	9	(L)
<i>Topical Courses</i>	Level	EC	
Advanced Biophysics	500	6	(L)
Biophysics	400	6	(D)
Introduction to Astroparticle Physics	400	6	(L)
Experimental Classical and Quantum Optics	500	6	(L)
Mesoscopic physics	400	6	(D)
Molecular Electronics	500	6	(D)
Physics of semiconductor devices	400	6	(D)
Quantum Information Processing	500	6	(D)
Single Molecule Optics	500	6	(L)
Surface Physics	500	6	(L)
Superconductivity	400	3	(L)
<i>Methods</i>	Level	EC	
Computational Physics	400	6	(L or D)
Nanotechnology	400	6	(D)
Physics of Scientific Space Instruments	400	4	(L)
Scanning Probe Microscopy	500	6	(L)

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

## MSc Chemistry

CROHO-number 66857

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

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

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

### Admission procedure

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

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

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

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

### **The programme**

Each student composes his/her own study programme in consent with the mentor, who is a permanent staff member of the LIC. The mentor is the supervisor of the major internship of the specialisation in one of major research areas as chosen by the student. The mentor will coach the student from the admission throughout the MSc programme. The choice in elective courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate. This study programme must be submitted for approval to the Board of Examiners at the start of the study. The intended programme may be adjusted during the course of the MSc programme. The study coordinator administrates a copy of the approved programme; it is used to keep track of the student's progress and forms the basis for the master portfolio. The master portfolio is updated by the student on a regular basis via the research group secretariat and it is accessible to the student, the mentor and the study coordinator. The mentor discusses the progress of the student at least every half year using the results documented in the portfolio. The study coordinator will mediate when the student encounters problems in the contact with the mentor.

### **Description of the research areas**

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

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

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

### **Programmes of the specialisations**

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

#### **Specialisation – Research in Chemistry (CHEM)**

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

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

The (major) internship is carried out in a LIC research group in one of the research areas (*Biological Chemistry, Physical & Theoretical Chemistry, Design & Synthesis*) and includes a presentation and a written report (the master thesis). The research internship may be split into two internships: the major and minor internship. The major internship is limited to 60 EC and a minor internship must comprise at least 20 EC. The minor and major internship project may be related and this may be reflected in a combined master thesis. In consent with the mentor the minor internship can be carried out in another research area, another institute (within the Netherlands or abroad), or in a company. Prior approval of the Board of Examiners is required for an internship outside the institute. The mentor has the final responsibility for the grading of the internship report of research not carried out in the LIC.

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

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

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

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

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

## **MSc Bio-Pharmaceutical Sciences**

**CROHO-number 60207**

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

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

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

### **Specialisation**

## **Medicinal Chemistry**

### **Description**

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

### **Qualifications for admission**

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

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

### Programme

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

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

### Specialisation

## Analytical Biosciences

### Description

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

### Qualifications for admission

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

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

### Programme

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

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

### Specialisation

## Pharmacology

### Description

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

### Qualifications for admission

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

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

### Programme

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

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

### Specialisation

## Drug Delivery Technology and Biopharmaceutics

### Description

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

### Qualifications for admission

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

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

### Programme

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

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

### Specialisation Toxicology

#### Description

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

#### Qualifications for admission

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

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

**Programme**

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

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

## **MSc Biology**

**CROHO-number 66860**

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

The duration of the programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Biology (MSc in Biology) with specification of the specialisation, if applicable. The degree provides graduates with the academic training and research skills required to pursue a scientific or science-related career. All specialisations have the same Director of Education and the same Board of Examiners. A Board of Admissions advises on admissions.

### **Admission**

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

### **Start of the programme**

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

## Specialisation

# Evolution, Biodiversity and Conservation

## Description

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

## Programme (120 EC)

The programme consists of a theoretical part and one or more research projects. Courses cover a broad range of relevant subjects and provide in-depth theoretical knowledge as well as training in practical skills and advanced research tools. Internationally leading scientists in fields relevant for the programme are invited for special lectures and discussion with students ('*Top lectures*'). Compulsory are the theoretical course elements indicated below, and at least one research project.

