



Universiteit Leiden

*Appendices to the  
Course and Examination Regulations  
Master's Programmes  
Faculty of Science*

valid from 1 September 2019

# Index

Index .....	2
MSc Astronomy.....	3
MSc Bio-Pharmaceutical Sciences.....	16
MSc Biology.....	30
MSc Chemistry.....	45
MSc Computer Science.....	56
MSc Governance of Sustainability.....	66
MSc ICT in Business and the Public Sector.....	72
MSc Life Science and Technology.....	78
MSc Mathematics.....	88
MSc Media Technology .....	95
MSc Physics .....	100
MSc Statistical Science for the Life and Behavioural Sciences.....	113
Specialisation Business Studies.....	119
Specialisation Science Communication and Society.....	121
Specialisation Education.....	123

# MSc Astronomy

CROHO-number 60200

## 1. Description of the programme (Course and Examination Regulations chapter 2)

### 1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

The aim of the Leiden Observatory MSc programme Astronomy is to provide students with the proficiency, experience and skills to pursue a successful career in science, or in companies, industry or society in general with a strong background in scientific thinking and understanding.

### 1.2 Specialisations (Course and Examination Regulations art. 2.2)

The programme offers seven specialisations, each comprising two years (120 EC): four research-oriented specialisations, and three combined specialisations.

The four research-oriented specialisations focus on major research themes including evolution of the universe, formation and evolution of galaxies, birth and death of stars, formation and occurrence of planets near other stars, astronomical instrumentation, and the analysis of very large and complex data sets. They allow the student to choose from either a broad research profile (“Astronomy Research” specialisation), or a profile that is more focused in a particular direction. The specialisations offered (and described in detail below) are:

1. “Astronomy Research”;
2. “Astronomy and Cosmology”;
3. “Astronomy and Data Science”;
4. “Astronomy and Instrumentation”.

In addition to the research-oriented specialisations, three other specialisations are offered, which combine the main elements of the research curriculum with topics in Business Studies (BS), Science Communication and Society (SCS), and Education (EDU), and which are described separately.

Upon successful completion of the programme, students receive the degree Master of Science in Astronomy, with specification of the chosen specialisation.

All specialisations have the same Director, the same Education Committee, the same Board of Examiners, and the same Board of Admissions. Exceptions to this are formed by the specialisations Business Studies, SCS, and EDU, which for the specialisation-specific part each have their own specialisation coordinator and a central Board of Examiners appointed by the Faculty of Science. Students with an MSc in any of the seven specialisations can be admitted to a PhD programme in Astronomy.

### 1.3 Learning outcomes (Course and Examination Regulations art. 2.3)

The international standards for astronomy MSc programs are defined in the Domain Specific Reference Frame (DSRF). The DSRF is based on the “Tuning Physics” document, developed at the European level following the Bologna Agreements, which specifies how the general qualifications are translated into the program itself. The DSRF explicitly links to the five Dublin Descriptors and translates these into a number of specific competences, with corresponding achievement levels. The comparison between the learning outcomes of the program and the DSRF (and hence the Dublin Descriptors) is presented below, which shows a detailed match between the learning outcomes of the program and the DSRF and Dublin Descriptors.

*(A) KNOWLEDGE AND UNDERSTANDING*

On completion of the programme, the student should:

- A1 have a good understanding of the important physical theories (logical and mathematical structure, experimental support, physical phenomena described).
- A2 be familiar with the most important areas of physics and with the common approaches, which span many areas in physics.
- A3 have a good knowledge of the state of the art in (at least) one of the presently active topics in physics research.

*(B) APPLYING KNOWLEDGE AND UNDERSTANDING*

On completion of the programme, the student should:

- B1 be able to frame, analyse and break down a problem in phases defining a suitable algorithmic procedure; be able to evaluate clearly the orders of magnitude in situations which are physically different, but show analogies, thus allowing the use of known solutions in new problems.
- B2 be able to identify the essentials of a process/situation and to set up a working model of the same; be able to perform the required approximations; i.e. critically think about how to construct physical models.
- B3 be able to understand and master the use of the most commonly used mathematical and numerical methods.
- B4 have become familiar with most important experimental methods and be able to perform experiments independently, as well as to describe, analyse and critically evaluate experimental data; and to be able to scientifically report the findings.
- B5 be able to use appropriate software, programming language, computational tools and methods in physical and mathematical investigations.
- B6 acquire an understanding of the nature and ways of physics research and of how physics research is applicable to many fields other than physics, e.g. engineering; be able to design experimental and/or theoretical procedures for: (i) solving current problems in academic or industrial research; (ii) improving the existing results.

*(C) JUDGEMENT*

On completion of the programme, the student should:

- C1 be able to develop a personal sense of responsibility; be able to gain professional flexibility through the wide spectrum of scientific techniques offered in the curriculum; be able to organize the personal learning process, evaluate personal work, consult experts for information (e.g. about career opportunities) and support when appropriate; have had the opportunity to take courses that prepare for teaching physics at secondary school, as well as the opportunity to gain in-depth interdisciplinary skills.
- C2 have become familiar with highly regarded research in the field, thus developing an awareness of the highest standards.
- C3 be able to understand the socially related problems related to the profession, and to comprehend the ethical characteristics of research and of the professional activity in physics and its responsibility to society; be able to conduct processes of decision making and inspect the consequences of actions taking into account principles, norms, values and standards both from a personal and a professional standpoint.
- C4 be able to work with a high degree of autonomy, even accepting responsibility in (project) planning, and in the managing of structures.

(D) COMMUNICATION

On completion of the programme, the student should:

- D1 be able to listen carefully and to present difficult ideas and complex information in a clear and concise manner to a professional as well as to lay audiences; be able to work in a multidisciplinary or in an interdisciplinary team.
- D2 be able to read, speak, and write in technical English.

(E) LEARNING SKILLS

On completion of the programme, the student should:

- E1 be able to search for and use physical and other technical literature, as well as any other sources of information relevant to research work and technical project development.
- E2 be able to enter new fields through independent study; have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy (lifelong learning).
- E2 enjoy the facility to remain informed of new developments and methods, and be able to provide professional advice on their possible impact or range of applications.

The aforementioned qualifications, which are derived from the international domain-specific reference framework for Physics, apply to all specialisations of the MSc Astronomy. For the 4 research-oriented specialisations they are complete. The three society-oriented specialisations have the following additional qualifications:

<b>Business Studies</b>
BS1- Insight in managerial issues related to knowledge-intensive businesses and basic theoretical skills in business disciplines most relevant to working in these businesses; BS2- The ability to make a plan for a new business or an innovation project; BS3- Experience with performing business activities in an existing company or organization or directed towards technology-based business creation.
<b>Science Communication and Society</b>
SCS1- Knowledge of and skills in science communication theory and methods ; SCS2- Experience in science communication practice; SCS3- Knowledge of ethical, historical and social aspects in the area of the natural sciences.
<b>Education</b>
EDU1- all qualifications necessary for teaching all years of secondary education and technical and vocational training (students from 12 to 18 years old);

The general qualifications of Faculty of Science are linked to the final learning outcomes of the programme as depicted below:

Final qualifications of Faculty of Science	Final learning outcomes MSc Astronomy
<b>A. Knowledge and understanding</b>	
A graduate has: * the ability to interrelate and integrate various areas of the discipline;	A1, A2, and A3
<b>B. Applying knowledge and understanding</b>	
* theoretical and/or practical skills in more than one specialist area of the discipline such that they can carry out research under overall supervision; * the ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, formulate verifiable hypotheses, and set up and carry out research and critical reflection on one's own research and that of others;	B1, B2, B3, B4, B5, and B6

C. Judgement	
* sufficient understanding of the social role of the natural sciences to be able to reflect upon them and in part consequently to come to an ethically sound attitude and corresponding execution of one's professional duties;	C1, C2, C3, and C4
D. Communication	
* the ability to present clearly, verbally as well as in writing, one's own research results, and the ability to communicate with colleagues and to present their research results as a contribution to a congress or as (part of) a scientific publication;	D1 and D2
E. Learning (Skills)	
* the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous.	E1, E2, and E3

#### 1.4 Start of the programme (Course and Examination Regulations art. 2.6)

Students can start their programme in September or February.

## 2. Curriculum (Course and Examination Regulations chapter 3)

The duration of the programme is two years (120 EC). For all specialisations, the selection of course work and research projects requires prior approval by the MSc Study Advisor. In individual cases a course from a different programme or field of study may be elected, but only after prior written approval from the Board of Examiners. In this case, the student should first discuss the course of choice with the MSc Study Advisor, and obtain agreement to proceed. Subsequently the chairman of the Board of Examiners may be contacted to seek the required official approval. At the start of the Master's Programme, the student and the MSc Study Advisor together draw up a complete list of planned courses and projects (the Master Study Plan). Changes in the Master Study Plan in the course of the programme are possible at any time, but always require prior approval by the Study Advisor.

### 2.1 Types of courses

A variety of courses is given each year. Specifics for all courses can be found in the E-prospectus. Courses are given at different intervals: once per year, once per 18 months, once per two years, or at irregular intervals. Students must therefore always consult the long-term teaching schedule (which is published in the E-prospectus and specifies the course schedule for the current and next year) when making their Master Study Plan. Courses are classified as follows:

**Astronomy Core Courses** (6 EC each): these are offered at regular intervals.

1. Origin and Evolution of the Universe;
2. Large Scale Structure and Galaxy Formation;
3. Stellar Structure and Evolution;
4. Interstellar Medium.

Students (in any specialisation) who enrolled in the programme in February 2018 or earlier, may also chose the course "Galaxies: Structure, Dynamics and Evolution" as a core course.

**General Astronomy Courses** (6 EC each): these vary with time, and are offered at regular or sometimes irregular intervals. Examples include:

1. Galaxies: Structure, Dynamics and Evolution;
2. Star and Planet Formation;
3. Computational Astrophysics;

**Instrumentation-related Astronomy Courses** (6 or 3 EC each): these vary with time, and are offered at regular or sometimes irregular intervals. Examples include:

1. Astronomical Telescopes and Instruments;
2. Detection of Light a (3 EC) or a+b (6 EC);

3. Radio Astronomy;
4. Astronomy from Space;
5. High Contrast Imaging;
6. Project Management for Scientists;

**Specialist Astronomy Courses** (6 or 3 EC each): these vary with time and are offered at regular or irregular intervals; these courses provide in-depth introductions to specialised topics. Examples include:

1. Observational Cosmology;
2. Astrochemistry;
3. High-energy Astrophysics;
4. Gravitational Lensing;
5. Compact Objects and Accretion;
6. Modern Astrostatistics;
7. Deep Learning in Astronomy;
8. Astronomical Spectroscopy;
9. Numerical Recipes in Astrophysics;
10. Exo-planets Interiors and Atmospheres.

**Non-Astronomy Courses**; these must be selected from the courses offered by the Leiden MSc programmes in Physics, Mathematics, or Computer Science.

**Astronomy Research Projects.** Students in the specialisations “Astronomy Research”, “Astronomy and Cosmology”, “Astronomy and Data Science”, and “Astronomy and Instrumentation” carry out two astronomy research projects: the First Research Project and the Master’s Research Project. Students in the Business Studies, SCS or EDU specialisations carry out only the Master’s Research Project. All research projects have a total credit of 30 EC. For the First and Master’s Research Project, the total credit includes 27 EC Research and 3 EC Thesis.

All research projects are carried out under the supervision of a member of the scientific staff. The First and Master’s Research Projects must be on different topics. The Master’s Research Project can be started only after completion of the First Research Project (if that forms part of the programme). The maximum duration in calendar time of any Research Project is 9 months. However, if the First Research Project is started before November 1 of the first year, the deadline is extended to August 1 for students who started the programme in September. For students who started the programme in February this deadline is extended to January 1 if the First Research Project is started before April 1 of the first year.

In the specialisations Astronomy Research, Astronomy and Cosmology, Astronomy and Data Science, and Astronomy and Instrumentation, it may be possible to carry out the Master’s Research project at a university abroad. This requires explicit permission from both the Study Advisor and Board of Examiners, and a Master Study Plan that allows for an extended stay abroad without causing delays to the study programme. Furthermore, it requires 2 supervisors: 1 in Leiden and 1 at the institute abroad. This option is only open to students who have no delays in their programme and with a grade-point average of at least 8.

Every student should deliver a Student Colloquium, as listed in the programs specified below. For the specialisations Astronomy Research, Astronomy and Data Science, Astronomy and Cosmology, Astronomy and Instrumentation, and Astronomy and Education, this colloquium should describe the Master’s Research Project. For the other specialisations, the colloquium can describe either the Master’s Research Project, or another research project or internship carried out in the context of the specialisation.

### 3. Specialisation Astronomy Research

#### 3.1 Description (Course and Examination Regulations chapter 2)

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 allows the broadest programme, including a significant component from adjacent fields (Physics, Mathematics, and Computer

Science). As such it prepares the student as much for a career in research as for a career outside academia.

### 3.2 Programme (Course and Examination Regulations chapter 3)

The requirements for the programme (120 EC) are as follows:

	Level	EC
<i>Choice of</i> Astronomy core courses, at least:	500	18
<i>Choice of</i> Instrument-related courses, at least:	400-500	6
<i>Choice of</i> Astronomy courses of any type	400-500	12
<i>Choice of</i> Non-Astronomy courses	400-500	24
First Astronomy research project	500	30
Master's Astronomy research project	600	30
Student Colloquium	600	-

The following remarks apply:

1. The First Research Project has to be done in the 1<sup>st</sup> year of the programme, while the Master's Research Project has to be done in the 2<sup>nd</sup> year.
2. One of the two courses "Science and the Public: Contemporary and Historical Perspectives" and "Science Methodology" may also be chosen as a non-Astronomy course.
3. The programme may be adapted for Master's students who have not followed the Leiden Astronomy Bachelor programme. Upon recommendation by the MSc Study Advisor and written approval by the Board of Examiners, the First Research Project can be reduced to a weight not smaller than 21 EC with a simultaneous increase in the number of courses in Astronomy. These additional courses can be selected from the normal courses in the Master's curriculum, and the BSc course Radiative Processes. These students may also add Astronomy courses at the cost of the non-Astronomy courses, in consultation with the MSc Study Advisor and approval by the Board of Examiners.
4. Students who have not followed the Leiden Bachelor programme and therefore not the BSc course "Radiative Processes" or an equivalent course, may take this course in the MSc programme, as a general or specialised astronomy course.

## 4. Specialisation Astronomy and Data Science

### 4.1 Description (Course and Examination Regulations chapter 2)

The 2-year programme Astronomy and Data Science offers the student the option to follow a Research Master in Astronomy with a particular focus on the big data and computation aspects of both astronomy (as a data-rich science) and computer science. It prepares as much for a career in astronomy as in computational science, and for careers in research as well as outside research, in academia or elsewhere in society. It consists of advanced Astronomy courses, two research projects in Astronomy, and selected courses from the Computer Science MSc programme. This specialisation is offered by Leiden Observatory in collaboration with the Leiden Institute of Advanced Computer Science (LIACS) of Leiden University.

### 4.2 Programme (Course and Examination Regulations chapter 3)

The requirements for the programme (120 EC) consist of 60 EC of courses, and 60 EC of research projects, as follows:

	Level	EC
<i>Mandatory courses</i>		
Modern Astrostatistics	500	3
<i>Choice of</i> Astronomy core courses	500	18
<i>Choice of</i> Instrument-related courses	400-500	3-6

<i>Choice of</i> Astronomy courses of any type	400-500	9-12
<i>Choice of</i> four of the following six courses (24 EC total)		
Computational Astrophysics	500	6
Numerical Recipes in Astrophysics	500	6
Advanced Data Management for Data Analysis (Computer Science)	500	6
Advances in Data Mining (Computer Science)	500	6
Deep Learning and Neural Networks (Computer Science)	500	6
Reinforcement Learning (Computer Science)	500	6
First Astronomy research project	500	30
Master's Astronomy research project	600	30
Student Colloquium	600	-

The following remarks apply:

1. In the programme listed above, the courses labelled “Computer Science” are offered by the Leiden Institute for Advanced Computer Science.
2. The First Research Project has to be done in the 1<sup>st</sup> year of the programme, while the Master's Research Project has to be done in the 2<sup>nd</sup> year. The Master's Research Project must involve data manipulation (which may be simulated data) and/or data-related computational or statistical aspects.
3. One of the two courses “Science and the Public: Contemporary and Historical Perspectives”, “Science Methodology” may also be chosen as a general/specialist/instrumentation Astronomy course.
4. The programme may be adapted for Master's students who have not followed the Leiden Astronomy Bachelor programme. Upon recommendation by the MSc Study Advisor and written approval by the Board of Examiners, the First Research Project can be reduced to a weight not smaller than 21 EC with a simultaneous increase in the number of courses in Astronomy. These additional courses can be selected from the normal courses in the Master's curriculum, and the BSc course Radiative Processes.
5. Students who have not followed the Leiden Bachelor programme and therefore not the BSc course “Radiative Processes” or an equivalent course, may take this course in the MSc programme, as a general or specialised astronomy course.

## 5. Specialisation Astronomy and Instrumentation

### 5.1 Description (Course and Examination Regulations chapter 2)

The specialisation “Astronomy and Instrumentation” offers the student the option to conduct a Research Master in Astronomy with a particular focus on advanced astronomical instrumentation, techniques, and instrument development. It prepares the student as much for a career in research as for a career outside academia.

### 5.2 Programme (Course and Examination Regulations chapter 3)

The requirements for the programme (120 EC) are as follows:

	Level	EC
<i>Mandatory Courses:</i>		
Astronomical Telescopes and Instruments	500	6
Detection of Light a+b	500	6
<i>Choice of</i> Astronomy core courses, at least:	500	6
<i>Choice of</i> core/general/specialist Astronomy courses	400-500	24-30
<i>Choice of</i> instrumentation-related Astronomy courses	400-500	12-18
First Research Project in Instrumental or General Astronomy	500	30

Master's Astronomy Research Project in Instrumental Astronomy	600	30
Student Colloquium	600	-

The following remarks apply:

1. Students who have not followed the Leiden Bachelor programme and therefore not the BSc course "Radiative Processes" or an equivalent course, may take this course in the MSc programme, as a general or specialised astronomy course.
2. The following courses offered by Delft Technical University may be included as instrumentation-related courses in the above programme:
  - a. Space Instrumentation (AE4880; 4 EC)
  - b. Space Systems Engineering (AE4S12; 3 EC)
  - c. Geometrical Optics (AP3392; 6 EC)
  - d. Advanced photonics (AP3382; 6 EC)
  - e. Imaging systems (AP3221 D; 6 EC)
3. Up to 12 EC of the general/specialist Astronomy courses may be replaced by non-astronomy courses, to be taken from the MSc programs in Mathematics, Physics, or Computer Science; among these 12 EC the student may choose one of the two courses "Science and the Public: contemporary and historical perspectives", "Science Methodology".
4. The 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 Technical Physics labs, or at external organisations directly involved in astronomical instrumentation.

## 6. Specialisation Astronomy and Cosmology

### 6.1 Description (Course and Examination Regulations chapter 2)

The specialisation "Astronomy and Cosmology" offers the student the possibility to conduct a Research Master in Astronomy with a particular focus on modern observational and theoretical cosmology. This specialisation is offered by Leiden Observatory in collaboration with the Institute Lorentz for Theoretical Physics in the Department of Physics at Leiden University (LION).