'*Fundamentals*' is a broad-ranging 6-week (9 EC) 'basics' course, consisting of 3 modules. The 3 modules ('*Fundamentals of evolutionary change*', '*Fundamentals of conservation biology*', and '*Richness of the world*') offer a broad kaleidoscope of subjects as starting points for the later individual specialisations. In addition, students are trained in advanced statistics and bioinformatics in the course Statistics and Modelling and choose among several '*Trends*' courses (lasting 4 weeks) providing students with an integrated picture on specific topics.

The research projects are the actual core of the MSc programme. Students will be member of a research group of their choice and work on a specific project in close collaboration with staff of one of the different institutes full time. Each project will be finished with an MSc thesis written in the form of a manuscript for an international scientific journal. Research projects can range from experimental studies on the molecular mechanisms of development or on animal behaviour to collection-based research on biodiversity or field projects in the Netherlands or elsewhere (e.g. terrestrial and marine studies in Southeast Asia). After an internal project, students are encouraged to do an external project at an affiliated institute abroad.

Compulsory:

The total programme consists of 120 EC. The compulsory theoretical component consists of 32 EC and the minimum time to be spent on research projects is 60 EC. A research project should be minimally 36 EC and compulsory is at least one research project (of min. 36 EC) within one of the participating institutes.

Compulsory theoretical courses:

	Level	EC
EBC fundamentals	400	12
Statistics and Modelling	500	3
Two EBC 'trends' courses	500	2x6 = 12
Top lectures	600	4
<i>And one of the following elements</i>		
Seminar	500	4
Book exam	500	6
Colloquium 'Spotlight Research talks'	500	4
 <u>Research projects</u>	 600	 min. 60

Optional elements:

The optional part of the programme can consist of either course work, or extra research project time. For courses outside the Leiden University Biology programme (max. 10 EC) and for all external research projects, prior approval of the Board of Examiners is required. Note: a maximum of 12 EC of optional elements at a level < 400 are permitted.

**Approval of programme**

The individual study programme consisting of choices of courses and one or two research projects must have prior approval of the Board of Examiners.

**Specialisation**

**Molecular and Cellular Biosciences**

**Description**

This MSc specialisation provides students with knowledge about all basic aspects of genetics and molecular and cellular biology of prokaryotes and eukaryotes. Attention is given to genetic, microbiological, cellular and physiological approaches to understand the functioning of uni- and multicellular organisms at the molecular level. Training in functional genomics, cellular imaging, transcriptomics, proteomics and metabolomics will provide essential knowledge and skills to apply these powerful techniques in the broad fields of biological and medical research. The implications of these techniques for biotechnology and the understanding of the molecular basis of development and diseases of animals and plants are highlighted. Research projects embrace a wide variety of different organisms including bacteria, yeast, fungi and the famous model species *Arabidopsis* and zebra fish. Students are trained in general academic skills and in understanding and critically evaluating specialised 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 analyse scientific data, to formulate scientific conclusions on basis of these data and they are trained to present scientific results in oral presentations and in writing.

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

### **Programme (120 EC)**

The programme consists of several compulsory components, mostly at the start and the end of the programme, and can be expanded with a wide choice of elective elements. The mandatory components in the 1<sup>st</sup> semester aim to provide students with the theoretical and practical background in molecular and cell biological research needed for an efficient start of the Research Project at the end of this semester. During the Research Project students are further trained in critically reading of and writing about recent scientific literature ranging from a general perspective to a chosen specialisation. At least one extensive Research Project including an MSc thesis and a colloquium should be part of the study programme.

A major and compulsory part of the master training is actively taking part in scientific research. The compulsory internal Research Project has to be done in one of the IBL departments. A Research Project within one of the 'Life Science' research groups of the Leiden Institute of Chemistry (LIC), at the Leiden-Amsterdam Centre of Drug Research (LACDR) or at the LUMC may substitute for a research project within the IBL. An external Research Project requires an MCB staff member as co-supervisor and prior approval by the Board of Examiners.