### 6.2 Programme (Course and Examination Regulations chapter 3)

The requirements for the programme (120 EC) are as follows:

	Level	EC
<i>Mandatory Astronomy Courses:</i>		
Origin and Evolution of the Universe	500	6
Large Scale Structure and Galaxy Formation	500	6
<i>Choice of:</i>		
Astronomy core courses	500	6
Astronomy courses of any type	400-500	18
<i>Mandatory Physics Courses:</i>		
Particle Physics and Early Universe	500	3
Origin and Structure of the Standard Model	400	3
Theory of General Relativity	400	6
<i>Choice of:</i>		
Related Physics courses	400-500	12
First Research Project in Cosmology <i>or</i> General Astronomy	500	30
Master's Astronomy Research Project in Cosmology	600	30
Student Colloquium	600	-

The following remarks apply:

1. Students who have not followed the Leiden Bachelor programme and therefore not the BSc course “Radiative Processes” or an equivalent course, may take this course in the MSc programme, as a general or specialised astronomy course.
2. For students who successfully completed the 6 EC version of the course Particle Physics and the Early Universe (which was offered in previous years), this is considered to be equivalent to the 3 EC version plus the course Origin and Structure of the Standard Model.
3. Related Physics courses are Effective Field Theory, Quantum Field Theory, Statistical Physics, Topics in Theoretical Physics, Black Holes and Gravitational Waves and Theoretical Cosmology.

## 7. Specialisation Business Studies

### 7.1 Description (Course and Examination Regulations chapter 2)

The specialisation Astronomy and Business Studies (BS) offers students the possibility to combine astronomy with knowledge, insights and skills in the area of Management, Business, New Technology Ventures, and Entrepreneurship. Students are encouraged to broaden their horizon, to form an opinion on and prepare for a career in industry and to enhance competences for pursuing entrepreneurial business opportunities created in science and research.

Students who complete the specialisation Astronomy and Business Studies are admissible to a PhD programme in Astronomy.

### 7.2 Programme (Course and Examination Regulations chapter 3)

The Astronomy and Business Studies (BS) programme consists of:

- a Master’s Research Project (30 EC) supervised by a member of the Leiden Observatory scientific staff;
- 30 EC of courses to be selected in correspondence with the research topic; these should at least include:
  - two Astronomy core courses; and
  - 6-12 EC of non-Astronomy courses, to be taken from the programmes of Physics, Mathematics or Computer Science; and
  - ‘6-12 EC of (non-) Astronomy courses related to the research topic’.
- a maximum of 20 EC of electives within either Astronomy or the BS component;
- the Management or New Technology Ventures track as described [here](#).
- a Student Colloquium, on either the Master’s Research Project or the BS internship or research project.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

## 8. Specialisation Science Communication and Society

### 8.1 Description (Course and Examination Regulations chapter 2)

The specialisation Astronomy and Science Communication and Society (SCS) offers students the possibility to combine astronomy and science communication. Students are prepared for a career in popularisation of science or for a career as a scientist with a communicating mind-set.

Students who complete the specialisation Astronomy and Science Communication and Society are admissible to a PhD programme in astronomy or in science communication.

## 8.2 Programme (Course and Examination Regulations chapter 3)

The Astronomy and Science Communication and Society (SCS) programme consists of:

- a Master's Research Project (30 EC) supervised by a member of the Leiden Observatory scientific staff;
- 30 EC of courses to be selected in correspondence with the research topic; these should at least include:
  - two Astronomy core courses; and
  - 6-12 EC of non-Astronomy courses, to be taken from the programmes of Physics, Mathematics or Computer Science; and
  - '6-12EC of (non-) Astronomy courses related to the research topic'.
- a maximum of 20 EC of electives within either Astronomy or the SCS component;
- the Science Communication and Society component as described [here](#).
- a Student Colloquium on either the Master's Research Project or on the internship or research project carried out for the SCS component of the program.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

## 9. Specialisation Education

### 9.1 Description (Course and Examination Regulations chapter 2)

The specialisation Astronomy and Education (EDU) prepares students for a career as physics (natuurkunde) teacher qualified to teach in Dutch secondary education.

Students who complete the specialisation Astronomy and Education are admissible to a PhD programme in Astronomy.

### 9.2 Programme (Course and Examination Regulations chapter 3)

The Astronomy and Education (EDU) programme consists of:

- a Master's Research Project (30 EC) supervised by a member of the Leiden Observatory scientific staff;
- 30 EC of courses to be selected in correspondence with the research topic; these should at least include:
  - two Astronomy core courses; and
  - 6-12 EC of non-Astronomy courses, to be taken from the programmes of Physics, Mathematics or Computer Science; and
  - '6-12EC of (non-) Astronomy courses related to the research topic'.
- the Education component as described on [here](#).
- a Student Colloquium on the Master's Research Project.

The Astronomy component of the programme will be followed during the first year of study, the Education component will be followed during the second year.

When the student has passed the minor Education (30 EC) during the BSc programme, the compulsory Education component is reduced by 30 EC. The remaining 30 EC can be used for either the Astronomy or the Education component of the MSc programme.

A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found [here](#).

## 10. Admission to the programme (Course and Examination Regulations chapter 5)

### 10.1 Confirmation of admission

10.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 10.2 and 10.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 10.2.1, the proof of registration is also confirmation of admission.

10.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.<sup>1</sup>

### 10.2 Admission to the programme

10.2.1 In accordance to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a) holders of a bachelor's degree in Astronomy (Sterrenkunde) from a research university in the Netherlands, or
  - b) holders of a bachelor's degree in an astronomy-related programme from a research university in the Netherlands or from a foreign university of similar level, under the provisions mentioned below. For admission to any of the research-based specialisations of this master this under the provision that the bachelor's programme has provided the candidate with in-depth knowledge of undergraduate courses of the Astronomy curriculum (referred to under a.) with a theoretical and mathematical emphasis, including quantum physics, electrodynamics, statistical physics, and complex analysis. And with proficiency in programming, preferably in the Python language,
- or,
- c) students who have successfully met the requirements of the imposed bridging programme on the basis of Article 10.4.1

10.2.2 The Board of Admissions may, upon request, admit persons to the programme who do not meet the requirements specified in 10.2.1, sub-sections a and b, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 10.2.1, sub-sections a and b, possibly under further conditions, without prejudice to the conditions specified in 10.2.4.

#### *Admission process*

The admission process may include an interview with the Board of Admissions, should this be necessary to clarify whether the applicant has the same level of knowledge, understanding and skills as holders of a degree specified in 10.2.1.a

### 10.2.3 Dutch and English languages<sup>2</sup>

10.2.3.1 As further clarification of Article 2.8 (see Faculty part of these regulations) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (or other with English A);

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<sup>1</sup>[Regulations for Admission to Master's Programmes](#)

<sup>2</sup> Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

- A diploma of secondary or higher education completed in the US, the United Kingdom, Ireland, New Zealand, Australia or Canada (with the exception of French-taught education in Canada);
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A pre-university education (vwo) diploma.
- A high school (or higher) diploma determined by SEA (Admissions Office) in an EER country, where English has been studied up to and including the final year of the programme, and where the level of English can be considered comparable to Dutch vwo (pre-university education).

10.2.3.2 If a student who wishes to be admitted does not meet the requirements in 10.2.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90
- Cambridge Certificate of Advanced English (CAE), minimum grade C

10.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*. This applies to the Education specialisation of this master's programme.

#### 10.2.4 Qualitative admission requirements

10.2.4.1 In addition to the requirements specified in 10.2.1 and 10.2.2, the following qualitative admission requirements apply for the programme in accordance to Article 7.30b (2) of the Act:

For the specialisation "Astronomy and Cosmology" the following qualitative admission requirements apply:

- knowledge of "Physics of elementary particles" at undergraduate level is required.

For the specialisation "Astronomy and Instrumentation":

- knowledge of "Solid state Physics" at undergraduate level is recommended (i.e. not an admission requirement)

#### 10.3 Deficiencies

10.3.1 Holders of a bachelor's degree from a research university, referred to in 10.2.1, subsections a and b, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

10.3.2 Students who still have the deficiencies referred to in 10.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

10.3.3 For the admission referred to in 10.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

10.3.4 If a student is admitted to the programme on the basis of 10.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

#### 10.4 Bridging programmes (Pre-master's)

10.4.1 The department has developed the following bridging programmes (for the following target groups) in order to remove deficiencies:

- a. For students with a BSc degree in Aerospace Engineering from Delft University of Technology, the Pre-Master's programme will consist of the following elements from the BSc programme Astronomy:

	<b>Level</b>	<b>EC</b>
Stars	300	5
Galaxies and Cosmology	300	5
Astronomy Lab and Observing Project	200	5
Astronomical Observing Techniques	300	5
Quantum Mechanics 1	200	6
Radiative Processes	300	6

The course Quantum Mechanics 1 may be replaced by the two courses Kwantummechanica 1 (TN 2304; 3 EC) and Kwantummechanica 2 (TN 2314; 3 EC) offered at Delft Technical University.

- b. For students with other bachelor's degrees the Board of Admissions may impose a Pre-Master's programme, tailored to the individual background of the prospective student, before admission into the MSc programme.

10.4.3 Information on the bridging programmes can be found on [Pre-Master's information page](#)

# MSc Bio-Pharmaceutical Sciences

CROHO-number 60207

## 1. Description of the programme (Course and Examination Regulations chapter 2)

The programme Bio-Pharmaceutical Sciences is taught in Leiden by the Leiden Academic Centre for Drug Research (LACDR).

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. 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. Exceptions to this are formed by the specialisations Business Studies, SCS and EDU. For the specialisations-specific part they have their own coordinator and Board of Examiners. For Business Studies the Board of Examiners is mandated by the Board of Examiners of Bio-Pharmaceutical Sciences. The Board of SCS is appointed by the Faculty of Science. The Board of EDU is appointed by a composed board of multiple faculties.

Students who complete any of the specialisations in Bio-Pharmaceutical Sciences are admissible to a PhD programme in Bio-Pharmaceutical Sciences or other Life Sciences.

### 1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

The aim of the MSc programme Bio-Pharmaceutical Sciences (BPS), organised by the Leiden Academic Centre for Drug Research (LACDR) of Leiden University, is to train students for a research career in drug research and development, not for a career as a (public) pharmacist. The general objective of the MSc programme BPS is to teach the master's student sufficient knowledge, insight, and skills to work independently at an academic level as a drug researcher, to contribute in an original manner to recognizing, introducing and solving questions in a specific knowledge area related to drug research, to discuss this contribution with experts in the field, to inform non-specialists about their ideas, goals and the public impact of their research.

### 1.2 Specialisations (Course and Examination Regulations art. 2.2)

The MSc programme BPS offers seven specialisations. Three of these are research specialisations corresponding to major research themes at the LACDR: Drug Discovery and Safety, Systems Biomedicine and Pharmacology, and BioTherapeutics. The remaining four specialisations combine Bio-Pharmaceutical research with training in Business Studies (BS), Science Communication and Society (SCS), Education (EDU), or Industrial Pharmacy (IP).

### 1.3 Learning outcomes (Course and Examination Regulations art. 2.3)

Graduates of the MSc programme BPS have reached the following general achievement levels:

- a. Theoretical and practical skills in more than one specialist area of drug research such that (s)he can carry out research under overall supervision, specifically the graduate has knowledge and understanding of
  - the core concepts and principles and recent developments in more than one specialist area of drug research
  - and is skilled in commonly used and state-of-the art practical and/or computational research methods in a specialised area of drug research
  - the principles of responsible scientific conduct and the regulations in relation to his/her specialist drug research areas.
- b. The ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, formulate verifiable hypotheses, and set up and carry out research and critical reflection on one's own research and that of others, specifically the graduate is able to

- apply knowledge, insights and skills to work independently as a drug researcher at an academic level
  - contribute, in an original manner, to define and solve questions in a specific drug research knowledge area
  - draw up a research plan in which the research questions, the hypothesis and the experimental design are related to relevant literature and relevant previous research and is able to present and defend the plan against the opinion of professional colleagues
  - process, critically analyse, and interpret experimental and/or computational data.
- c. The ability to interrelate and integrate various areas of drug research, specifically the graduate is able to
- interrelate and integrate various areas of drug research and reflect on his/her research and that of others
- d. The ability to present clearly, verbally as well as in writing, one's own research results, and the ability to communicate with colleagues and to present his/her research results as a contribution to a congress or as (part of) a scientific publication, specifically the graduate is able to
- co-operate in a multi-disciplinary team on (bio)pharmaceutical-oriented research questions
  - participate in scientific discussions on drug research-related topics with scientific peers
  - provide a clear, structured oral presentation on the background, hypothesis, purpose of his/her research, experimental design, and on the obtained results, interpretation and conclusions, that is adjusted to the level of the target audience
  - communicate in writing on the background, hypothesis, purpose of his/her research, experimental design, and on the obtained results, interpretation and conclusions in the form of a scientific article according to the standards of an international peer-reviewed journal in the field.
- e. Sufficient understanding of the social role of drug research to be able to reflect upon them and in part consequently to come to an ethically sound attitude and corresponding execution of one's professional duties. Specifically the graduate is able to
- critically assess the significance for society and the applicability of his/her own research results and that of scientific literature
  - judge any conflicts of interest and other factors that may influence the trustworthiness of his/her research and/or the presentation of his/her research
  - judge and critically reflect on the scientific, ethical, societal and economic consequences of drug research.
- f. Learning skills to allow him/her to continue to study in a manner that may be largely self-directed or autonomous. Specifically, the graduate
- is able to study in a manner that is largely self-directed or autonomous and is able to make conscious choices for his/her own professional development
  - has the academic competences for employment as a drug researcher at an academic institution or in (bio)pharmaceutical/life science industry
  - is aware of the necessity to keep up-to-date on recent developments for his/her research
  - is able to independently acquire in-depth expert understanding in an unfamiliar drug research subject area by critical review of scientific literature.

#### **1.4 Start of the programme (Course and Examination Regulations art. 2.6)**

Starting the programme is only possible in September or February.

## 2. Admission to the programme (Course and Examination Regulations chapter 5)

### 2.1 Confirmation of admission

2.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 2.2 and 2.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 2.2.1, the proof of registration is also confirmation of admission.

2.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.<sup>3</sup>

### 2.2 Admission to the programme

2.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a. holders of a bachelor's degree in Bio-Pharmaceutical Sciences (Bio-farmaceutische wetenschappen) from a research university in the Netherlands, or
- b. holders of a bachelor's degree in a programme related to Bio-Pharmaceutical Sciences from a research university in the Netherlands or from a foreign research university of similar level, provided that the candidate has accumulated at least 150 EC (or the equivalence thereof) in courses/projects belonging to the domain of Bio-Pharmaceutical Sciences and has had basic research training in the field of life science including a 16 EC, level 400 (or equivalent) final research assignment, covering all aspects of the research cycle and being concluded with a research thesis written in academic English, and an oral presentation.

Article 2.2.1 b) may, amongst others, apply to holders of a degree from a research university in Biology, Biomedical Sciences, Chemistry, Informatics with the specialisation Informatics & Biology, Life Science and Technology, and Pharmaceutical Sciences.

2.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in 2.2.1, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 2.2.1, possibly under further conditions.

Article 2.2.2 may, amongst others, apply to holders of a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo) in Chemistry or Biomedical Sciences (or equivalent field of science). As a guideline for applicants with a degree from a Dutch University of Applied Sciences (hbo/HLO), the degree must have been obtained within four years with a grade point average (GPA) above 7.5. In addition, the research project that was included in the (hbo/HLO) programme must have been conducted at a research university or a university medical centre and must have been assessed with a grade above 8.0 (grades according to the Dutch grading scale).

#### *Admission process*

Applicants as referred to in Article 2.2.1.b and Article 2.2.2. are requested to provide the Board of Admissions with a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified 2.2.1.a.

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<sup>3</sup>[Regulations for Admission to Master's Programmes](#)

The admission process may include an interview with the Board of Admissions, should this be necessary to clarify whether the applicant has the same level of knowledge, understanding and skills as holders of a degree specified in 2.2.1.a.

#### 2.2.4 Dutch and English languages<sup>4</sup>

2.2.4.1 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (or other with English A);
- A diploma of secondary or higher education completed in the US, the United Kingdom, Ireland, New Zealand, Australia or Canada (with the exception of French-taught education in Canada);
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A pre-university education (vwo) diploma.
- A high school (or higher) diploma determined by SEA (Admissions Office) in an EER country, where English has been studied up to and including the final year of the programme, and where the level of English can be considered comparable to Dutch vwo (pre-university education).

2.2.4.2 If a student who wishes to be admitted does not meet the requirements in 2.2.4.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90
- Cambridge Certificate of Advanced English (CAE), minimum grade C

2.2.4.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*. This applies to following specialisations of this master's programme:

- Industrial Pharmacy
- Education

#### 2.2.5 Maximum capacity

2.2.5.1 If the Executive Board has determined a maximum capacity for the programme, the order of admission will be determined by the qualitative admission requirements as referred to in sub-article 2.2.4.

2.2.5.2 Admission to the specialization in Industrial Pharmacy is limited to two students in the academic year 2020-2021.

2.2.5.3 Where article 2.2.5.1 applies, the method of selection on the grounds of the criteria will be as follows:

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<sup>4</sup> Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

With respect to qualification for the specialization in Industrial Pharmacy the Board of Admissions will judge the following personal skills and traits:

- awareness of responsibility
- accuracy
- communication skills
- methodological approach when analyzing complex problems
- motivation

2.2.5.4 Where article 5.2.5.1 applies, the deadlines for selection are as follows:

Application for the master specialisation Industrial Pharmacy should be done before April 1, 2020. A final decision on admission to the specialisation Industrial Pharmacy will be made after completion of at least half of ( $\geq 22$  EC) of the research project at one of the research Divisions of the LACDR (Research Project 1).

## 2.3 Deficiencies

2.3.1 Holders of a bachelor's degree from a research university, referred to in 2.2.1, subsections a and b, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

2.3.2 Students who still have the deficiencies referred to in 2.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

2.3.3 For the admission referred to in 2.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

2.3.4 If a student is admitted to the programme on the basis of 2.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

## 2.4 Bridging programmes (Pre-master's)

For students with bachelor's degrees related to Bio-Pharmaceutical Sciences the Board of Admissions may impose a Pre-Master's programme, tailored to the individual background of the prospective student, before admission into the MSc programme.

# 3. Examinations, Final Examination (Course and Examination Regulations chapter 4)

## 3.1 Obligatory sequence (Course and Examination Regulations art. 4.2)

3.1.1 Students may only take the following courses and sit their attendant examinations once they have passed the examinations for one or more other components:

<i>Programme component:</i>	<i>Follow course and sit its attendant examination after having passed:</i>
Literature study	Research project 1
Specialisation	Research project 1

- 3.1.2 For the components and their attendant examinations which must be completed in a given sequence, the Board of Examiners may in special cases, and following a substantiated written request by the student, agree to an alternative sequence.

## 4. Programmes of the specialisations

The aim of each programme is to train the student as an independent researcher in Bio-Pharmaceutical Sciences, and to develop the necessary skills and proficiency to advance their career.

## 5. Specialisation Drug Discovery and Safety

The MSc specialisation Drug Discovery and Safety offers research-orientated education into the discovery of new drug targets and new lead molecules, particularly in the field of cancer. For identification of novel drug targets and development of novel, highly effective and safe drug leads students are trained in advanced imaging techniques ('systems microscopy'), in vitro and in vivo model systems, organic synthesis, molecular biology, pharmacology, and computational approaches (chem- and bioinformatics and computational biology). The Division Drug Discovery and Safety of the Leiden Academic Centre for Drug Research, and the Division of Bio-organic Synthesis of the Leiden Institute of Chemistry (LIC), are involved in the MSc specialisation Drug Discovery and Safety. Admission to this specialisation may be restricted by available places.

### 5.1 Learning outcome (Course and Examination Regulations art. 2.3)

In addition to the general achievements, graduates of the MSc programme BPS with the specialisation Drug Discovery and Safety have obtained in-depth knowledge of a specific subject related to the discovery of novel drug targets and new lead molecules.

### 5.2 Programme (Course and Examination Regulations chapter 3)

The programme contains two research periods (51 and 36 EC), and compulsory and optional programme components (33 EC):

	Level	EC
Introduction Course BPS: Drug Discovery and Safety	500	4
Lecture series (in BPS)	500	4
Research Project 1, in		
• Literature research, practical implementation and performance	600	44
• Thesis	600	5
• Oral presentation	500	2
Research Project 2		
• Literature research, practical implementation and performance	600	31
• Thesis	600	5
Literature Study	500	7
Advanced Academic Skills and Career Orientation	500	3
Optional courses or traineeships	≥400 (max 12 EC <400 <sup>5</sup> )	15

<sup>5</sup> Permission from the Board of Examiners is required for courses with level 100 or 200 and for courses of which the level is not explicitly given, e.g. courses offered by other universities and institutions of higher education.

### **Research Project 1**

Research Project 1 must be conducted within the Division Drug Discovery and Safety of the LACDR, or Bio-organic Synthesis (LIC). After approval by the Board of Examiners, research project 1 can also take place in the research area of Drug Discovery and Safety at external research groups to which LACDR professors are affiliated or under the supervision of a staff member of the LACDR.

### **Research Project 2**

Research Project 2 may be conducted within the Faculty of Science in another discipline of BPS or, at the Center for Human Drug Research, the Leiden University Medical Center, other University Medical Centers or health research institutes, or at an R&D Department of a (Bio-)Pharmaceutical company. Students are encouraged to go abroad for Research Project 2. All projects outside the LACDR require permission from the Board of Examiners and the Director of Education *before the start* of the project.

### **Literature Study**

The Literature Study must be conducted under supervision of another Principal Investigator than of the Research Project 1 and 2. Otherwise, permission from the Board of Examiners is required. The Literature Study is completed with a written thesis.

## **6. Specialisation Systems Biomedicine and Pharmacology**

The MSc specialisation Systems Biomedicine and Pharmacology offers research-orientated education into understanding and predicting drug-induced modulation of disease networks at the systems level. Systems Biomedicine and Pharmacology offers a unique combination of cutting-edge experimental training in the field of metabolomics and translational systems biology as well as quantitative pharmacology education in the area of computational modelling of pharmacokinetic and pharmacodynamic (PK/PD) relationships. The Division Systems Biomedicine and Pharmacology of the Leiden Academic Centre for Drug Research, and the Center for Human Drug Research (CHDR), are involved in the MSc specialisation Systems Biomedicine and Pharmacology. Admission to this specialisation may be restricted by available places.

### **6.1 Learning outcome (Course and Examination Regulations art. 2.3)**

In addition to general achievements, graduates of the MSc programme BPS with the specialisation Systems Biomedicine and Pharmacology have obtained in-depth knowledge of a specific subject related to the understanding or the predicting of drug-induced modulation of disease networks at the systems level.

### **6.2 Programme (Course and Examination Regulations chapter 3)**

The programme contains two research periods (51 and 36 EC), and compulsory and optional programme components (33 EC):

	<b>Level</b>	<b>EC</b>
Introduction Course BPS: Systems Biomedicine and Pharmacology	500	4
Lecture series (in BPS)	500	4
Research Project 1, in Systems Biomedicine and Pharmacology		
• Literature research, practical implementation and performance	600	44
• Thesis	600	5
• Oral presentation	500	2
Research Project 2		

• Literature research, practical implementation and performance	600	31
• Thesis	600	5
Literature Study	500	7
Advanced Academic Skills and Career Orientation	500	3
Optional courses or traineeships	≥400 (max 12 EC <400 <sup>6</sup> )	15

### **Research Project 1**

Research Project 1 must be conducted within the Division Systems Biomedicine and Pharmacology of the LACDR, or the CHDR. After approval by the Board of Examiners, Research Project 1 can also take place in the research area of Drug Discovery and Safety at external research groups to which LACDR professors are affiliated or under the supervision of a staff member of the LACDR.

### **Research Project 2**

Research Project 2 may be conducted within the Faculty of Science in another discipline of BPS or in another MSc programme, or at the Center for Human Drug Research, the Leiden University Medical Center, other University Medical Centers or health research institutes, or at an R&D Department of a (Bio-)Pharmaceutical company. Students are encouraged to go abroad for Research Project 2. All projects outside the LACDR require permission from the Board of Examiners and the Director of Education *before the start* of the project.

### **Literature Study**

The Literature Study must be conducted under supervision of another Principal Investigator than of the Research Project 1 and 2. Otherwise, permission from the Board of Examiners is required. The Literature Study is completed with a written thesis.

## **7. Specialisation BioTherapeutics**

### **7.1 Description (Course and Examination Regulations chapter 2)**

The MSc specialisation BioTherapeutics offers research-orientated education into the development of new therapeutic approaches to treat immune-based disorders, such as atherosclerosis, metabolic disorders and inflammatory skin diseases. Focus is on state-of-the-art therapies using novel biologicals, such as tolerogenic vaccines, therapeutic proteins and peptides, and gene therapy. The Division BioTherapeutics of the Leiden Academic Centre for Drug Research is involved in the MSc specialisation BioTherapeutics. Admission to this specialisation may be restricted by available places.

### **7.2 Learning outcome (Course and Examination Regulations art. 2.3)**

In addition to general achievements, graduates of the MSc programme BPS with the specialisation BioTherapeutics have obtained in-depth knowledge of a specific subject related to the development of new therapeutic approaches to treat immune-based disorders, such as atherosclerosis, metabolic disorders and inflammatory skin diseases.

### **7.3 Programme (Course and Examination Regulations chapter 3)**

The programme contains two research periods (51 and 36 EC), and compulsory and optional programme components (33 EC):

	<b>Level</b>	<b>EC</b>
Introduction Course BPS: BioTherapeutics	500	4

<sup>6</sup> Permission from the Board of Examiners is required for courses with level 100 or 200 and for courses of which the level is not explicitly given, e.g. courses offered by other universities and institutions of higher education.

Lecture series (in BPS)	500	4
Research Project 1, in BioTherapeutics		
• Literature research, practical implementation and performance	600	44
• Thesis	600	5
• Oral presentation	500	2
Research Project 2		
• Literature research, practical implementation and performance	600	31
• Thesis	600	5
Literature Study	500	7
Advanced Academic Skills and Career Orientation	500	3
Optional courses or traineeships	≥400 (max 12 EC <400 <sup>7</sup> )	15

### **Research Project 1**

Research Project 1 must be conducted within the Division BioTherapeutics of the LACDR. After approval by the Board of Examiners, research project 1 can also take place in the research area of Drug Discovery and Safety at external research groups to which LACDR professors are affiliated or under the supervision of a staff member of the LACDR.

### **Research Project 2**

Research Project 2 may be conducted within the Faculty of Science in another discipline of BPS or in another MSc programme, or at the Center for Human Drug Research, the Leiden University Medical Center, other University Medical Centers or health research institutes, or at an R&D Department of a (Bio-)Pharmaceutical company. Students are encouraged to go abroad for Research Project 2. All projects outside the LACDR require permission from the Board of Examiners and the Director of Education *before the start* of the project.

### **Literature Study**

The Literature Study must be conducted under supervision of another Principal Investigator than of the Research Project 1 and 2. Otherwise, permission from the Board of Examiners is required. The Literature Study is completed with a written thesis.

## **8. Specialisation Industrial Pharmacy**

### **8.1 Description (Course and Examination Regulations chapter 2)**

The MSc specialisation Industrial Pharmacy trains students in safety and quality control in the production of medicinal products, and prepares students for a career in Quality Assurance and Quality Control in the biotechnological and pharmaceutical industry.

### **8.2 Learning outcomes (Course and Examination Regulations art. 2.3)**

In addition to general achievements, graduates of the MSc programme BPS with the specialisation Industrial Pharmacy have reached the following specific achievement levels:

- a. Industrial pharmaceutical knowledge and understanding of prerequisites for production, quality and safety management, and batch release;
- b. Experience with industrial pharmaceutical quality documentation systems;
- c. Knowledge of industrial pharmaceutical regulatory affairs and ethical issues.

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<sup>7</sup> Permission from the Board of Examiners is required for courses with level 100 or 200 and for courses of which the level is not explicitly given, e.g. courses offered by other universities and institutions of higher education.

### 8.3 Programme (Course and Examination Regulations chapter 3)

The programme contains a research project of 49 EC (consisting of 42 EC for literature research, practical implementation and performance, 5 EC for writing a thesis and 2 EC for giving an oral presentation) and other compulsory components (71 EC):

	Level	EC
Introduction Course BPS in subject of Research project 1	500	4
Lecture series (in BPS)	500	4
Research Project 1, at one of the Divisions of the LACDR		
• Literature research, practical implementation and performance	600	42
• Thesis	600	5
• Oral presentation	500	2
Advanced Academic Skills and Career Orientation	500	3
Internship Quality Control/Quality Assurance, in a Pharmaceutical Company under supervision of a Qualified Person (QP) and an examiner of the LACDR, including Practical Work, Thesis and Oral Presentation	600	37
Essay Quality Control/Quality Assurance	600	7
Course Basic Good Manufacturing Practices (GMP)	NA	1
Course Ethics in Quality Control Practices	500	1
Course Legislation of Production of Medicinal Products	600	2
Course Sterile Manufacturing in Practice	600	4
Course Quality Management in Pharma and Biotech <sup>8</sup>		
• the Role of the Qualified Person	500	2
• Drug development: from 'Quality by Design' to Clinical Studies	600	2
• Sterile Manufacturing	600	2
• Quality and Safety for the Manufacturing of Biopharmaceuticals	600	2

The programme of the specialisation Industrial Pharmacy is under development and may be subject to change.

#### Research Project 1

Research Project 1 must be conducted within any of the divisions of the LACDR or at the CHDR. Permission from the Board of Examiners and the Director of Education is required when projects are conducted within external research groups led by Professors affiliated with a division of the LACDR.

### 8.4 Additional qualifications for admission (Course and Examination Regulations chapter 5)

Master's students in Bio-Pharmaceutical Sciences of Leiden University with a BSc degree in Bio-Pharmaceutical Sciences, Pharmaceutical Sciences or Pharmacy will be considered for admittance to this specialisation of the programme. An average grade of 7.5 or higher (grades according to the Dutch grading scale) has been set as a selection criterion.

Additionally, the Board of Admissions will judge the candidate's personal skills (e.g. awareness of responsibility, accuracy, communication skills, methodological approach when analysing complex problems, and motivation) for qualification to the specialisation. Applicants must provide proof of proficiency in Dutch (TUL halfgevoerd (= staatsexamen NT2-II)). A conditional decision on admission to the specialisation Industrial Pharmacy will be made after completion of at least half ( $\geq 21$

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<sup>8</sup> PAOFarmacie: Netherlands Centre for Post-Academic Education in Pharmacy

EC) of the research project at one of the Divisions of the LACDR. If the student meets the requirements, the admission becomes unconditional after completion of Research Project 1.

The selection for this specialisation takes place in spring. Students must apply by writing a motivation letter. The Board of Admissions will invite students, who meet the requirements, for an interview after which she makes the final selection.

## 8.5 Capacity Limitation

Admission to the programme is limited to two students in the academic year 2019-2020.

# 9. Specialisation Business Studies

## 9.1 Description (Course and Examination Regulations chapter 2)

The specialisation Bio-Pharmaceutical Sciences and Business Studies (BS) offers students the possibility to combine bio-pharmaceutical sciences with knowledge, insights and skills in the area of Management, Business and Entrepreneurship.

Students are encouraged to broaden their horizon, to form an opinion on and prepare for a career in industry and to enhance competences for pursuing entrepreneurial business opportunities created in science and research.

Students who complete the specialisation Bio-Pharmaceutical Sciences and Business Studies are admissible to a PhD programme.

## 9.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to general achievements, graduates of the MSc programme BPS with the specialisation Business Studies have reached the following specific achievement levels:

- a. insight in managerial issues related to knowledge-intensive businesses and basic theoretical skills in business disciplines most relevant to working in these businesses;
- b. the ability to make a plan for a new business or an innovation project;
- c. experience with performing business activities in an existing company or organisation or directed towards technology-based business creation.

## 9.3 Programme (Course and Examination Regulations chapter 3)

The Bio-Pharmaceutical Sciences and Business Studies (BS) programme consists of:

- the Introduction Course BPS (on the subject of the research project) of 4 EC;
- a research project of 49 EC, consisting of 42 EC for literature research, practical implementation and performance, 5 EC for a thesis and 2 EC for an oral presentation and conducted within any of the divisions of the LACDR or at the CHDR; permission from the Board of Examiners and the Director of Education is required when projects are conducted within external research groups led by Professors affiliated with a division of the LACDR;
- a lecture series (in BPS) of 4 EC<sup>9</sup>;
- the Course Advanced Academic Skills and Career Orientation of 3 EC;
- a maximum of 20 EC of electives within either Bio-Pharmaceutical Sciences or the Business Studies component of the programme; and
- the Management or New Technology Ventures track<sup>10</sup> as described [here](#).

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<sup>9</sup> The choice for lecture series and research project will be made in concert with the study adviser.

<sup>10</sup> Completion of the specialisation Business Studies requires a minimum of 40 EC and a maximum of 60 EC within the BS component.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

## 10. Specialisation Science Communication and Society

### 10.1 Description (Course and Examination Regulations chapter 2)

The specialisation Bio-Pharmaceutical Sciences and Science Communication and Society (SCS) offers students the possibility to combine bio-pharmaceutical sciences and science communication.

Students are prepared for a career in popularisation of science or for a career as a scientist with a communicating mind-set.

Students who complete the specialisation Bio-Pharmaceutical Sciences and Science Communication and Society are admissible to a PhD programme in bio-pharmaceutical sciences or in science communication.

### 10.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to general achievements, graduates of the MSc programme BPS with the specialisation Science Communication and Society have reached the following specific achievement levels:

- a. Knowledge and understanding of modern information and communication technology;
- b. Experience in science communication;
- c. Knowledge of ethical, historical and social aspects in the area of the natural sciences.

### 10.3 Programme (Course and Examination Regulations chapter 3)

The Bio-Pharmaceutical Sciences and Science Communication and Society (SCS) programme consists of:

- the Introduction Course BPS (on the subject of the research project) of 4 EC;
- a research project of 49 EC, consisting of 42 EC for literature research, practical implementation and performance, 5 EC for a thesis and 2 EC for an oral presentation and conducted within any of the divisions of the LACDR or at the CHDR; permission from the Board of Examiners and the Director of Education is required when projects are conducted within external research groups led by Professors affiliated with a division of the LACDR;;
- a lecture series (in BPS) of 4 EC<sup>11</sup>;
- the Course Advanced Academic Skills and Career Orientation of 3 EC;
- a maximum of 20 EC of electives within either Bio-Pharmaceutical Sciences or the SCS component of the programme; and
- the Science Communication and Society component<sup>12</sup> as described [here](#).

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

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<sup>11</sup> The choice for lecture series and research project will be made in concert with a study adviser.

<sup>12</sup> Completion of the specialisation Science Communication and Society requires a minimum of 40 EC and a maximum of 60 EC within the SCS component.

## 11. Specialisation Education

### 11.1 Description (Course and Examinations Regulations chapter 2)

The specialisation Bio-Pharmaceutical Sciences and Education (EDU) prepares students for a career as biology (biologie)<sup>13</sup> or chemistry (scheikunde)<sup>14</sup> teacher qualified to teach in Dutch secondary education.

Students who complete the specialisation Bio-Pharmaceutical Sciences and Education are admissible to a PhD programme.

### 11.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to general achievements, graduates of the MSc programme BPS with the specialisation Education have reached the following specific achievement levels:

- a. All qualifications necessary for teaching all years of secondary education and technical and vocational training (for 12–18 year-olds);

### 11.3 Programme (Course and Examination Regulations chapter 3)

The Bio-Pharmaceutical Sciences and Education (EDU) programme consists of:

- the Introduction Course BPS (on the subject of the research project) of 4 EC;
- a research project of 49 EC, consisting of 42 EC for literature research, practical implementation and performance, 5 EC for a thesis and 2 EC for an oral presentation and conducted within any of the divisions of the LACDR or at the CHDR; permission from the Board of Examiners and the Director of Education is required when projects are conducted within external research groups led by Professors affiliated with a division of the LACDR;
- a lecture series (in BPS) of 4 EC<sup>15</sup>;
- the Course Advanced Academic Skills and Career Orientation of 3 EC;
- the Education component as described [here](#).

The Bio-Pharmaceutical Sciences component of the programme will be followed during the first year of study, the Education component will be followed during the second year.

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 Bio-Pharmaceutical Sciences and Education component of the MSc programme.

A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found on [here](#).

### 11.4 Qualification for admission (Course and Examination Regulations chapter 5)

Master's students in Bio-Pharmaceutical Sciences of Leiden University with a BSc degree in Bio-Pharmaceutical Sciences as well as those with a BSc degree in Pharmaceutical Sciences, Pharmacy, Molecular Science & Technology, Chemistry or Life Science & Technology or an equivalent degree of a Dutch university will be considered for admittance to this specialisation of the programme. The

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<sup>13</sup> Master's Students in Bio-Pharmaceutical Sciences wishing to qualify for the school subject "Biology", need to remedy their deficiencies in concert with the teacher educator Biology of the ICLON. As a rule, Master's students with a BSc degree in Bio-Pharmaceutical Sciences of Leiden University need to complete the following courses in the Biology BSc programme of Leiden University for qualification: Biodiversiteit Plant en Fylogenie (level 100, 7 EC); Evolutie en Biodiversiteit Dier (level 100, 6 EC); Ecologie, Gedrag en Milieu (level 200, 4 EC).

<sup>14</sup> Master's students in Bio-Pharmaceutical Sciences wishing to qualify for the school subject "Chemistry", need to remedy the deficiencies in concert with the *teacher educator Chemistry* of the ICLON. As a rule, Master's students with a BSc degree in Bio-Pharmaceutical Sciences of Leiden University need to complete the following course in the Life Science & Technology BSc programme of Leiden University/Delft University of Technology for qualification: Natuurkunde (incl. aansluitmodule) (level 100, 4 EC).

<sup>15</sup> The choice for lecture series and research project will be made in concert with a study adviser.

teacher educator of Chemistry respectively Biology will assess if there are deficiencies in the prior education of the student. When deficiencies are identified, the teacher educator will propose how these can be solved.

Apart from the general qualifications that apply for a MSc Bio-Pharmaceutical Science, applicants must provide proof of proficiency in Dutch (“Toelatingsexamen Universiteit Leiden – gevorderd, met spreekvaardigheid minimaal een 7.5”).