#### Compulsory components:

The compulsory theoretical components consist of at least 35 EC, and the minimum time to be spent on research projects is 60 EC. In case of two research projects, each project should be minimally 36 EC. At least one of the research projects is done within the IBL, one of the 'Life Science' research groups of the Leiden Institute of Chemistry (LIC), the Leiden-Amsterdam Centre of Drug Research (LACDR) or at the LUMC.

	level	EC
Fundamentals of MCB	400	6
Orientation on MCB research	400	3
Statistics, modelling and bioinformatics	500	6
Top Lectures in MCB	600	4
<i>One of the courses</i>		
Mechanisms of Disease	500	6
Global Regulatory Networks for Bacteria	500	6
Immune Systems of Plants	500	6
<i>and one of the following elements</i>		
Colloquium "Spot Lights research talks"	500	4
Advanced MCB textbook	500	6
MCB PhD Orientation Course	600	6
MCB research project (s)	600	min. 60
Electives		max. 25

Electives:

The optional part of the programme can consist of either additional courses or lectures, or an extension of the duration of a research project. A list of approved elective courses is available on the e-prospectus. For courses outside the LU biology programme and for all external research projects, prior approval of the Board of Examiners is required.

Note: maximally 12 EC of optional theoretical elements of level < 400 are permitted, and max. 10 EC non-biology courses.

**Approval of programme**

The individual study programme consisting of choices of courses and one or two research projects must have prior approval of the Board of Examiners.

**Short description of the Courses**

The MCB MSc study programme comprises 6 compulsory courses. The course *Fundamentals of Molecular and Cellular Biosciences* concerns the basic theoretical knowledge of microbiology, cellular biology, molecular genetics, immunology and physiology and the connection between these sub disciplines. This course should preferably be successfully completed before starting with the rest of the programme. The course *Orientation on MCB research* provides a state of the art overview of the scientific research and research methods used in the departments participating in this MSc specialisation taken from presentations by group leaders and PhD students.

Together with the Statistics, modelling and bioinformatics course and one of the 3 specialisation courses Mechanisms of Disease, Global Regulatory Networks for Bacteria or Immune Systems of Plants, this will prepare the students theoretically for their training in scientific research during the Research Project(s).

Another obligatory element in the MCB specialisation is the Top lectures series. This course consists of 6 lectures by internationally leading scientists in fields relevant for the MCB programme. Students prepare for the lectures by reading scientific papers and by discussion these papers with the speaker.

The colloquium course Spot Lights research talks is aimed at providing highlights and update on the research in the IBL. At the end of the MSc programme, students can prepare individually from an advanced text book for a specialised oral examination. Available book titles are provided in the electronic study guide (e-prospectus). Students can finalise their MCB MSc programme with a *PhD Orientation Course* that entails writing a PhD research proposal.

For details (description, literature, exam dates and further calendar events) about the different courses during see the e-prospectus and Blackboard.

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

CROHO-number 66286

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

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

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

### Admission procedure

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

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

### The programme

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

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

<sup>2</sup> If the student has taken a minor Education (tweedegraadsbevoegdheid) of 30 EC in the BSc study, only 30 EC are necessary in the MSc study to obtain the "eerstegraadsbevoegdheid"; then 30 EC free electives are added to the LS&T programme.

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

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

## **Programmes of the specialisations**

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

### **Specialisation – Life science research and development (RESEARCH)**

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

The (major) internship is carried out within the Cell Observatory or related LIC research groups. Our MSc students also have the opportunity to carry out pre-clinical master projects in biomedical research institutes, including the LUMC, ErasmusMC and NKI. The research internship includes a presentation and a written report (the master thesis). The research internship may be split into two internships: the major and minor internship. The major internship is limited to 60 EC and the minor internship must comprise at least 20 EC. The topics of the minor and major internship project may be related which may be reflected in a combined master thesis. In consent with the mentor the minor internship can be carried out in another specialisation, another institute (within the Netherlands or abroad), or in industry. Prior approval of the Board of Examiners is required for an internship outside the institute. The mentor has the final responsibility for the grading of the minor internship report of the research not carried out in the LIC.

The compulsory theoretical component comprises a selection of four core courses (24 EC) and a literature essay with colloquium (6 EC). Three of the courses are chosen from the list

of advanced compulsory modules below (18 EC) and one is chosen from the core courses offered by the Leiden MSc programme Chemistry or within the Delft MSc programme Life Science & Technology: Analysis of Metabolic Networks, Bioprocess Integration or Proteomics 1 and Proteomics 2. These modules comprise 6, 6 and 3+3 EC respectively. Both Proteomics 1 and Proteomics 2 have to be passed, if chosen.