# MSc Biology

CROHO-number 66860

## 1. Description of the programme (Course and Examination Regulations chapter 2)

The MSc Biology programme builds on the unique combination of biological institutes in Leiden joining forces: the Institute of Biology Leiden (IBL), the Institute of Environmental Sciences (CML), and the Naturalis Biodiversity Center (Naturalis). The choice of courses and research projects is further increased by the embedding in the Faculty of Science and the connections with the Leiden University Medical Center (LUMC), the Netherlands Institute of Ecology (NIOO, Wageningen) and with bioscience-based companies that are also located at the Leiden Bioscience Park.

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, Education Committee and Board of Examiners. A Board of Admissions advises on admissions.

### 1.2 Specialisations (Course and Examination Regulations art. 2.2)

Students can follow a *General Biology (GR)* programme or choose one of the research specialisations: *Biodiversity and Sustainability (BS)*, *Evolutionary Biology (EB)*, *From Cells to Organisms (FCTO)*, *Molecular Genetics and Biotechnology (MGB)*. In addition a programme can be taken that combines biology with training in either *Business Studies (BS)*, *Education (EDU)* or *Science Communication and Society (SCS)*.

### 1.3 Start of the programme (Course and Examination Regulations art. 2.6)

Students can start their programme in September or February. However, they are strongly encouraged to start in September when a general introduction to the master programme and most of the compulsory theoretical courses are scheduled.

## 2. Admission to the programme (Course and Examination Regulations chapter 5)

### 2.1 Confirmation of admission

2.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 2.2 and 2.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 5.2.1, the proof of registration is also confirmation of admission.

2.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.<sup>16</sup>

### 2.2 Admission to the programme

2.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

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<sup>16</sup>[Regulations for Admission to Master's Programmes](#)

- a. holders of a bachelor's degree in Biology from a research university in the Netherlands, or
- b. holders of a bachelor's degree in a biology-related programme from a research university in the Netherlands or from a foreign research university of similar level after assessment of the application by the Board of Admissions.
- c. students who have successfully met the requirements of the imposed bridging programme on the basis of Article 2.4.1

2.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in 2.2.1, sub-sections a and b, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 2.2.1, sub-sections a and b, possibly under further conditions.

Article 2.2.2 may, amongst others, apply to holders of a degree from a research university or to a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo) in biology-related programmes, such as Natural Sciences, Life Sciences, Bio-informatics, or Biomedical Sciences.

As a guideline for applicants with a Dutch hbo diploma, the hbo diploma has to be obtained within a maximum of five years and with an average final grade of at least 7.5 and a research internship grade of 8 or higher.

#### *Admission process*

Applicants as referred to in Article 2.2.1. b and Article 2.2.2. are requested to provide the Board of Admissions with a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified in 2.2.1 a.

The admission process may include an interview with the Board of Admissions, should this be necessary to clarify whether the applicant has the same level of knowledge, understanding and skills as holders of a degree specified 2.2.1 a.

#### **2.2.3 Dutch and English languages<sup>17</sup>**

2.2.3.1 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (or other with English A);
- A diploma of secondary or higher education completed in the US, the United Kingdom, Ireland, New Zealand, Australia or Canada (with the exception of French-taught education in Canada);
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A pre-university education (vwo) diploma.
- A high school (or higher) diploma determined by SEA (Admissions Office) in an EER country, where English has been studied up to and including the final year of the programme, and where the level of English can be considered comparable to Dutch vwo (pre-university education).

2.2.3.2 If a student who wishes to be admitted does not meet the requirements in 2.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90

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<sup>17</sup> Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

- Cambridge Certificate of Advanced English (CAE), minimum grade C

2.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*. This applies to the Education specialisation of this master's programme.

## 2.3 Deficiencies

2.3.1 Holders of a bachelor's degree from a research university, referred to in 2.2.1, subsections a and b, or an equivalent diploma with x (x may vary from 1 to 15) EC of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

2.3.2 Students who still have the deficiencies referred to in 2.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

2.3.3 For the admission referred to in 2.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

2.3.4 If a student is admitted to the programme on the basis of 2.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

## 2.4 Bridging programmes (Pre-master's)

2.4.1 The department has developed the following bridging programmes (for the following target groups) in order to remove deficiencies:

- For students with bachelor's degrees related to Biology the Board of Admissions may impose a Pre-Master's programme, tailored to the individual background of the prospective student, before admission into the MSc programme.

2.4.2 Information on the bridging programmes can be requested from the department. For more information contact the Education Office via [assistentopleiding@biology.leidenuniv.nl](mailto:assistentopleiding@biology.leidenuniv.nl)

# 3. Specialisation Biodiversity and Sustainability

## 3.1 Description (Course and Examination Regulations chapter 2)

This research-oriented master specialisation offers students in-depth knowledge on relationships between biodiversity and society. The critical importance of biodiversity and the services provided by nature for our society is increasingly endorsed by national and international conventions. However, to implement the right policy measures for creating a sustainable society, a much better understanding of the biological processes involved is essential. This master specialisation aims to discuss and answer societal relevant biological questions for instance on the amount of biodiversity we need to ensure that nature functions well and how we can optimize ecosystem functioning and biodiversity for a sustainable society. By using 'sustainability' as a guiding principle, the programme provides students with an academic attitude by stimulating reflective, independent and creative thinking to support, conserve and manage biodiversity and sustainable ecosystem services. This master specialisation prepares students for a PhD programme and/or for research positions at universities or research institutes and for positions at governmental organisations and consultancy agencies.

### 3.2 Programme (Course and Examination Regulations chapter 3)

The programme of Biodiversity and Sustainability (120 EC) consists of:

- a theoretical part (36-60 EC); and
- one or more research projects (60-84 EC).

The programme includes some compulsory components 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 needed for an efficient start of the Research Project at the end of this semester. The Research Projects are the actual core of the MSc programme. Students will be member of a research group of their choice and work full time on a specific project. Each project will be finished with a MSc thesis written in the form of a manuscript for an international scientific journal. At least one but preferably two Research Projects are part of the study programme.

The Specialisation Research Project has to be done within the theme of the specialisation at the CML, Naturalis, the IBL, other departments of the Faculty of Science, the LUMC or NIOO. Prior to the start of the Research Project, the Board of Examiners has to approve the individual study plan of the student and the Research Project agreement.

#### Compulsory components:

Each MSc-programme consists for at least 36 EC of theoretical components and the Research project(s) contribute at least 60 EC. The specialisation Research Project should be minimally 36 EC, and a second Research Project should be at least 30 EC. A single research project cannot exceed 60 EC. A “Fish specific animal experimentation course (2 EC) or a “Bird specific animal experimentation course (2 EC) is obligatory in case of a research project that involves handling or experimental use of fish species or birds species.

<i>Compulsory:</i>	<b>Level</b>	<b>EC</b>
Orientation on Biodiversity and Sustainability	400	2
Advanced Statistics	500	4
Genomic Architecture	400	6
Human Impacts on Biodiversity	500	6
Methods in Biodiversity Analysis	500	6
<i>At least one of the following courses:</i>		
• Ecosystem Services	500	6
• Ecotoxicology	500	6
Research Project(s) (at least 36 EC within the specialisation)	600	min. 60
Electives		max. 30
<b>Total Programme</b>		<b>120</b>

#### Electives/Optional elements

The optional part of the programme can consist of either additional courses, or an extension of the duration of a research project. A list of approved elective courses is available in the e-guide. For courses outside the Leiden University biology programme, prior approval of the Board of Examiners is required.

Note: No more than 12 EC of optional theoretical elements of level < 400 are permitted and at most 15 EC of non-biology courses.

### 3.3 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.

### 3.4 Short description of the courses

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. The course *Orientation on Biodiversity and Sustainability* provides a state of the art overview of the scientific research and research methods used in the departments participating in this MSc specialisation.

The course “*Genomic Architecture*” aims at training students to become “genome-enabled” biologists by giving an overview of the structure, function and evolution of genomes as tools for biomonitoring, and an introduction into bio-informatics. The interface between biodiversity and sustainability is taught in ‘*Ecosystem Services*’ and ‘*Human Impacts on Biodiversity*’. In addition, students are trained in ‘*Advanced Statistics*’ and ‘*Methods in Biodiversity Analysis*’, providing the methodological tools for their training in scientific research during the Research Project(s).

A variety of additional courses from other MSc specialisations in Biology and from other MSc programmes at the Faculty of Science can be chosen as electives. For details (description, literature, exam dates and further calendar events) about the different courses see the e-Prospectus and Blackboard.

## 4. Specialisation Evolutionary Biology

### 4.1 Description (Course and Examination Regulations chapter 2)

This research-oriented master specialisation provides students with in-depth knowledge about Evolutionary Sciences. Students learn about evolutionary changes over time and study the origin and maintenance of biological variation all over the tree of life. The mechanisms that drive the adaptation of organisms and their features are investigated at all biological levels. Thus, the specialisation includes genomics, functional developmental genetics, paleobiology, behavioural biology and evolutionary ecology. With this master specialisation completed, the students are well equipped to start a career in evolutionary research or to take the responsibility for projects in an industrial or institutional research environment.

### 4.2 Programme (Course and Examination Regulations chapter 3)

The programme of Evolutionary Biology (120 EC) consists of:

- a theoretical part (30-60 EC); and
- one or more research projects (60-90 EC).

The programme includes some compulsory components 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 needed for an efficient start of the Research Project at the end of this semester. The Research Projects are the actual core of the MSc programme. Students will be member of a research group of their choice and work full time on a specific project. Each project will be finished with a MSc thesis written in the form of a manuscript for an international scientific journal. At least one but preferably two Research Projects are part of the study programme.

The Specialisation Research Project has to be done within the theme of the specialisation at the IBL, Naturalis, CML, other departments of the Faculty of Science, the LUMC or NIOO. Prior to the start of the Research Project, the Board of Examiners has to approve the individual study plan of the student and the Research Project agreement.

#### Compulsory components:

Each MSc-programme consists for at least 30 EC of theoretical components and the Research project(s) contribute at least 60 EC. The specialisation Research Project should be minimally 36 EC,

and a second Research Project should be at least 30 EC. A single research project cannot exceed 60 EC. A “Fish specific animal experimentation course (2 EC) or a “Bird specific animal experimentation course (2 EC) is obligatory in case of a research project that involves handling or experimental use of fish species or birds species.

<i>Compulsory:</i>	<b>Level</b>	<b>EC</b>
Orientation on Evolutionary Biology	400	2
Advanced Statistics	500	4
Genomic Architecture	400	6
Development & Evolution	500	6
Integrative Taxonomy	500	6
Research Project(s) (at least 36 EC within the specialisation)	600	min. 60
Electives		max. 30
<b>Total Programme</b>		<b>120</b>

#### Electives/Optional elements:

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 Leiden University biology programme and for all research projects, prior approval of the Board of Examiners is required.

Note: No more than 12 EC of optional theoretical elements of level < 400 are permitted and at most 15 EC of non-biology courses.

### **4.3 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.

### **4.4 Short description of the courses**

The Evolutionary Biology study programme comprises several compulsory courses. The course *Orientation on Evolutionary Biology* provides a state of the art overview of the scientific research and research methods used in the departments participating in this MSc specialisation. The course “*Genomic Architecture*” aims at training students to become “genome-enabled” biologists by giving an overview of the structure, function and evolution of genomes, and an introduction into the bio-informatics required to study these genomes. Together with the Advanced Statistics course, and one of the specialisation courses this will prepare the students theoretically for their training in scientific research during the Research Project(s).

A variety of additional courses from other MSc specialisations in Biology and from other MSc programmes at the Faculty of Science and LUMC can be chosen as electives. For details (description, literature, exam dates and further calendar events) about the different courses see the e-prospectus and Blackboard.

## **5. Specialisation From Cells to Organisms**

### **5.1 Description (Course and Examination Regulations chapter 2)**

This research-oriented master specialisation offers students the unique possibility to integrate molecular, cellular and organismal levels of research, but also provides the possibility to specialize in one of these levels. It equips students with advanced knowledge ranging from the functioning of

individual cells to the communication between cells, and the development, physiology and behaviour of multicellular organisms. An important aspect of this specialisation is to understand the molecular mechanisms underlying health and disease and how cells and organisms adapt to environmental factors ranging from light, stress and pathogens to ecological and social conditions. Model organisms include bacteria, fungi, plants and animals (invertebrates and vertebrates). The subject areas covered encompass functional genomics, signal transduction, cellular differentiation, development, host-microbe interactions and animal behaviour.

This master specialisation is suited as a basis for starting a research career at a university or research institute and for a position in a bioscience-based company.

## 5.2 Programme (Course and Examination Regulations chapter 3)

The programme of the specialisation From Cells to Organisms (120 EC) consists of:

- a theoretical part (30-60 EC); and
- one or more research projects (60-90 EC).

The programme includes some compulsory components 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 needed for an efficient start of the Research Project at the end of this semester. The Research Projects are the actual core of the MSc programme. Students will be member of a research group of their choice and work full time on a specific project. Each project will be finished with a MSc thesis written in the form of a manuscript for an international scientific journal. At least one but preferably two Research Projects are part of the study programme.

The Specialisation Research Project has to be done within the theme of the specialisation at the IBL, at other departments of the Faculty of Science or at the LUMC or NIOO. Prior to the start of the Research Project, the Board of Examiners has to approve the individual study plan of the student and the Research Project agreement.

### Compulsory components:

Each MSc-programme consists for at least 30 EC of theoretical components and the Research project(s) contribute at least 60 EC. The specialisation Research Project should be minimally 36 EC, and a second Research Project should be at least 30 EC. A single research project cannot exceed 60 EC. A “Fish specific animal experimentation course (2 EC) or a “Bird specific animal experimentation course (2 EC) is obligatory in case of a research project that involves handling or experimental use of fish species or birds species.

<i>Compulsory:</i>	<b>Level</b>	<b>EC</b>
Orientation on From Cells to Organisms	400	2
Advanced Statistics	500	4
Genomic Architecture	400	6
<i>At least two of the following courses:</i>		
• Advanced Cell Biology	500	4
• Animal Personality	500	6
• Development and Evolution	500	6
• Innate Immune Systems	500	6
• Mechanisms of Disease	500	6
Research Project(s) (at least 36 EC within the specialisation)	600	min. 60
Electives		max. 30
<b>Total Programme</b>		<b>120</b>

### Electives/Optional elements

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 Leiden University biology programme and for all research projects, prior approval of the Board of Examiners is required.

Note: No more than 12 EC of optional theoretical elements of level < 400 are permitted and at most 15 EC of non-biology courses.

## 5.3 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.

## 5.4 Short description of the Courses

The From Cells to Organisms study programme comprises several compulsory courses. The course *Orientation on From Cells to Organisms* provides a state of the art overview of the scientific research and research methods used in the departments participating in this MSc specialisation. The course “*Genomic Architecture*” aims at training students to become “genome-enabled” biologists by giving an overview of the structure, function and evolution of genomes, and an introduction into the bio-informatics required to study these genomes. Together with the Advanced Statistics course, and two specialisation courses this will prepare the students theoretically for their training in scientific research during the Research Project(s).

A variety of additional courses from other MSc specialisations in Biology and from other MSc programmes at the Faculty of Science and LUMC can be chosen as electives. For details (description, literature, exam dates and further calendar events) about the different courses see the e-prospectus and Blackboard.

# 6. General Biology Programme

*(no research specialisation)*

## 6.1 Programme (Course and Examination Regulations chapter 3)

The General Biology programme (120 EC) consists of:

- a theoretical part (30-60 EC); and
- one or more research projects (60-90 EC).

The programme includes some compulsory components, 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 needed for an efficient start of the specialisation Research Project at the end of this semester.

At least one Research Project has to be done within a research area at the IBL, CML, Naturalis, Faculty of Science or LUMC. All Research Projects require prior approval by the Board of Examiners through approval of the individual study plan of a student and approval of the research agreement.

### Compulsory components:

Each MSc-programme consists for at least 30 EC of theoretical components and the Research project(s) contribute at least 60 EC. Each Research Project should be at least 30 EC. A single research project cannot exceed 60 EC. A “Fish specific animal experimentation course (2 EC) or a “Bird specific animal experimentation course (2 EC) is obligatory in case of a research project that involves handling or experimental use of fish species or birds species.

	Level	EC
<i>One of the courses:</i>		
• Orientation on Biodiversity and Sustainability	400	2
• Orientation on Evolutionary Biology	400	2

• Orientation on From Cells to Organisms	400	2
• Orientation on Molecular Genetics and Biotechnology	400	2
Advanced Statistics	500	4
Genomic Architecture	400	6
<i>At least 18 EC of the courses:</i>		
• Advanced Cell Biology	500	4
• Advanced Molecular Genetics and Biotechnology	500	3
• Animal Personality	500	6
• Paleobiology	500	3
• Development and Evolution	500	6
• Ecotoxicology	500	6
• Human impacts on biodiversity	500	6
• Innate Immune Systems	500	6
• Integrative Taxonomy	500	6
• Mechanisms of Disease	500	6
• Methods in Biodiversity Analysis	500	6
• <i>Or courses from the list of approved electives</i>		
Research Project(s)	600	min. 60
Electives		max. 30

### Electives/Optional elements

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 research projects, prior approval of the Board of Examiners is required.

Note: No more than 12 EC of optional theoretical elements of level < 400 are permitted and at most 15 EC of non-biology courses.

## 6.2 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.

## 6.3 Short description of the Courses

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. The Orientation courses provide a state of the art overview of the scientific research and research methods of the participating Institutes.

The course “*Genomic Architecture*” aims at training students to become “genome-enabled” biologists by giving an overview of the structure, function and evolution of genomes, and an introduction into the bio-informatics required to study these genomes. In addition, students are trained in ‘*Advanced Statistics*’ and follow at least one specialised course providing students with an integrated picture on specific topics for their training in scientific research during the Research Project(s).

A variety of additional courses from other MSc specialisations in Biology and from other MSc programmes at the Faculty of Science can be chosen as electives. For details (description, literature, exam dates and further calendar events) about the different courses see the e-prospectus and Blackboard.

## 7. Specialisation Molecular Genetics and Biotechnology

### 7.1 Description (Course and Examination Regulations chapter 2)

The master specialisation *Molecular Genetics and Biotechnology* focusses on genetics, molecular biology, genomics and biotechnology of animal, plant and microbial systems. Through courses and research projects, students are trained by experts in the areas of molecular biology, microbiology, plant genetics, cellular imaging, animal disease models, and various –omics technologies and the corresponding bioinformatics. Attention is paid to the application of these techniques to biotechnology, i.e. how studies on model organisms can be translated to improve crops or human health. Students graduating in this master specialisation are well trained to start a research career in biological and medical sciences or lead projects in industrial or institutional research environments.

This master specialisation is suited as a basis for starting a research career at a university or research institute and for a position in a bioscience-based company.

### 7.2 Programme (Course and Examination Regulations chapter 3)

The programme of *Molecular Genetics and Biotechnology* (120 EC) consists of:

- a theoretical part (30-60 EC); and
- one or more research projects (60-90 EC).

The programme includes some compulsory components 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 needed for an efficient start of the Research Project at the end of this semester. The Research Projects are the actual core of the MSc programme. Students will be member of a research group of their choice and work full time on a specific project. Each project will be finished with an MSc thesis written in the form of a manuscript for an international scientific journal. At least one but preferably two Research Projects are part of the study programme.

The Specialisation Research Project has to be done within the theme of the specialisation at the IBL, at other departments of the Faculty of Science or at the LUMC or NIOO. Prior to the start of the Research Project, the Board of Examiners has to approve the individual study plan of the student and the Research Project agreement.

#### Compulsory components:

Each MSc-programme consists for at least 30 EC of theoretical components and the Research project(s) contribute at least 60 EC. The specialisation Research Project should be minimally 36 EC, and a second Research Project should be at least 30 EC. A single research project cannot exceed 60 EC. A “Fish specific animal experimentation course” (2 EC) or a “Bird specific animal experimentation course” (2 EC) is obligatory in case of a research project that involves handling or experimental use of fish species or birds species.

<i>Compulsory:</i>	<b>Level</b>	<b>EC</b>
Orientation on Molecular Genetics and Biotechnology	400	2
Advanced Statistics	500	4
Genomic Architecture	400	6
Advanced Molecular Genetics and Biotechnology	500	3
<i>At least one of the following courses:</i>		
• Advanced Cell Biology	500	4
• Innate Immune Systems	500	6
• Mechanisms of Disease	500	6
Research Project(s) (at least 36 EC within the specialisation)	600	min. 60

Electives	max. 30
<b>Total Programme</b>	<b>120</b>

### Electives

Electives 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 research projects, prior approval of the Board of Examiners is required. Note: No more than 12 EC of optional theoretical elements of level < 400 are permitted and at most 15 EC of non-biology courses.

## 7.3 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.

## 7.4 Short description of the courses

The Molecular Genetics and Biotechnology study programme comprises several compulsory courses. The course *Orientation on Molecular Genetics and Biotechnology* provides an overview of the scientific research and research methods used in the departments participating in this MSc specialisation. The course "*Genomic Architecture*" aims at training students to become "genome-enabled" biologists by giving an overview of the structure, function and evolution of genomes, and an introduction into the bio-informatics required to study these genomes. Together with the Advanced Statistics course, and the specialisation courses, this will prepare the students theoretically for their training in scientific research during the Research Project(s).

A variety of additional courses from other MSc specialisations in Biology and from other MSc programmes at the Faculty of Science and LUMC can be chosen as electives. For details (description, literature, exam dates and further calendar events) about the different courses see the e-prospectus and Blackboard.

# 8. Specialisation Business Studies

## 8.1 Description (Course and Examination Regulations chapter 2)

The specialisation Biology and Business Studies offers students the possibility to combine biology with knowledge, insights and skills in the area of Management, Business and Entrepreneurship.

Students are encouraged to broaden their horizon, to form an opinion on and prepare for a career in industry and to enhance competences for pursuing entrepreneurial business opportunities created in science and research.

Students who complete the specialisation Biology and Business Studies are admissible to a PhD programme.

## 8.2 Programme (Course and Examination Regulations chapter 3)

The Biology and Business Studies programme consists of:

- 24 EC of advanced theory;
- a research project of 36 EC;
- a maximum of 20 EC of electives within either Biology or the Business Studies component; and

- the Management or New Technology Ventures track<sup>18</sup> as described [here](#).

The theoretical part of the Biology research component comprises:

	<b>Level</b>	<b>EC</b>
<i>One of the courses:</i>		
• Orientation on Biodiversity and Sustainability	400	2
• Orientation on Evolutionary Biology	400	2
• Orientation on From Cells to Organisms	400	2
• Orientation on Molecular Genetics and Biotechnology	400	2
Advanced Statistics	500	4
Genomic Architecture	400	6
<i>At least 12 EC of the courses:</i>		
• Advanced Cell Biology	500	4
• Advanced Molecular Genetics and Biotechnology	500	3
• Animal Personality	500	6
• Paleobiology	500	3
• Development and Evolution	500	6
• Ecotoxicology	500	6
• Human impacts on biodiversity	500	6
• Innate Immune Systems	500	6
• Integrative Taxonomy	500	6
• Mechanisms of Disease	500	6
• Methods in Biodiversity Analysis	500	6
• <i>Or courses from the list of approved electives</i>		
Research Project(s)	600	36
<b>Total Programme</b>		<b>120</b>

A “Fish specific animal experimentation course (2 EC) or a “Bird specific animal experimentation course (2 EC) is obligatory in case of a research project that involves handling or experimental use of fish species or birds species.

The Biology component can be extended with an additional 20 EC (courses or extension of the research project)). The research project has to take place in one of the research groups of the IBL, CML or Naturalis, other Institutes of the Faculty of Sciences or LUMC.

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 through approval of the individual study plan of a student and approval of the research agreement.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

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<sup>18</sup> Completion of the specialisation Business Studies requires a minimum of 40 EC and a maximum of 60 EC within the Business Studies component.

## 9. Specialisation Education

### 9.1 Description (Course and Examination Regulations chapter 2)

The specialisation Biology and Education (EDU) prepares students for a career as biology (biologie) teacher qualified to teach in Dutch secondary education.

Students who complete the specialisation Biology and Education are admissible to a PhD programme.

### 9.2 Programme (Course and Examination Regulations chapter 3)

The Biology and Education (EDU) programme consists of:

- 24 EC of advanced theory;
- a research project of 36 EC;
- the Education component as described [here](#).

The theoretical part of the Biology research component comprises:

	Level	EC
<i>One of the courses:</i>		
• Orientation on Biodiversity and Sustainability	400	2
• Orientation on Evolutionary Biology	400	2
• Orientation on From Cells to Organisms	400	2
• Orientation on Molecular Genetics and Biotechnology	400	2
Advanced Statistics	500	4
Genomic Architecture	400	6
<i>At least 12 EC of the courses:</i>		
• Advanced Cell Biology	500	4
• Advanced Molecular Genetics and Biotechnology	500	3
• Animal Personality	500	6
• Paleobiology	500	3
• Development and Evolution	500	6
• Ecotoxicology	500	6
• Human impacts on biodiversity	500	6
• Innate Immune Systems	500	6
• Integrative Taxonomy	500	6
• Mechanisms of Disease	500	6
• Methods in Biodiversity Analysis	500	6
• <i>Or courses from the list of approved electives</i>		
Research Project(s)	600	36

### Total Programme

120

A “Fish specific animal experimentation course (2 EC) or a “Bird specific animal experimentation course (2 EC) is obligatory in case of a research project in which experiments with fish or birds are involved.

The research project has to take place in one of the research groups of the IBL, CML or Naturalis, other Institutes of the Faculty of Sciences or LUMC.

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 through approval of the individual study plan of a student and approval of the research agreement.

### 9.3 Qualifications for admission

The Education specialisation requires proof of proficiency in Dutch. In addition to the general admission requirements of the MSc programme in Biology, students must provide proof of proficiency in Dutch (Toelatingsexamen Universiteit Leiden –gevorderd, met spreekvaardigheid minimaal een 7 ½).

A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found [here](#).

## 10. Specialisation Science Communication and Society

### 10.1 Description (Course and Examination Regulations chapter 2)

The specialisation Biology and Science Communication and Society (SCS) offers students the possibility to combine physics and science communication.

Students are prepared for a career in popularisation of science or for a career as a scientist with a communicating mind-set.

Students who complete the specialisation Biology Sciences and Science Communication and Society are admissible to a PhD programme in biology or in science communication.

### 10.2 Programme (Course and Examination Regulations chapter 3)

The Biology Science Communication and Society (SCS) programme consists of:

- 24 EC of advanced theory;
- a research project of 36 EC;
- a maximum of 20 EC of electives within either Biology or the SCS component; and
- the Science Communication and Society component<sup>19</sup> as described [here](#).

The theoretical part of the Biology research component comprises:

	Level	EC
<i>One of the courses:</i>		
• Orientation on Biodiversity and Sustainability	400	2
• Orientation on Evolutionary Biology	400	2
• Orientation on From Cells to Organisms	400	2
• Orientation on Molecular Genetics and Biotechnology	400	2
Advanced Statistics	500	4
Genomic Architecture	400	6
<i>At least 12 EC of the courses:</i>		
• Advanced Cell Biology	500	4
• Advanced Molecular Genetics and Biotechnology	500	3
• Animal Personality	500	6
• Paleobiology	500	3
• Development and Evolution	500	6
• Ecotoxicology	500	6
• Human impacts on biodiversity	500	6

<sup>19</sup> Completion of the specialisation Science Communication and Society requires a minimum of 40 EC and a maximum of 60 EC within the SCS component.

• Innate Immune Systems	500	6
• Integrative Taxonomy	500	6
• Mechanisms of Disease	500	6
• Methods in Biodiversity Analysis	500	6
• <i>Or courses from the list of approved electives</i>		
Research Project(s)	600	36
<b>Total Programme</b>		<b>120</b>

A “Fish specific animal experimentation course (2 EC) or a “Bird specific animal experimentation course (2 EC) is obligatory in case of a research project in which experiments with fish or birds are involved.

The Biology component can be extended with an additional 20 EC (courses or extension of the research project). The research project has to take place in one of the research groups of the IBL, CML or Naturalis, other Institutes of the Faculty of Sciences or LUMC.

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 through approval of the individual study plan of a student and approval of the research agreement.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

# MSc Chemistry

CROHO-number 66857

## 1. Description of the programme (Course and Examination Regulations chapter 2)

The Leiden Institute of Chemistry (LIC) forms the basis for research and collaborations of the Leiden chemistry and life sciences groups. The LIC offers two MSc programmes, namely the MSc Chemistry and the MSc Life Science and Technology. Chemistry research in the LIC is centred on the two research areas *Chemical Biology* and *Energy & Sustainability*, which are leading for the courses and research training projects offered in the MSc programme Chemistry.

**Chemical Biology** research at the Leiden Institute of Chemistry is aimed at understanding biological processes at the molecular level to strengthen the knowledge base of human health and disease. The approach to achieve this goal is a fundamental chemical one; biological systems are interrogated with the aid of chemical probes. Our chemical biology research is conducted in the context of health and disease, and aims to acquire knowledge, tools and techniques for human medicine. The ultimate goal is to contribute to human health through conceptually new chemical methods for diagnosis, drug development and new therapies for diseases.

The **Energy & Sustainability** research is focused on a fundamental level on chemical reactions that are of importance to the sustainable and efficient production and storage of energy, as well as the subsequent usage of stored energy. The researchers apply advanced spectroscopic techniques, nano-imaging, inorganic synthesis, and theoretical methods to elucidate the molecular processes that are at the basis of the conversion of solar energy to chemical energy.

Detailed information concerning the research topics that are investigated at the LIC can be found on the websites of the research groups, via <https://www.universiteitleiden.nl/en/science/chemistry/>.

### 1.1 Specialisations (Course and Examination Regulations art. 2.2)

The MSc programme Chemistry offers four specialisations, each with a focus on one of these two major research areas. The four specialisations are: Research in Chemistry (CHEM), Chemistry and Business Studies (BS), Chemistry and Science Communication and Society (SCS) and Chemistry and Education (EDU). 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.

**Table 1:** Overview of the programmes of the four MSc Chemistry specialisations (weights in EC)

Specialisation	CHEM	EDU	SCS	BS
Research Training Project	60	30	30	30
Academic Skills <sup>20</sup>	6	6	6	6
Core courses in research area	24	24*	24	24
Essay & Colloquium	6	-	-	-
Free electives**	24	30 / 0 <sup>#</sup>	20	20
EDU/SCS/BS components	-	30 / 60	40	40
<b>Total</b>	<b>120</b>	<b>120</b>	<b>120</b>	<b>120</b>

\* Students in the EDU specialisation are advised to choose from both research areas, to obtain a broader knowledge of chemistry.

\*\* The choice in the free electives is restricted to the boundaries specified in this document. A maximum of 20 EC can be used for extension of the research project. A maximum of 20 EC may be used as an extension of the SCS or BS components.

<sup>20</sup> Compulsory for students who started with the MSc Chemistry per September 2017 or later.

# If the student has taken a minor in Education (“tweedegraadsbevoegdheid”) of 30 EC in the BSc programme, only 30 EC are necessary in the MSc programme to obtain the “eerstegraadsbevoegdheid”; then 30 EC free electives are added to the programme of the MSc Chemistry.

## 1.2 Learning outcomes (Course and Examination Regulations art. 2.3)

After completion of the MSc Chemistry programme students will have developed:

- Knowledge and understanding of theoretical concepts of Chemistry from textbooks and primary literature pertaining to the research area “Chemical Biology” or “Energy & Sustainability”
- The ability to plan chemical research, perform experiments within an appropriate time frame, collect and store data in a logical way, such that colleagues can easily find and access the data (data management)
- The ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, and formulate verifiable hypotheses
- An appropriate critical scientific attitude, i.e. the ability to analyse results and critically evaluate their validity and accuracy
- The skill to communicate chemical research progress and results to colleagues, supervisors and experts
- The ability to write independently a structured and accurate report on performed chemical research
- The ability to perform with an academic attitude and the skills for autonomous self-development, taking into account the ethical and social aspects of the natural sciences.

## 1.3 Start of the programme (Course and Examination Regulations art. 2.6)

Students can start their programme in September or February; international students are strongly advised to start in September.

## 1.4 Programme organisation

All specialisations have the same Programme Director and the same Board of Admission. The Programme Committee for the MSc programme Chemistry is combined with the one for the MSc programme Life Science and Technology and is responsible for the Research specialisation and the programme-specific components of the other specialisations. The specialisation-specific components of the BS, EDU and SCS specialisations have their own Programme Committee. The Board of Examiners of the MSc programme Chemistry is also combined with the one of the MSc programme Life Science and Technology. In addition the specialisations BS, SCS, and EDU each have their own faculty-wide Board of Examiners appointed by the Faculty of Science for the specialisation-specific part of the MSc Chemistry programme.

All MSc students are guided by a personal mentor. The mentor generally is the supervisor of the major research training project in the research area chosen by the student. The mentor will coach the student from the admission throughout the MSc programme to the final examination. The web-based master planner is used for planning and registration of the study program, and is to be filled in by the student in consult with the mentor. The mentor and student discuss the progress of the student at least every 6 months using the results documented in the master planner. The master planner is updated by the student on a regular basis. It is accessible to the student, the mentor and the study coordinator. The study coordinator administrates a copy of the individual study programme; it is used to keep track of the student’s progress and forms the basis for the master portfolio. The study adviser will mediate when a student encounters problems in the interaction with the mentor.

## 2. Programme (Course and Examination Regulations chapter 3)

Students compose their own study programme (choice in core courses, electives and research training project) in consent with their mentor, who is a scientific staff member of the LIC. 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. The programme may be adjusted during the course of the MSc study.

Specialisation-specific components of the specialisations Chemistry and Business Studies, Chemistry and Science Communication and Society, and Chemistry and Education are described separately in this Appendix. A 'double' specialisation should comprise a full programme of one specialisation plus the specialisation-specific components of the second specialisation, with the Research specialisation counting as the 'main' specialisation. The number of credits for 'double' specialisations thus must be at least 150 EC (Research + EDU-30), 160 EC (Research + BS; Research + SCS; BS + SCS) or 180 EC (Research + EDU-60).

### **3. Admission to the programme (Course and Examination Regulations chapter 5)**

#### **3.1 Confirmation of admission**

3.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 3.2 and 3.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 3.2.1, the proof of registration is also confirmation of admission.

3.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.<sup>21</sup>

#### **3.2 Admission to the programme**

3.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a) holders of a bachelor's degree in Molecular Science and Technology (MST) from any research university in the Netherlands, or
- b) holders of a bachelor's degree in an MST- or chemistry-related programme from a research university in the Netherlands or from a foreign research university of equal level, provided that the candidate has:
  - accumulated at least 150 EC (or the equivalence thereof) in courses/projects belonging to the domain of Molecular Science and Technology and
  - obtained the degree with an average final grade of at least 7.0 (Dutch grading system) and
  - a research project/internship grade of at least 7.5

such to be judged by the Board of Admissions,

- c) students who have successfully met the requirements of the imposed bridging programme.

Applicants as referred to in Article 3.2.1 subsection b are requested to provide the Board of Admissions with the following:

- A letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified in Article 3.2.1 subsection a,
- A curriculum vitae,
- Transcript of grades received in the previous education,
- Letter of recommendation preferably by the internship supervisor,

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<sup>21</sup> [Regulations for Admission to Master's Programmes](#)

3.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in Article 3.2.1, subsections a and b, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified in Article 3.2.1, subsections a and b, without prejudice to the qualitative conditions specified in Article 3.2.4.

Article 3.2.2 may, amongst others, apply to holders of a degree from a foreign research university that does not meet the requirements specified in Article 3.2.1 subsection b or to a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo) in an MST or chemistry-related programme provided that the candidate has:

- obtained the degree with an average final grade of at least 7.5 (Dutch grading system) and
- a research project/internship grade of at least 8.0

Applicants as referred to in Article 3.2.2 are requested to provide the Board of Admissions with the following:

- A letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified in Article 5.2.1 subsection a,
- A curriculum vitae,
- Transcript of grades received in the previous education,
- Letter of recommendation preferably by the internship supervisor,
- Hbo students should also submit a letter of recommendation of the mentor ('studieloopbaanbegeleider') of the BAS programme.

### **Article 3.2.3 Dutch and English languages<sup>22</sup>**

3.2.3.1 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (or other with English A);
- A diploma of secondary or higher education completed in the US, the United Kingdom, Ireland, New Zealand, Australia or Canada (with the exception of French-taught education in Canada);
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A pre-university education (vwo) diploma.
- A high school (or higher) diploma determined by SEA (Admissions Office) in an EER country, where English has been studied up to and including the final year of the programme, and where the level of English can be considered comparable to Dutch vwo (pre-university education).

3.2.3.2 If a student who wishes to be admitted does not meet the requirements in 3.2.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5 (minimum score on each subtest: 6.0)
- TOEFL: internet based 90
- Cambridge Certificate of Advanced English (CAE), minimum grade C

3.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's

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<sup>22</sup> Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*. This condition applies to the Education specialisation of the master programme.

### 3.3 Deficiencies

3.3.1 Holders of a bachelor's degree from a research university, referred to in Article 3.2.1 subsections a and b, or an equivalent diploma with x (x may vary from 1 to 15) EC of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

3.3.2 Students who still have the deficiencies referred to in Article 3.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

3.3.3 For the admission referred to in Article 3.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

3.3.4 If a student is admitted to the programme on the basis of Article 3.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

## 4. Specialisation Research in Chemistry (CHEM)

### 4.1 Description (Course and Examination Regulations chapter 2)

The research specialisation offers the student the opportunity to spend two full years on training and specialisation not only to become an independent and creative researcher, but also someone who can use their analytical skills to resolve challenges in their career in science or in society. The majority of the students with an MSc in Research in Chemistry will continue their career in a PhD position.

### 4.2 Programme (Course and Examination Regulations chapter 3)

The Research in Chemistry programme (CHEM) consists of the parts specified in Table 2.

**Table 2:** Overview of the programme of the MSc Chemistry Research specialisation

Catalog number	Component	Study load	Level
	Research training:	60 - 80 EC*	600
	Major research project	40-60 EC	600
	Minor research project (optional)	20-40 EC	600
4603SCMT4	Science Methodology	4 EC	400
4423ACWR2	Academic Writing	2 EC	400
4333ESCOLY	Essay and colloquium	6 EC	500
	Core courses (in research area)	24 EC	400-500
	Electives	4-24 EC	400-600

\* The total weight of research projects may not exceed 80 EC.