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

## List of Advanced Compulsory Modules

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

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

Three courses have to be followed for the research specialisation, two courses have to be followed for the other specialisations.

## Specialisation Science Based Business

### Description

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

### Qualifications for Admission

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

### Exemptions

Students with prior education in management, business and entrepreneurship may – depending on the contents and extent of such education – be exempted from following (parts of) one or more of the Foundation and Advancement courses. These courses need to be substituted such that their master programme contains at least 40 EC of SBB courses. Decisions on exemptions are taken by the Board of Examiners governing the students MSc Programme.

### Programme

Completion of the specialisation SBB requires a minimum of 40 EC and a maximum of 60 EC from the courses listed in the table below. This includes at least, either

1. SBB Fundamentals, SBB Management and SBB Internship; or
2. The RBB foundation courses, RBB Technology Transfer or Business Development, and RBB Assignment.

If SBB Fundamentals is part of the programme, then the RBB foundation course “RBB Opportunities” is not mandatory.

#### *Mathematics*

The Mathematics research component of the Science Based Business (SBB) specialisation consists of:

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

#### *Computer Science*

The Computer Science research component of the Science Based Business (SBB) specialisation consists of:

- a research project in computer science of 40 EC (incl. 7 EC for the thesis and an oral presentation) in one of the research groups of LIACS, and
- 20 EC of level-500 courses to be selected in correspondence with the research topic.

The choices for courses and research project will be made in consultation with a supervisor.

### *Astronomy*

The Astronomy research component of the Science Based Business (SBB) specialisation consists of:

- a Medium Research Project (30 EC) supervised by a member of the Leiden Observatory scientific staff,

as well as courses to be selected in correspondence with the research topic to a minimum of 30 EC and a maximum of 50 EC.

These include at least:

- the mandatory course Stellar structure and evolution,
- one other Astronomy core course, and
- 8-14 EC of non-Astronomy courses.

### *Physics*

The Physics research component of the Science Based Business (SBB) specialisation consists of:

- a project in Physics of 30 EC in one of the research groups of the institute and a master's thesis and an oral presentation (5+1=6 EC), and
- 24 EC of courses to be selected in correspondence with the research topic.

### *Chemistry*

The Chemistry research component of the Science Based Business (SBB) specialisation consists of:

- a research project in chemistry of 30 EC in one of the major research areas,
- 12 EC of courses within, and
- 12 EC outside the chosen research area.

The programme comprises 26 EC of free electives; an extension of the research project is restricted to 20 EC and no more than 20 EC can be used for SBB courses.

### *Bio-Pharmaceutical Sciences*

The BPS research component of the Science Based Business (SBB) specialisation consists of:

- a research project of 50 EC in one of the research groups of CBPS, including 5 EC for a thesis and 2 EC for an oral presentation,
- two lecture series of 4 EC each,
- the course Scientific Conduct of 1 EC, and
- attendance of at least 20 colloquia or seminars (1 EC).

The choices for lecture series and research project will be made in concert with an advisor.

### *Biology*

The Biology research component of the Science Based Business (SBB) specialisation consists of:

- a research project of 36-40 EC, and
- 20-24 EC of advanced theory (courses and lectures) to be selected in relation to the research topic.

The biology component can be extended with an additional 19 EC (courses or extension of the research project to 79 EC in total). The research project has to take place in one of the research groups of the Institute of Biology (IBL), Institute of Environmental Sciences (CML), or NCB Naturalis.

A research project within one of the 'Life Science' research groups of the Leiden Institute of Chemistry (LIC), at the Leiden-Amsterdam Centre of Drug Research (LACDR) or at the

Leiden University Medical Centre (LUMC) may substitute for a research project within the IBL pending prior approval by the Board of Examiners.

Theoretical components should be minimally at level 400. The individual study programme consisting of choices of courses and the research project must have prior approval by the Board of Examiners.