### 4.3 Research Training Project

The (major) research training project is carried out in a LIC research group in the chosen research area (*Chemical Biology* or *Energy & Sustainability*). The research training project may be split into a major and a minor project. The major training project is limited to a minimum of 40 and a maximum of 60 EC; an optional minor research training project must comprise at least 20 EC. A minor training project can be carried out in another research group, another research area, another institute (within the Netherlands or abroad), or in a company; in all cases a scientific staff member of the LIC must act as a (co) supervisor. All external research training projects need prior approval from the Board of Examiners. External training projects cannot be the major training project. Students can only start with an optional minor research training project (within or outside the LIC) when the major project has been successfully concluded with a grade (including a Thesis Talk).

Each research training project must be supervised and evaluated by two scientific staff members. Two LIC staff members evaluate and grade the student for projects carried out in the LIC. Optional minor research training projects carried out within the LIC are evaluated and graded by two LIC scientific staff members, who were not involved in the major research training project. All external research training projects are evaluated and graded by a scientific staff member of the LIC (not the supervisor of the LIC research project; internal supervisor) and a staff member from the host institute. The LIC co-supervisor has the final responsibility for the creation of the research project agreement, grading of the research project report and creation and signing of the project evaluation form.

All research training projects are concluded with a written report; for the major research training this is the MSc thesis. Written reports are graded by the main supervisor and an independent second examiner who was not involved in the writing process. The final version of the report should be handed in within 3 months after the last day of practical work. The supervisor is allowed to limit the grade to a 6 if this deadline is exceeded.

The major research project is concluded with an oral presentation for an independent jury of two staff members, as well as an audience of interested students and staff members of the LIC (i.e. Thesis Talk). Students should attend at least 7 Thesis Talks during their MSc programme as part of their training. Students who started before September 2019 should attend at least 10 Thesis Talks. Students who started before September 2019, but take the co-curricular component 'WORK' (see below) should attend at least 7 Thesis Talks.

#### **4.4 Theoretical compulsory components**

The compulsory theoretical component comprises a selection of four core courses, courses on academic skills (Science Methodology<sup>20</sup> and Academic Writing<sup>20</sup>), and a literature essay with a colloquium.

The colloquium supervisor cannot be the mentor, but students can discuss with their mentor possible topics and fields of study of interest. The final grade for the colloquium is determined by a colloquium jury, composed of two LIC staff members. The jury cannot include the mentor or colloquium supervisor. All students should attend at least 7 colloquia during their MSc programme. Students who started before September 2019 should attend at least 10 colloquia. Students who started before September 2019, but take the co-curricular component 'WORK' (see below) should attend at least 7 colloquia.

The core courses are selected within the chosen research area: Chemical Biology (CB) or Energy & Sustainability (ES). A list of the core courses offered by the two research areas is given in Table 3.

**Table 3:** Core courses compulsory for the research areas *Chemical Biology (CB)* and *Energy & Sustainability (ES)*. All courses encompass 6 EC.#,\*

	Catalog number	Level	Research area
Advanced Medicinal Chemistry	4423ADMC6	500	CB
Cell Biology**	4423CELBI	400	CB
Chemical Biology	4423CHEMB	500	CB
Enzyme Dynamics: NMR Spectroscopy and Kinetics	4423EDNMR	500	CB
Modern Organic Chemistry	4423MODOC	500	CB
Molecular Biology**	4423MOB64	400	CB
Reactivity in Organic Chemistry	4423RIOCH	500	CB
Supramolecular Chemistry	4423SUPC6	500	CB
Dynamics of Molecule-surface Reactions***	4423DYMOL	500	ES
Electrochemistry & Bioelectrochemistry	4423ELECB	500	ES
Heterogeneous Catalysis	4423HETCA	500	ES
Modern Quantum Chemistry	4423MOQUA	400	ES
Organometallic Chemistry & Homogeneous Catalysis	4423ORGHO	500	ES
Photochemistry	4423PHCH6	500	ES
Photosynthesis & Bioenergy	4423PBE06	500	ES
Quantum Dynamics of Chemical Reactions***	4423QDOCR	500	ES
Spectroscopy	4423SPECT	400	ES

# Students who started before September 2017 may compose their set of core courses as described in the OER of the year in which they started their MSc programme chemistry.

\* Courses that were taken in the BSc programme cannot be taken again in the MSc programme.

\*\* These courses cannot be chosen by students with a BSc degree in Life Science and Technology.

\*\*\* Biennial courses scheduled in alternating years.

#### 4.5 Compulsory co-curricular component

Students starting per September 2019 or later have to take the compulsory co-curricular component "WORK". Students will have to *Write* an application letter and CV, attend seminars and workshops for job market *Orientation*, and have to *Reflect* on their skills, strengths and weaknesses. After finalization of this component they will have acquired improved *Knowledge* of what they are good at and what kind of career they would like to pursue! This component comprises a number of activities and workshops to create awareness of the job market, and give students insight in their skills, abilities and weaknesses. During the two years of the MSc programme, a number of different activities will be offered, some of which will be compulsory, and others can be chosen. The activities will comprise: alumni-events (lectures, speed-dating), workshops offered by the Career Service, self-assessment and self-reflection tasks, participation in excursions to companies or a visit to the 'β-banenmarkt'. All students have to do a self-evaluation test at the start of their programme, take part in the workshop 'CV, LinkedIn profile and cover letter' during their studies, and write a self-reflection after their major research project. In addition students take at least 6 of the offered workshops or other activities that are offered by the programme or career service during their studies.

#### 4.6 Elective components

The elective component can comprise either theoretical courses, or an extension of the duration of a research project with a maximum of 20 EC, within the limitations described in the section 'Research Training Project'. Elective theoretical courses can be chosen from: the core courses within or outside the chosen research area, approved elective MSc courses of the Leiden University Faculty of Science published in the electronic study guide, the MSc courses offered in a Science Faculty of any Dutch or foreign university of level 400 or higher, or level 400 courses from the BSc MST or LST programmes. Elective theoretical courses can be taken provided that these were not part of the student's earlier

studies, and do not overlap in content with other courses already taken as part of the MSc curriculum. Students in the research area ‘Energy & Sustainability’ who are admitted to the HRSMC (Holland Research School of Molecular Sciences) excellence programme ‘Sustainability, a Molecular Approach’ offered by Leiden University, the University of Amsterdam and the VU Amsterdam are allowed to take a ‘short rotation’ (for 6 EC) or ‘research proposal’ (for 6 EC) as part of their electives.

Students must apply for approval of the Board of Examiners prior to taking any theoretical courses offered by universities outside the Netherlands, as well as starting of any external research project (i.e. outside the LIC).

## 5. Specialisation Chemistry and Business Studies

### 5.1 Description (Course and Examination Regulations chapter 2)

The specialisation Chemistry and Business Studies (BS) offers students the possibility to combine chemistry with knowledge, insights and skills in the area of Management, Business and Entrepreneurship.

Students are encouraged to broaden their horizon, to form an opinion on and prepare for a career in industry and to enhance competences for pursuing entrepreneurial business opportunities created in science and research.

### 5.2 Programme (Course and Examination Regulations chapter 3)

The Chemistry and Business Studies (BS) programme consists of the parts specified in Table 4. A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

**Table 4.** Overview of the programme of the specialisation Chemistry and Business Studies

Catalog number	Component	Study load	Level
	Research training	30 EC	600
4603SCMT4	Science Methodology <sup>20</sup>	4 EC	400
4423ACWR2	Academic Writing <sup>20</sup>	2 EC	400
	Core courses (in research area)	24 EC	400-500
	Electives	0-20 EC	400-600
<b>BS components (track ‘Management ‘or ‘New Technology Venture’)</b>			
	BS core courses	20 EC	400-500
	BS internship	20-40 EC	600
	BS elective courses	0-20 EC	400-500

### 5.3 Research Training Project

The research training project in Chemistry should be carried out in one of the research groups of the Leiden Institute of Chemistry. It includes a written report (MSc thesis) and is finalised with a Thesis Talk (as described above). Students should attend at least 7 Thesis Talks. Students who started before September 2019 should attend at least 10 Thesis Talks. Students who started before September 2019, but take the co-curricular component ‘WORK’ (see below) should attend at least 7 Thesis Talks.

### 5.4 Theoretical compulsory components

The compulsory theoretical component comprises four core courses to be selected from Table 3 in correspondence with the chosen research area, and courses on academic skills (Science Methodology<sup>20</sup> and Academic Writing<sup>20</sup>).

### 5.5 Compulsory co-curricular component

Students starting per September 2019 or later have to take the compulsory co-curricular component “WORK”. See the description and specifications described in the research specialisation.

## 5.6 Elective components

Elective components may consist of additional theoretical courses within or outside the chosen research area, an extension of the research project or additional BS courses. Furthermore, the restrictions and conditions specified above for elective components apply.

## 5.7 BS components

A minimum of 40 EC and a maximum of 60 EC within the BS component is required to complete the BS specialisation. A specification of the 'BS Management' or 'BS New Technology Ventures' track is described [here](#).

# 6. Specialisation Chemistry and Science Communication and Society

## 6.1 Description (Course and Examination Regulations chapter 2)

The specialisation Chemistry and Science Communication and Society (SCS) offers students the possibility to combine chemistry and science communication. Students are prepared for a career in popularisation of science or for a career as a scientist with a communicating mind-set.

## 6.2 Programme (Course and Examination Regulations chapter 3)

The Chemistry and Science Communication and Society (SCS) programme consists of the parts specified in Table 5. A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

**Table 5:** Overview of the specialisation Chemistry and Science Communication and Society

Catalog number	Component	Study load	Level
	Research training	30 - 50 EC	600
4603SCMT4	Science Methodology <sup>20</sup>	4 EC	400
4423ACWR2	Academic Writing <sup>20</sup>	2 EC	400
	Core courses (in research area)	24 EC	400-500
	Electives	0-20 EC	400-600
<b>SCS components</b>			
	SCS internship	14-34 EC	600
	SCS theoretical courses	26-46 EC	400-500

## 6.3 Research Training Project

The research training project in Chemistry should be carried out in one of the research groups of the Leiden Institute of Chemistry. It includes a written report (MSc thesis) and is finalised with a Thesis Talk (as described above). Students should attend at least 7 Thesis Talks. Students who started before September 2019 should attend at least 10 Thesis Talks. Students who started before September 2019, but take the co-curricular component 'WORK' (see below) should attend at least 7 Thesis Talks.

## 6.4 Theoretical compulsory components

The compulsory theoretical component comprises four core courses to be selected from Table 3 in correspondence with the chosen research area, and courses on academic skills (the course Science Methodology<sup>20</sup> and Academic Writing<sup>20</sup>).

## 6.5 Compulsory co-curricular component

Students starting per September 2019 or later have to take the compulsory co-curricular component "WORK". See the description and specifications described in the research specialisation.

## 6.6 Elective components

Elective components may consist of additional theoretical courses within or outside the chosen research area, an extension of the research project or additional SCS courses. Furthermore, the restrictions and conditions specified above for elective components apply.

## 6.7 SCS components

A minimum of 40 EC and a maximum of 60 EC within the SCS component is required to complete the SCS specialisation. A specification of the SCS specialisation is described [here](#).

# 7. Specialisation Chemistry and Education (NL)

## 7.1 Description (Course and Examination Regulations chapter 2)

The specialisation Chemistry and Education (EDU) prepares students for a career as chemistry (scheikunde) teacher qualified to teach in Dutch secondary education.

## 7.2 Programme (Course and Examination Regulations chapter 3)

The Chemistry and Education (EDU) programme consists of the parts specified in Table 6. The Chemistry component of the programme must be followed during the first year of study, the Education component will be taken during the second year.

A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found on page [here](#).

**Table 6:** Overview of the programme of specialisation Chemistry and Education

Catalog number	Component	Study load	Level
	Research training	30 - 50 EC	600
4603SCMT4	Science Methodology <sup>20</sup>	4 EC	400
4423ACWR2	Academic Writing <sup>20</sup>	2 EC	400
	Core courses	24 EC	400-500
<b>EDU components</b>			
	EDU internship	30 EC	600
	EDU theoretical courses	30 EC	400-500

## 7.3 Research Training Project

The research training project in Chemistry should be carried out in one of the research groups of the Leiden Institute of Chemistry. It includes a written report (MSc thesis) and is finalised with a Thesis Talk (as described above). Students should attend at least 7 Thesis Talks. Students who started before September 2019 should attend at least 10 Thesis Talks. Students who started before September 2019, but take the co-curricular component 'WORK' (see below) should attend at least 7 Thesis Talks.

## 7.4 Theoretical compulsory components

The compulsory theoretical component comprises four core courses to be selected from Table 3, and courses on academic skills (Science Methodology<sup>1</sup> and Academic Writing<sup>1</sup>). Students in the EDU specialisation are advised to select courses from both research areas, to obtain a broader knowledge of chemistry.

## 7.5 Compulsory co-curricular component

Students starting per September 2019 or later have to take the compulsory co-curricular component "WORK". See the description and specifications described in the research specialisation.

## **7.6 Elective components**

When the student has passed the minor Education (30 EC) during their BSc programme, the compulsory Education component is reduced with 30 EC. The remaining 30 EC are added to the Chemistry programme as elective courses. Elective components may consist of additional theoretical courses, or an extension of the research project. Furthermore, the restrictions and conditions specified above for elective components apply.

## **7.7 EDU components**

To complete the EDU specialisation 60 EC within the EDU component is required. If a minor EDU was successfully taken in the BSc programme the EDU component is limited to 30 EC. A specification of the EDU specialisation is described [here](#).

# MSc Computer Science

CROHO-number 60300

## 1. Description of the programme (Course and Examination Regulations art. 2)

The MSc programme Computer Science is taught in Leiden by the Leiden Institute of Advanced Computer Science (LIACS).

### 1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

The general objective of the MSc programme Computer Science is to teach master's students sufficient knowledge, insight, and skills to work independently at an academic level as computer scientists, and to contribute in an original manner to recognizing, defining and solving problems in specific knowledge areas of computer science, to discuss this contribution with experts in the field, and to inform non-specialists in a clear and unambiguous manner on their own ideas, goals and the public impact of their research, and to successfully follow a PhD programme within the field of Computer Science and its adjacent areas.

### 1.2 Specialisations (Course and Examination Regulations art. 2.2)

The MSc programme Computer Science offers five specialisations corresponding to major research themes at the LIACS. The first two are the specialisations '*Computer Science and Advanced Data Analytics*' and '*Bioinformatics*'. The third specialisation '*Data Science: Computer Science*' is in cooperation with the Mathematical Institute. The remaining two specialisations combine research in computer science with *Science Communication and Society* (SCS), and *Education* (EDU). In addition, LIACS offers two MSc programmes in *Media Technology* and in *ICT in Business and the Public Sector*, which are described separately in this appendix.

From 1 September 2019, the specialisation Business Studies (BS) is no longer available to students in the MSc Computer Science programme. Students who started this specialisation on February 1<sup>st</sup>, 2019 or earlier, follow the programme as described in the appendix of OER 2018-2019.

All specialisations have the same Director of Education, the same Board of Examiners, and the same Department Teaching Committee. Exceptions to this are formed by the specialisations SCS, and EDU, which for the specialisation-specific part each have their own specialisation coordinator and a Board of Examiners appointed by the Faculty of Science. A Board of Admissions will advise on admissions.

### 1.3 Learning outcomes (Course and Examination Regulations art. 2.3)

Graduates of the MSc programme Computer Science have attained the following general learning outcomes:

- a. theoretical and practical skills in more than one specialist area of computer science such that they can carry out research under overall supervision;
- b. the ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, formulate verifiable hypotheses, and set up and carry out research and critical reflection on one's own research and that of others;
- c. the ability to interrelate and integrate various areas of computer science;
- d. the ability to present clearly, verbally as well as in writing, one's own research results, and the ability to communicate with colleagues and to present their research results as a contribution to a congress or as (part of) a scientific publication;
- e. sufficient understanding of the social and societal role of computer science to be able to reflect upon it and in part consequently to come to an ethically sound attitude and corresponding execution of one's professional duties;
- f. have the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous.

### **1.4 Programme duration and completion (Course and Examination Regulations art. 2.5)**

The duration of the *MSc programme Computer Science* is two years (120 EC). Students who complete the programme receive the degree Master of Science in Computer Science, with a description of the specialisation. Students who complete any of the specialisations in Computer Science are admissible to a PhD programme in Computer Science or related fields.

### **1.5 Start of the programme (Course and Examination Regulations art. 2.6)**

Students can start their programme in September or February, with the exception of the specialisation '*Data Science: Computer Science*' that can be started in September only.

### **1.6 Language of the programme (Course and Examination Regulations art. 2.8)**

The programme is taught in English with the exception of few courses in the Education specialisation.

## **2. Admission to the programme (Course and Examination Regulations chapter 5)**

### **2.1 Confirmation of admission**

2.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 2.2 and 2.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 2.2.1, the proof of registration is also confirmation of admission.

2.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.<sup>23</sup>

### **2.2 Admission to the programme**

2.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a. holders of a bachelor's degree in Computer Science (Informatica) or Artificial Intelligence from a research university in the Netherlands, or
- b. holders of a bachelor's degree in a computer science-related programme from a research university in the Netherlands or from a foreign research university of similar level, provided that the candidate has accumulated at least 90 EC (or the equivalence thereof) in courses/projects belonging to the domain of Computer Science, or
- c. students who have successfully met the requirements of the imposed bridging programme on the basis of Article 2.4.1

2.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in 2.2.1, sub-sections a and b, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 2.2.1, sub-sections a and b, possibly under further conditions.

Article 2.2.2 may, amongst others, apply to holders of a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo) in computer science or bioinformatics related programmes. As a guideline for applicants with a Dutch hbo diploma, the hbo diploma has to be obtained within a maximum of five years and with an average final grade of at least 7.5. Eventual deficiencies up to 30 EC can be removed upon discussion with the study advisor using a bridging programme (see 2.4).

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<sup>23</sup>The Regulations for Admission to Master's Programmes can be found on the website: [Regulations for Admission to Master's Programmes](#)

### *Admission process*

Applicants as referred to in Article 2.2.1.b and Article 2.2.2 are requested to provide the Board of Admissions with a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified in Article 2.2.1.a.

#### **2.2.3 Dutch and English languages<sup>24</sup>**

2.2.3.1 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (or other with English A);
- A diploma of secondary or higher education completed in the US, the United Kingdom, Ireland, New Zealand, Australia or Canada (with the exception of French-taught education in Canada);
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A pre-university education (vwo) diploma.
- A high school (or higher) diploma determined by SEA (Admissions Office) in an EER country, where English has been studied up to and including the final year of the programme, and where the level of English can be considered comparable to Dutch vwo (pre-university education).

2.2.3.2 If a student who wishes to be admitted does not meet the requirements in 2.2.5.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90
- Cambridge Certificate of Advanced English (CAE), minimum grade C

2.2.3.3 As further clarification of Article 2.8 of the Course and Examination Regulations concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*. This applies to the Education specialisation of this master's programme.