### *Life Science & Technology*

The LS&T research component of the Science Based Business (SBB) specialisation consists of:

- a research project in LS&T of 30 EC,
- 12 EC of courses within the LS&T programme, and
- 12 EC of courses offered by Chemistry or the Delft LS&T programme.

The programme comprises 26 EC of free electives; an extension of the research project is restricted to 20 EC and no more than 20 EC can be used for SBB courses.

<b><i>Specialisation Science Based Business: Courses</i></b>		
<b><i>Foundation:</i></b>	Level	EC
- SBB Fundamentals	400	15
- Research Based Business Opportunities	400	5
- Research Based Business Ventures	400	5
- Research Based Business Planning	400	5
<b><i>Advancement:</i></b>		
- RBB New Business Development <sup>1</sup>	500	3
- RBB Technology Transfer <sup>1</sup>	500	3
- SBB Management	500	3
- Learning from Silicon Valley: Entrepreneurship and New Business Venturing <sup>2</sup>	500	5
- SBB Essay	500	3-7
- SBB Elective	400-600	3-15
<b><i>Finishing:</i></b>		
- SBB Internship	600	22-35
- RBB Assignment	600	22-35

<sup>1</sup> When these courses are taken together, tot total amount of credits is reduced to 5 EC

<sup>2</sup> This course is offered in collaboration with Delft University of Technology and Erasmus University Rotterdam, and will only be taught when sufficient participants from all three universities are enrolled.

# Specialisation Science Communication & Society

## Description

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

## Qualifications for admission

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

## Programme

The programme of the of the Science Communication & Society (SCS) specialisation consist of two components:

- a research component within the MSc programme
- a communication component

Completion of the specialisation SCS requires a minimum of 40 EC and a maximum of 60 EC within the communication component.

### *Mathematics*

The Mathematics research component of the Science Communication & Society (SCS) consists of:

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

### *Computer Science*

The Computer Science research component of the Science Communication & Society (SCS) consists of:

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

### *Astronomy*

The Astronomy research component of the Science Communication & Society (SCS) specialisation consists of:

- a Medium Research Project (30 EC) supervised by a member of the Leiden Observatory scientific staff,

as well as courses to be selected in correspondence with the research topic to a minimum of 30 EC and a maximum of 50 EC.

These include at least:

- the mandatory course Stellar structure and evolution,
- one other Astronomy core course, and
- 8-14 EC of non-Astronomy courses.

### *Physics*

The Physics research component of the Science Communication & Society (SCS) specialisation consists of:

- a research project of 30 EC in one of the research groups of the Leiden Institute of Physics (LION) and a master's thesis and an oral presentation (5+1=6 EC), and
- 24 EC of courses to be selected in correspondence with the research topic.

### *Chemistry*

The Chemistry research component of the Science Communication & Society (SCS) specialisation consists of:

- a research project in chemistry of 30 EC in one of the major research areas,
- 12 EC of courses within, and
- 12 EC outside the chosen research area.

The programme comprises 26 EC of free electives; an extension of the research project is restricted to 20 EC and no more than 20 EC can be used for SCS courses.

### *Bio-Pharmaceutical Sciences*

The BPS research component of the Science Communication & Society (SCS) specialisation consists of:

- a research project of 50 EC in one of the research groups of CBPS, including 5 EC for a thesis and 2 EC for an oral presentation,
- two lecture series of 4 EC each,
- the course Scientific Conduct of 1 EC, and
- attendance of at least 20 colloquia or seminars (1 EC).

The choices for lecture series and research project will be made in concert with an advisor.

### *Biology*

The Biology research component of the Science Communication & Society (SCS) specialisation consists of:

- a research project of 36-40 EC, and
- 20-24 EC of advanced theory (courses and lectures) to be selected in relation to the research topic.

The biology component can be extended with an additional 20 EC (courses or extension of the research project to 80 EC in total)

The research project has to take place in one of the research groups of the Institute of Biology (IBL), Institute of Environmental Sciences (CML), or NCB Naturalis.

A research project within one of the 'Life Science' research groups of the Leiden Institute of Chemistry (LIC), at the Leiden-Amsterdam Centre of Drug Research (LACDR) or at the

Leiden University Medical Centre (LUMC) may substitute for a research project within the IBL pending prior approval by the Board of Examiners. Theoretical components should be minimally at level 400. The individual study programme consisting of choices of courses and the research project must have prior approval by the Board of Examiners.