## **2.3 Deficiencies**

2.3.1 Holders of a bachelor's degree from a research university, referred to in 2.2.1, subsections a and b, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

2.3.2 Students who still have the deficiencies referred to in 2.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

2.3.3 For the admission referred to in 2.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

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<sup>24</sup> Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

2.3.4 If a student is admitted to the programme on the basis of 2.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

## 2.4 Bridging programmes (Pre-master's)

2.4.1 The department has developed the following bridging programmes (for the following target groups) in order to remove deficiencies:

- For students with bachelor's degrees related to Computer Science the Board of Admissions may impose a Pre-Master's programme, tailored to the individual background of the prospective student, before admission into the MSc programme.

2.4.2 Information on the bridging programmes can be requested from the LIACS Education Office.

## 3. Specialisation Computer Science and Advanced Data Analytics

### 3.1 Description (Course and Examination Regulations art. 2)

The specialisation Computer Science and Advanced Data Analytics offers future-oriented topics in computer science, covering both foundations and applications in four different areas: *Advanced Computing and Systems* (with a focus on high performance computing, cloud and distributed computing, and system security), *Advanced Data Analytics* (with a focus on data mining, algorithmic aspects of data analysis, and social network), *Artificial Intelligence* (with focus on machine learning, optimization algorithms, and decision support techniques), and *Foundations of Computing* (with a focus on algorithms, model checking, and software testing).

This specialisation of the MSc programme Computer Science 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 consists in the large choice of courses and seminars complemented by mandatory courses for each area so that for each student an individually tailored programme can be designed. Each programme is concluded with a master's thesis research project.

### 3.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to the general achievements, graduates of the MSc programme Computer Science with the specialisation Computer Science and Advanced Data Analytics have obtained in-depth knowledge of a specific subject related to at least one of the four areas covered by the programme: *computing systems* (programming high performance computers and embedded systems, building multimedia systems), *data analytics* (in-depth knowledge of data mining techniques, algorithms for large graphs, and neural networks), *artificial intelligence* (knowledge on deep and reinforcement learning methods, understanding the principles of evolutionary computation and its application for optimization algorithms) or *algorithms* (knowledge of verification methods and modelling techniques, and understanding of advanced data structures and algorithms).

### 3.3 Programme (Course and Examination Regulations art. 3)

The programme is 120 EC in extent and consists of a choice of one among four compulsory core components (36 EC), specialisation courses and seminars (42 EC in total), and a master's thesis research project in computer science (second year; 42 EC in total). The choice of the specialisation courses may be limited by the need to adapt the programme to the prior knowledge of the candidate. Every student of the specialisation Computer Science and Advanced Data Analytics has to complete one of the following four compulsory core components<sup>25</sup>:

<u>Core component</u>	<u>Advanced Computing and Systems</u>	<u>Level</u>	<u>EC</u>
Cloud Computing		500	6

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<sup>25</sup> Students who started before September 2019 are not required to complete one of the core components and can freely compose their own 78 EC study plan using the specialisation courses and seminars below.

Embedded Systems and Software	500	6
High Performance Computing I	500	6
High Performance Computing II	500	6
Multimedia Systems	500	6
Secure Systems	500	6
<u>Core component Advanced Data Analytics</u>	<u>Level</u>	<u>EC</u>
Advances in Data Mining	500	6
Deep Learning and Neural Networks	500	6
Information Retrieval and Text Analytics	500	6
Reinforcement Learning	500	6
Seminar Distributed Data Mining <i>or</i> Complex Networks	500/400	6
Social Network Analysis for Computer Scientists	500	6
<u>Core component Artificial Intelligence</u>	<u>Level</u>	<u>EC</u>
Automated Machine Learning	500	6
Deep Learning and Neural Networks	500	6
Evolutionary Algorithms	500	6
Modern Game AI Algorithms	500	6
Multicriteria Optimization and Decision Analysis	500	6
Reinforcement Learning	500	6
<u>Core component Foundations of Computing</u>	<u>Level</u>	<u>EC</u>
Advances in Model Checking	500	6
Coordination and Component Composition	500	6
Foundations of Software Testing	500	6
Modern Game AI Algorithms <i>or</i> Reinforcement Learning	500	6
Quantum Algorithms	500	6
Seminar Combinatorial Algorithms	500	6

Specialisation courses and seminars

A choice can be made from the specialisation courses and seminars below during the first and second year of the programme for at least 42 EC. The specialisation courses and seminars have level 400 - 500, and range from 3 - 6 EC each. It is possible to substitute 18 EC of specialisation courses and seminars with an introductory research project of 18 EC supervised by at least one LIACS scientific staff member.

	<u>Level</u>	<u>EC</u>
Advances in Data Mining	500	6
Advances in Model Checking	500	6
Audio Processing and Indexing	500	6
Automated Machine Learning	500	6
Better Science for Computer Scientists	500	3
Bio-Modeling	500	6
Cloud Computing	500	6
Competitive Programming	500	6
Complex networks (BM)	400	6
Computational Molecular Biology	500	6
Coordination and Component Composition	500	6
Advanced Data Management for Data Analysis	500	6
Deep Learning and Neural Networks	500	6
Embedded Systems and Software	500	6
Evolutionary Algorithms	500	6
Foundations of Software Testing	500	6
High Performance Computing I	500	6
High Performance Computing II	500	6
Image Analysis with Applications in Microscopy	500	6

Information Retrieval and Text Analytics	500	6
Information Theoretic Data Mining	500	6
Introductory Research Project	600	18
Modern Game AI Algorithms	500	6
Multicriteria Optimization and Decision Analysis	500	6
Multimedia Information Retrieval	500	6
Multimedia Systems	500	6
Psychology of Programming	500	6
Quantum Algorithms	500	6
Quantum Computing	500	3
Applied Quantum Algorithms	500	6
Reinforcement Learning	500	6
Robotics	500	6
Secure Systems	500	6
Seminar Combinatorial Algorithms	500	6
Seminar Distributed Data Mining	500	6
Seminar Swarm-based Computation with Applications in Bioinformatics	500	6
Social Network Analysis for Computer Scientists	500	6
Social Signal Processing	500	6
Software Development & Product Management	500	6
Text Mining	500	6
Urban Computing	500	6
<i>Master's thesis research project</i>	<i>Level</i>	<i>EC</i>
Master's Thesis Research Project	600	42
(including Master Class, written thesis and oral presentation)		

## 4. Specialisation Bioinformatics

### 4.1 Description (Course and Examination Regulations chapter 2)

The focus of this programme is on *Data Analysis and Modelling of Biological Processes*, which represents the unique expertise of the Bioinformatics research group at LIACS. This expertise is used to address issues like data acquisition, data warehousing, data analysis, data mining, and data modelling which 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 reductionist approach.

### 4.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to the general achievements, graduates of the MSc programme Computer Science with the specialisation Bioinformatics have obtained in-depth knowledge of the **core concepts of bioinformatics** including methods in computational biology, the design and mining of bio databases, the process and analysis of images, and the construction of mathematical models of biological systems.

### 4.3 Programme (Course and Examination Regulations chapter 3)

The programme is 120 EC in extent and consists of a compulsory core component (36 EC in total), specialisation courses and seminars (42 EC in total), and a master's thesis research project in computer science (second year; 42 EC in total). Every student of the specialisation Bioinformatics has to complete the following compulsory core component<sup>26</sup>:

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<sup>26</sup> Students who started before 1 September 2019 are allowed to substitute at most two courses from the Core component Bioinformatics with *Pattern Recognition* and *Functional Genomics and Systems Biology* from the Technical University of Delft. The support programme of 12 EC and the Research Assignment of 15 EC of previous academic years can be exchanged with the current specialisation courses and seminars. These changes should be

<u>Core component Bioinformatics</u>	<u>Level</u>	<u>EC</u>
Advances in Data Mining	500	6
Bio-Modeling	500	6
Computational Molecular Biology	500	6
Deep Learning and Neural Networks	500	6
Evolutionary Algorithms	500	6
Image Analysis with Applications in Microscopy	500	6

#### Specialisation courses and seminars

A choice can be made from several specialisation courses and seminars during the first and second year of the programme for at least 42 EC. The specialisation courses and seminars have level 400 - 500 and range from 3 - 6 EC each. The selection of the specialisation courses and seminars takes place in coordination with the Bioinformatics study adviser. It is possible to substitute 18 EC of specialisation courses with an introductory research project of 18 EC (level 600) supervised by at least one LIACS scientific staff member.

	<u>Level</u>	<u>EC</u>
Advanced Data Management for Data Analysis	500	6
Automated Machine Learning	500	6
Better Science for Computer Scientists	500	3
Complex Networks (BM)	400	6
Introductory Research Project	600	18
Psychology of Programming	600	6
Reinforcement Learning	500	6
Seminar Distributed Data Mining	500	6
Seminar Functional Genomics (TUD)*	500	6
Seminar Swarm-based Computation with Applications in Bioinformatics	500	6
Text Mining	500	6

\* *Not yet confirmed*

<u>Master's thesis research project</u>	<u>Level</u>	<u>EC</u>
Master's Thesis Research Project (including Master Class, written thesis and oral presentation)	600	42

## 5. Specialisation Data Science: Computer Science

### 5.1 Description (Course and Examination Regulations chapter 2)

Data science is an interdisciplinary discipline at the intersection of statistical science and computer science aiming at discovering knowledge from typically large sets of structured or unstructured data. To achieve this goal, data scientists combine statistical methods and machine learning with exploration and optimization algorithms from computer science. The specialisation Data Science: Computer Science equips students interested in data analysis with state-of-the-art knowledge in the advanced statistical techniques, machine learning and algorithmic aspects of data analysis. The programme is a unique collaboration between the Leiden Institute for Advanced Computer Science and the Mathematical Institute.

### 5.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to the general achievements, graduates of the MSc programme Computer Science with the specialisation Data Science: Computer Science have obtained in-depth knowledge of data

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applied for with the Board of BioInformatics and with a proposal from the Study Advisor sent to the Board of Examiners for approval.

management, have a thorough understanding of statistical analysis of data and are able to develop new data model and techniques and execute statistical analysis.

### 5.3 Programme (Course and Examination Regulations chapter 3)

The programme is 120 EC in extent and consists of a compulsory core component (36 EC in total), specialisation courses and seminars (42 EC in total), and a master's thesis research project in computer science (second year; 42 EC in total). Every student of the specialisation Data Science has to complete the following compulsory core components<sup>27</sup>:

<u>Core component Data Science</u>	<u>Level</u>	<u>EC</u>
Advanced Statistical Computing	500	3
Advances in Data Mining	500	6
Deep Learning and Neural Networks	500	6
Information Theoretic Data Mining	500	6
Introduction to Data Science for Computer Scientists	400	6
Linear & Generalized Linear Models and Linear Algebra	400	9

#### Specialisation courses and seminars

A choice can be made from several specialisation courses and seminars during the first and second year of the programme for at least 42 EC. The specialisation courses and seminars have level 400 - 500 and range from 3 - 6 EC each. The selection of the specialisation courses and seminars takes place in coordination with the study advisor.

	<u>Level</u>	<u>EC</u>
Automated Machine Learning	500	6
Competitive Programming	500	6
Complex networks (BM)	400	6
Advanced Data Management for Data Analysis	500	6
Better Science for Computer Scientists	500	3
Deep Learning and Neural Networks	500	6
Evolutionary Algorithms	500	6
Image Analysis with Applications in Microscopy	500	6
Information Retrieval and Text Analytics	500	6
Modern Game AI Algorithms	500	6
Multicriteria Optimization and Decision Analysis	500	6
Multimedia Information Retrieval	500	6
Multivariate Analysis and Multidimensional Data Analysis	500	6
Psychology of Programming	500	6
Quantum Algorithms	500	6
Quantum Computing	500	3
Reinforcement Learning	500	6
Seminar Distributed Data Mining	500	6
Social Network Analysis for Computer Scientists	500	6
Social Signal Processing	500	6
Statistical Learning	500	6
Text Mining	500	6
Urban Computing	500	6

<u>Master's thesis research project</u>	<u>Level</u>	<u>EC</u>
Master's Thesis Research Project (including Master Class, written thesis and oral presentation)	600	42

<sup>27</sup> Students who started before 1 September 2019 are allowed to substitute at most two courses from *Advances in Data Mining*, *Information Theoretic Data Mining*, and *Deep Learning and Neural Networks* with *Statistical Learning* and/or *Multivariate and Multidimensional Data Analysis*.

## 6. Specialisation Computer Science and Science Communication and Society

### 6.1 Description (Course and Examination Regulations chapter 2)

The specialisation Computer Science and Science Communication and Society (SCS) offers students the possibility to combine computer science and science communication.

Students are prepared for a career in popularisation of science or for a career as a scientist with a communication mind-set.

Students who complete the specialisation Computer Science and Science Communication and Society are admissible to a PhD programme in computer science or in science communication.

### 6.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to the general achievements, graduates of the MSc programme Computer Science with the specialisation Science Communication and Society have reached the following specific achievement levels:

- a. Knowledge and understanding of modern information and communication technology;
- b. Experience in science communication;
- c. Knowledge of ethical, historical and social aspects in the area of the natural sciences.

### 6.3 Programme (Course and Examination Regulations chapter 3)

The Computer Science and Science Communication and Society (SCS) programme consists of:

- a Master's thesis research project in Computer Science of 30 EC, level 600 (including Master Class, written thesis and oral presentation) in one of the research groups of LIACS;
- at least 30 EC of level-500 specialisation courses and seminars in Computer Science to be selected in correspondence with the Master's thesis research topic;
- a maximum of 20 EC of SCS electives and/or Computer Science specialisation courses and seminars; and
- the Science Communication and Society component<sup>28</sup> as described [here](#).

A more comprehensive description, exemptions and more information on the full programme can be found [here](#).

## 7. Specialisation Computer Science and Education

### 7.1 Description (Course and Examination Regulations chapter 2)

The specialisation Computer Science and Education (EDU) is offered as a joint programme with the Leiden University Graduate School of Teaching (ICLON). It prepares students for a career as computer science (in Dutch: 'informatica') teacher. This programme leads up to the so-called "eerstegraads onderwijsbevoegdheid", qualifying the student to teach in Dutch upper secondary education.

### 7.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to general achievements, graduates of the MSc programme Computer Science with the specialisation Education have all qualifications necessary for teaching all years of secondary education and technical and vocational training (for 12-18 year-olds).

### 7.3 Programme (Course and Examination Regulations chapter 3)

The Computer Science and Education programme consists of:

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<sup>28</sup> Completion of the specialisation Science Communication and Society requires a minimum of 40 EC and a maximum of 60 EC within the SCS component.

- a Master's thesis research project in Computer Science of 30 EC, level 600 (including Master Class, written thesis and oral presentation) in one of the research groups of LIACS;
- at least 30 EC of level-500 specialisation courses and seminars in Computer Science to be selected in correspondence with the Master's thesis research topic and including the mandatory course Psychology of Programming (level 500, 6 EC); and
- the Education component as described [here](#).

The Computer Science component of the programme will be followed during the first year of study, the Education component will be followed during the second year.

When the student has passed the minor Education (30 EC) during the BSc programme, the compulsory Education component is reduced by 30 EC. The remaining 30 EC can be used for both the Computer Science and Education component of the Master's programme.

A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found [here](#).

# MSc Governance of Sustainability

CROHO-number 60965

## 1. Description of the programme (Course and Examination Regulations chapter 2)

The MSc programme is instituted in the Faculty of Science of Leiden University, herein referred to as the Faculty, and taught in The Hague by the Institute of Public Administration and Leiden University College, Faculty of Governance and Global Affairs, and by the Institute of Environmental Sciences, Faculty of Science”;

The duration of the programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Governance of Sustainability.

The goal of the master programme Governance of Sustainability is to provide students with a thorough basis in natural sciences and in governance needed to handle the grand challenges regarding sustainability. Students learn how to analyse these complex issues from both perspectives and how to integrate these perspectives in order to develop and improve the quality of governance solutions needed to achieve a sustainable society. In addition, you will acquire a variety of skills required to cope with wicked sustainability problems and to develop oneself into a future ‘change agent’.

### 1.1 Learning outcomes (Course and Examination Regulations art. 2.3)

#### *Knowledge and understanding*

##### **The student has:**

- a) Thorough knowledge of the technical and scientific aspects of the key sustainability issues. These issues include:
  - i) materials and circular economy;
  - ii) biodiversity and ecosystems;
  - iii) climate and energy;
  - iv) toxicity and water.
- b) Thorough knowledge of the key concepts and theories that are relevant to understanding governance processes. These include:
  - i) institutions and policy cycles;
  - ii) decision making and governance networks;
  - iii) global governance and multi-level analysis;
  - iv) policy framing.

##### **The student is able to:**

- a) recognize normative and culture positions of all actors involved in the governance of sustainability – both academics and practitioners.
- b) select and apply a wide variety of social science and natural science methods to evaluate sustainability issues, among others:
  - i) Material Flow Analysis (MFA);
  - ii) Geographic Information Systems (GIS);
  - iii) Environmental Input Output Analyses;
  - iv) Discourse analyses;
  - v) Network analyses;

- vi) Stakeholder analyses;
  - vii) Univariate and multivariate statistical analyses;
  - viii) Qualitative analyses (interviewing, observing, coding);
  - ix) Multi-level analysis
- c) explain why sustainability issues are wicked problems, starting from an integrated analysis of both the natural and the social sciences.
  - d) understand how sustainability issues are constrained and enabled by multilevel and multistakeholder governance settings and policy processes.
  - e) explain which theories, concepts, and data from the natural sciences is -or could be- applied in transnational, national and local governance processes.
  - f) analyse a complex sustainability issue and combine knowledge and methods from various disciplines to come to an integrated proposal for governance solution for the issue at hand.
  - g) formulate integrated and innovative solutions and implementation pathways regarding sustainability issues.

### ***Skills***

The student is able to:

- a) operate within a transdisciplinary and diverse international context, by applying the following skills: critical thinking, synthesizing, reflecting, arguing, debating and intercultural skills.
- b) design and carry out in-depth research on sustainability issues, starting from a set of concepts, theories and research methods based on either the natural or the social sciences, or from a combined approach.
- c) execute integrative scientific research projects (design, organize, execute, analyse and report).
- d) convincingly communicate results from scientific research about sustainability issues to both specialist and non-specialist audiences
- e) argue a well-considered stance on the governance of sustainability issues, making use of the relevant disciplines.
- f) able to be a governance broker and is able to work with and for others, can create commitment for action, has a sense of responsibility and intercultural sensitivity, and demonstrates leadership.
- g) recognise, respect and use individual and cultural differences within a team.

### ***Judgement***

A student is able to:

- a) make an integral and critical assessment of available scientific knowledge and knowledge about governance processes to make judgements about sustainability issues.
- b) compare different transnational, national and local governance settings, policy approaches and institutions to address sustainability issues and apply the most suitable approach.
- c) critically reflect on ethical and normative dimensions regarding the governance of sustainability issues and the associated questions of complexity and uncertainty.
- d) act according to the different normative and culture positions of all actors involved in the governance of sustainability.

### ***Learning skills***

A student:

- a) Has a positive attitude and openness towards self-directed and life-long learning.
- b) Is able to design and plan their own learning processes by virtue of continuous reflection on personal knowledge, skills, attitudes and performance.
- c) Is able to study independently and explore new areas of interest regarding the governance of sustainability issues.

## 2. Admission to the programme (Course and Examination Regulations chapter 5)

The programme starts in September and February. Admission in September is however preferred. The two faculty boards will jointly appoint the Board of Admissions. The Board of Admissions consists of two members: one staff member from each faculty. The Board of Admissions will judge the qualifications of the applicants on the basis of their previous training.