### *Life Science & Technology*

The LS&T research component of the Science Communication & Society (SCS) specialisation consists of:

- a research project in LS&T of 30 EC,
- 12 EC of courses within LS&T programme, and
- 12 EC of courses offered by Chemistry or the Delft LS&T programme.

The programme comprises 26 EC of free electives; an extension of the research project is restricted to 20 EC and no more than 20 EC can be used for SCS courses.

### *Communication*

The Communication component consists of the following:

<i>Mandatory:</i>	Level	EC
- Fundamentals of Science Communication and Society	400 17	
- Training period	60023-34	

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:*

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

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

## Specialisation Education

### Description

The MSc specialisation Education prepares students for a career in teaching in their subject matter specialisation. This programme leads up to the so-called “eerstegraads-lesbevoegdheid”, qualifying the student to teach in Dutch upper secondary education in the school subject associated with the MSc programme.

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

### Qualifications for admission

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

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

Applicants must provide proof of proficiency in Dutch.

### Programme

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

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

#### *Mathematics (60 EC)*

The Mathematics research component of the Education (EDU) specialisation consists of:

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

#### *Astronomy (60 EC)*

The Astronomy research component of the Education (EDU) specialisation consists of:

- a Medium Research Project (30 EC) supervised by a member of the Leiden Observatory scientific staff,

as well as courses to be selected in correspondence with the research topic to a total of 30 EC.

These include at least:

- the mandatory course Stellar structure and evolution,
- one other Astronomy core course, and
- 12 EC of non-Astronomy courses.

#### *Physics (60 EC)*

The Physics research component of the Education (EDU) specialisation consists of:

- a physics project of 30 EC in one of the research groups of the institute and a master's thesis and an oral presentation (5+1=6 EC), and
- 24 EC of courses to be selected in correspondence with the research topic.

### *Chemistry (60 EC)*

The Chemistry research component of the Education (EDU) specialisation consists of:

- a research project in Chemistry of 30 EC in one of the major research areas,
- 12 EC of courses within, and
- 12 EC outside the chosen research area.

The programme comprises 6 EC of free elective.

### *Bio-Pharmaceutical Sciences (60 EC)*

The BPS research component of the Education (EDU) specialisation consists of:

- a research project of 50 EC in one of the research groups of CBPS, including 5 EC for a thesis and 2 EC for an oral presentation,
- two lecture series of 4 EC each,
- the course Scientific Conduct of 1 EC, and
- attendance of at least 20 colloquia or seminars (1 EC).

The choices for lecture series and research project will be made in concert with an advisor.

### *Biology (60 EC)*

The Biology research component of the Education (EDU) specialisation consists of:

- a biology research project of 36-40 EC, and
- 20-24 EC of advanced theory (courses and lectures) to be selected in relation with the research topic.

The research project has to take place in one of the research groups of the Institute of Biology (IBL), Institute of Environmental Sciences (CML), or NCB Naturalis.

A research project within one of the 'Life Science' research groups of the Leiden Institute of Chemistry (LIC), at the Leiden-Amsterdam Centre of Drug Research (LACDR) or at the Leiden University Medical Centre (LUMC) may substitute for a research project within the IBL pending prior approval by the Board of Examiners.

Theoretical components should be minimally at level 400. The individual study programme consisting of choices of courses and the research project must have prior approval by the Board of Examiners.

### *Life Science & Technology (60 EC)*

The LS&T research component of the Education (EDU) specialisation consists of:

- a research project in LS&T of 30 EC,
- 12 EC of courses within LS&T programme, and
- 12 EC of courses offered by Chemistry or the Delft LS&T programme.

The programme comprises 6 EC of free electives.

*Education (60 EC)*

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

	Level	EC
Educational Theory	300	5
Learning and Instruction 1	400	5
Learning and Instruction 2	400	2
Teaching Methodology 1	500	5
Teaching Methodology 2	500	5
Design Research	600	7
Individual Choice	400	1
Teaching Practice 1		15
Teaching Practice 2		15