### 2.1 Confirmation of admission

The Faculty Board provides confirmation of admission if the student meets the entry requirements specified below.

Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.<sup>29</sup>

### 2.2 Admission to the programme

Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme:

holders of a bachelor's degree from a research university in the Netherlands, or from a foreign research university of similar level.

The Board of Admissions may, on request, admit persons to the programme who do not hold a bachelor's degree from a research university in the Netherlands, or from a foreign research university of similar level, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of such a bachelor's degree, possibly under further conditions, without prejudice to the conditions specified below.

This may, amongst others, apply to holders of a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo) in the Netherlands, or from a foreign University of Applied Sciences of similar level and length of studies. The hbo diploma has to be obtained with a grade point average of at least 7.5.

### 2.3 Dutch and English languages<sup>30</sup>

As further clarification of Article 2.8 in the Faculty part of this master's Course and Examination Regulations concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (or other with English A);
- A diploma of secondary or higher education completed in the US, the United Kingdom, Ireland, New Zealand, Australia or Canada (with the exception of French-taught education in Canada);
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A pre-university education (vwo) diploma.
- A high school (or higher) diploma determined by SEA (Admissions Office) in an EER country, where English has been studied up to and including the final year of the programme, and where the level of English can be considered comparable to Dutch vwo (pre-university education).

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<sup>29</sup>[Regulations for Admission to Master's Programmes](#)

<sup>30</sup> Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

If a student who wishes to be admitted does not meet the abovementioned language requirements, at least one of the following language requirements can be set:

- IELTS: minimum overall score of 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90 (minimum 20 component score)
- Cambridge C2 Proficiency (CPE) or C1 Advanced (CAE): a score of at least 180 (minimum 169 component score).

## 2.4 Qualitative admission requirements

In addition to the aforementioned requirements, the following qualitative admission requirements apply for the programme pursuant to Article 7.30b (2) of the Act:

- a. Demonstrable knowledge of environmental sustainability issues. Environmental sustainability refers to the capacity of the Earth to produce vital renewable resources and to allow long-term environmental quality (and the governance thereof). This may include activities at an academic level in the field of environmental sustainability issues. Eligible are activities carried out in the context of bachelor education, such as internships and research projects or student assistance activities.
- b. Demonstrable experience with inter- or trans-disciplinary education and research. Eligible are elective courses, a minor, major, internship or a summer course (minimal bachelor level) on topics that are outside his or her own primary discipline. For instance, this may be a minor in terms of sustainability such as the minor Sustainable Development of CML or the minor Science and Technology in Society (coordinated by the Centre for Science and Technology Studies, Faculty of Social Sciences).
- c. Passed one or multiple courses in quantitative methods or quantitative modelling, including statistical methods, equivalent to a minimum of 8 EC.

Applicants need to provide the Board of Admissions with a letter which, in relation to the qualitative admission requirements specified above, elaborates on relevant course modules, summer courses, internships, or other relevant experiences at a sufficient academic level.

The admission process may include an interview with the Board of Admissions, should this be necessary to clarify whether the applicant has the same level of knowledge, understanding and skills as holders of a degree from a research university in the Netherlands, or from a foreign research university of similar level and meets the aforementioned qualitative requirements.

The deadline for the fulfilment of qualitative admission requirements mentioned above is before the start of the academic year in which the student starts the programme. However, applicants need to elaborate on the qualitative admission requirements in their motivation letter when applying for the programme.

## 2.5 Deficiencies

Holders of a bachelor's degree from a Dutch or foreign research university with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

Students who still have such deficiencies when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

For the admission of candidates with deficiencies referred to above, the Board of Admissions assembles a catch-up programme with examination opportunities.

If a student is admitted to the programme and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

## 2.6 Bridging programmes (Pre-master's)

For holders of a bachelor's degree who do not sufficiently meet the admission requirements the Board of Admissions may impose a Pre-Master's programme, tailored to the individual background of the prospective student, before admission into the MSc programme.

## 3. Programme (Course and Examination Regulations chapter 3)

The programme consists of compulsory courses (78 EC), electives (12 EC) and a Research project (30 EC). The programme is outlined below.

	Level	EC
Transdisciplinary skills	500	6
Thematic course 1: Governance of Materials & Circular Economy	500	12
Thematic course 2: Governance of Biodiversity & Ecosystems	500	12
Thematic course 3: Governance of Climate change & Energy Transition	500	12
Qualitative Research skills	500	6
Thematic course 4: Governance of Water & Toxicity	500	12
Quantitative Research skills	500	6
Sustainability Challenge	600	12
Thesis Preparation Course	600	6
Thesis Research Project	600	24
Electives		12

### 3.1 Electives

Students have to complete at least 12 EC of electives. The electives have to be approved by the Board of Examiners before the start of the study components and must meet the following criteria:

1. The elective course should be on MSc level;
2. The elective course should not show a (considerable) overlap with or replace compulsory courses or other chosen electives;
3. The elective course should:
  - a. Deepen the understanding in governance, or
  - b. Deepen the understanding in natural science aspects of sustainability, or
  - c. Improve non-transferable or transferable skills needed to become a knowledge broker or change agent, or
  - d. Gather topical knowledge on the masters' thesis research.
4. The elective course cannot be more than 12 EC.

### **3.2 Compulsory and optional components**

- If a large difference exists between the expected and actual enrolment of students in a mandatory component, the programme management can decide to change the format of teaching methods and assessment.
- If a large difference exists between the expected and actual enrolment of students in a non-mandatory, elective component, the institute's board that offers this elective component may decide not to offer this component or to offer it in a different form; in this case, students will be informed before the start of the component and will be offered an alternative.

### **3.3 Validity of interim examinations**

The validity period of a partial grade is limited until the end of the academic year in which the interim examination was obtained.

# MSc ICT in Business and the Public Sector

CROHO-number 60205

## 1. Description of the programme (Course and Examination Regulations chapter 2)

The MSc *ICT in Business and the Public Sector* is offered by the Leiden Institute of Advanced Computer Science (LIACS) as a two-year research master on the management and application of ICT in an organizational context.

Over the last years, rapid changes in information and communication technology (ICT) and its applications have caused major challenges for all kinds of organisations, industries, and individuals. The Internet, information systems, and communication technology in general, have radically impacted our professional and personal lives. They challenged our thinking on physical, geographical and industry boundaries, on distance, speed and communication.

### 1.1 Objectives of the programme (Course and Examination Regulations art 2.1)

The MSc *ICT in Business and the Public Sector* aims at providing a deeper understanding of the issues, challenges and opportunities in this area, with a specific focus on the management and alignment of ICT in a business and/or governmental context. The programme builds on a technical foundation of Computer Science that students bring from their bachelor's education.

### 1.2 Specialisations (Course and Examination Regulations art. 2.2)

The MSc *ICT in Business and the Public Sector* offers the following two specialisations:

- ICT in Business
- ICT in the Public Sector

The specialisations Business Studies, Science Communication and Society, and Education are not available to students in the ICT in Business programme.

### 1.3 Learning outcomes (Course and Examination Regulations art. 2.3)

Graduates of the master programme *ICT in Business and the Public Sector* have attained the following general learning outcomes:

- a. theoretical and practical skills in more than one specialist area of business, management and information and communication technology such that they can carry out research under overall supervision;
- b. the ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, formulate verifiable hypotheses, and set up and carry out research and critical reflection on one's own research and that of others;
- c. the ability to interrelate and integrate various areas of management and information and communication technology;
- d. the ability to present clearly, verbally as well as in writing, one's own research results, and the ability to communicate with colleagues and to present their research results as a contribution to a conference or as (part of) a scientific publication;
- e. sufficient understanding of the social and societal role of ICT in an organizational context to be able to reflect upon it and in part consequently to come to an ethically sound attitude and corresponding execution of one's professional duties;
- f. have the learning skills to allow one to continue to study in a manner that is largely self-directed or autonomous.

Graduates with the specialisation *ICT in Business* have obtained in-depth knowledge on how ICT enables innovations in all business areas including marketing, operations, finance, strategy and IT itself, and have developed practical skills and experience in applying these concepts in the context of private organisations. Graduates with the specialisation *ICT in the Public Sector* have obtained in-depth knowledge on areas relevant in the public domain such as politico-administrative relations, European

procurement, and data-driven policy development, and have developed practical skills and experience in applying these concepts on an administrative and managerial level.

#### **1.4 Programme duration and completion (Course and Examination Regulations art. 2.5)**

The duration of the programme, which is taught entirely in English, is two years (120 EC). Courses can be organised on campus in Leiden as well as in The Hague. Students who complete the programme receive the degree Master of Science in ICT in Business and the Public Sector, with a description of the specialisation.

#### **1.5 Start of the programme (Course and Examination Regulations art. 2.6)**

Students can start their programme in September or February. Courses can be organised in Leiden as well as in The Hague.

#### **1.6 Language of the programme (Course and Examination Regulations art. 2.8)**

The programme is taught entirely in English.

## **2. Programme (Course and Examination Regulations chapter 3)**

The master programme consists of 15 months of course-work, and a 38 EC thesis project, for example based on an in-company project. The courses cover business or governmental 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.

### **2.1 Curriculum outline ICT in Business and the Public Sector**

The curriculum depends on the student's background. Students with a Leiden University bachelor degree in Computer Science with specialisation "*Informatica & Economie*" follow an alternative curriculum: all courses marked with an \* have to be replaced by electives. All the other students follow the main curriculum.

As of this year, the program offers a technical track. Courses marked § have to be replaced by students with a bachelor degree in Computer Science that want to follow the technical track within the ICTiB specialisation. The courses of a total amount of 21 ECTS have to be replaced by MSc Computer Science courses at Leiden University.

The main curriculum consists of the following courses:

<b>Main curriculum for both specialisations:</b>	<b>EC</b>	<b>Level</b>
Global Business Game	1	400
Leading & Managing People §	5	500
Strategy	5	500
Systems Optimisation §	3	500
Technology and Operations Management	4	500
ICT Architectures	6	500
ICT Enabled Process Innovation	3	500
Accounting * §	3	500
Process Modelling *	3	500
Research Methods	5	500

System Development ‡ §	3	500
Software Development & Product Management	6	500
Applied Research Methodology	4	500
Business Intelligence * §	4	500
Specialisation (see below)	18	500
Electives	9	500
MSc Research Project	38	600
Total	120	

### Specialisation ICT in Business

Entrepreneurship †	3	500
Corporate Decision Making	3	500
Corporate Entrepreneurship	3	500
Marketing * §	3	500
Marketing Analytics	3	500
Managing the Digital Business	3	500
Financial Management * †	3	500
Managing Innovation	3	500
Capstone Cases †	3	500

Courses marked † are obligatory courses for the ICTiB specialisation.

For the ICTiB specialisation, out of the above courses, a total of at least 18 EC will have to be selected, including 9 EC of the three mandatory courses. The course marked ‡ can optionally be replaced by students with a Leiden University bachelor degree in Computer Science (including the specialisation Informatica & Economie) by a 3 ECTS specialisation course within the ICTiB&PS curriculum or one of the 3 ECTS electives that are offered yearly within the ICTiB&PS programme. The course *Corporate Entrepreneurship* is only offered if more than 20 students register for this course.

### Specialisation ICT in the Public Sector

Role of ICT in Public Administration	6	500
Digital Government-Citizen Interaction	3	500
Data-driven Policy Making	3	500
Working for the Government as ICT Expert	6	500

The electives need approval by the Board of Examiners *before* the courses can be taken. Without this preliminary approval we cannot guarantee these electives to be part of the curriculum.

### Optional electives (both public sector and business)

Cyber Security	3	500
Lean Six Sigma	3	500
Computing and public policy in European and international perspective	3	500

As of 2019-2020, the Post Experience programme (for candidates with working experience) is no longer offered. Current PE students (starting September 2017 and earlier) will be enabled to follow the former PE programme (see appendix OER ICT in Business and the Public Sector 2018-2019).

## 3. Admission to the programme (Course and Examination Regulations chapter 5)

### 3.1 Confirmation of admission

3.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 3.2 and 3.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 3.2.1, the proof of registration is also confirmation of admission.

3.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.<sup>31</sup>

### 3.2 Admission to the programme

3.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a. holders of a bachelor's degree in Computer Science (Informatica) from a research university in the Netherlands, or
- b. holders of a bachelor's degree in a computer science-related programme from a research university in the Netherlands or from a foreign research university of similar level provided that the candidate has accumulated at least 90 EC (or the equivalence thereof) in courses/projects belonging to the domain of Computer Science.
- c. students who have successfully met the requirements of the imposed bridging programme on the basis of Article 3.4.1

3.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in 3.2.1, sub-sections a and b, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 3.2.1, sub-sections a and b, possibly under further conditions.

Article 3.2.2 may, amongst others, apply to holders of a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo) in computer science or business information science-related programmes. As a guideline for applicants with a Dutch hbo diploma, the hbo diploma has to be obtained within a maximum of five years and with an average final grade of at least 7.5.

#### *Admission procedure*

Applicants as referred to in Article 3.2.1.b and Article 3.2.2 are requested to provide the Board of Admissions with a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified 3.2.1.a.

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<sup>31</sup>[Regulations for Admission to Master's Programmes](#)

### 3.2.3 Dutch and English languages<sup>32</sup>

3.2.3.1 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (or other with English A);
- A diploma of secondary or higher education completed in the US, the United Kingdom, Ireland, New Zealand, Australia or Canada (with the exception of French-taught education in Canada);
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A pre-university education (vwo) diploma.
- A high school (or higher) diploma determined by SEA (Admissions Office) in an EER country, where English has been studied up to and including the final year of the programme, and where the level of English can be considered comparable to Dutch vwo (pre-university education).

3.2.3.2 If a student who wishes to be admitted does not meet the requirements in 3.2.5.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90
- Cambridge Certificate of Advanced English (CAE), minimum grade C

3.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*.

## 3.3 Deficiencies

3.3.1 Holders of a bachelor's degree from a research university, referred to in 3.2.1, subsections a and b, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

3.3.2 Students who still have the deficiencies referred to in 3.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

3.3.3 For the admission referred to in 3.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

3.3.4 If a student is admitted to the programme on the basis of 3.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

## 3.4 Bridging programmes (Pre-master's)

3.4.1 The department has developed the following bridging programmes in order to remove deficiencies:

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<sup>32</sup> Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

- For students with bachelor's degrees related to Computer Science the Board of Admissions may impose a Pre-Master's programme, tailored to the individual background of the prospective student, before admission into the MSc programme.

3.4.2 Information on the bridging programmes can be requested from the LIACS Education Office.

# MSc Life Science and Technology

CROHO-number 66286

## 1. Description of the programme (Course and Examination Regulations chapter 2)

The Leiden Institute of Chemistry (LIC) forms the basis for research and collaborations of the Leiden chemistry and life sciences groups. The LIC offers two MSc programmes, namely the MSc Life Science and Technology and the MSc Chemistry. The study Life Science and Technology concerns the processes in the living cell. The cell is the building block of life, the smallest unit with the characteristics of living systems. Increased knowledge of the mechanisms of the cell can lead to better medicines, new methods for combating diseases. The MSc programme LST participates in the Leiden University research profiling theme of “BioScience: Science base of Health”.

Research topics in *Life Science and Technology* comprise molecular and cellular as well as chemical biology research creating an unprecedented progress in understanding of fundamental cellular processes and mechanisms underlying diseases. Knowledge about genomic organization, studies on protein-protein interactions, synthesis and application of molecular chemical structures and understanding of bio(medical) informatics are a core part of our modern understanding of health & disease. Our MSc students learn to understand the molecular and structural chemical and biological aspects of disease-related processes and will be able to apply chemical tools in treating diseases.

Several disease-related studies can be carried out e.g. at the LIC, LACDR, IBL, LUMC, Dutch Cancer Institute (NKI) or ErasmusMC. Detailed information concerning the research topics that are investigated at the LIC can be found on the websites of the research groups, via <https://www.universiteitleiden.nl/en/science/chemistry/>.

### 1.1. Specialisations (Course and Examination Regulations art. 2.2)

The MSc LST programme offers four specialisations: Life Science Research and Development (RESEARCH), Life Science and Business Studies (BS), Life Science and Science Communication and Society (SCS) and Life Science and Education (EDU). The duration of each specialisation is two years (120 EC); a general programme overview of the four specialisations is given in Table 1. Students who complete the programme receive the degree Master of Science in LST, with specification of the specialisation. Students with an MSc degree in LST are admissible to a PhD programme.

**Table 1:** Overview of the programmes of the four MSc LST specialisations (weights in EC)

Specialisation	RESEARCH	EDU	SCS	BS
Research Training Project	60	30	30	30
Academic Skills <sup>33</sup>	6	6	6	6
Core courses in research area	24	24	24	24
Essay & Colloquium	6	-	-	-
Free electives*	24	30 / 0**	20	20
EDU/SCS/BS components	-	30 / 60	40	40
<b>Total</b>	<b>120</b>	<b>120</b>	<b>120</b>	<b>120</b>

\* 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 research project. A maximum of 20 EC may be used as an extension of the SCS or BS components.

\*\* If the student has taken a minor in Education (“tweedegraadsbevoegdheid”) of 30 EC in the BSc programme, only 30 EC are necessary in the MSc programme to obtain the “eerstegraadsbevoegdheid”; then 30 EC free electives are added to the programme of the MSc LST.

<sup>33</sup> Compulsory for students who started with the MSc LST per September 2017 or later.

## 1.2 Learning outcomes (Course and Examination Regulations art. 2.3)

After completion of the MSc LST programme students will have developed:

- Knowledge and understanding of theoretical concepts of Life Sciences from textbooks and primary literature pertaining to the research area
- The ability to plan chemical research, perform experiments within an appropriate time frame, collect and store data in a logical way, such that colleagues can easily find and access the data (data management)
- The ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, and formulate verifiable hypotheses
- An appropriate critical scientific attitude, i.e. the ability to analyse results and critically evaluate their validity and accuracy
- The skill to communicate Life Sciences research progress and results to colleagues, supervisors and experts
- The ability to write independently a structured and accurate report on performed research in Life Sciences
- The ability to perform with an academic attitude and the skills for autonomous self-development, taking into account the ethical and social aspects of the natural sciences.

## 1.3 Start of the programme (Course and Examination Regulations art. 2.6)

Students can start their programme in September or February; international students are strongly advised to start in September.

## 1.4 Programme organisation

All specialisations have the same Programme Director and the same Board of Admission. The Programme Committee for the MSc programme LST is combined with that for the MSc programme Chemistry and is responsible for the Research specialisation and the programme-specific components of the other specialisations. The specialisation-specific components of the BS, EDU and SCS specialisations have their own Programme Committee. The Board of Examiners of the MSc programme LST is also combined with the one of the MSc programme Chemistry. The specialisations BS, SCS, and EDU each have their own faculty-wide Board of Examiners appointed by the Faculty of Science for the specialisation-specific part of the MSc programme.

All MSc students are guided by a personal mentor. The mentor generally is the (internal LIC) supervisor of the major research training project. The mentor will coach the student from the admission throughout the MSc programme to the final examination. The web-based master planner is used for planning and registration of the study programme, and is to be filled in by the student in consult with the mentor. The mentor and student discuss the progress of the student at least every 6 months using the results documented in the master planner. The master planner is updated by the student on a regular basis. It is accessible to the student, the mentor and the study coordinator. The study coordinator administrates a copy of the individual study programme; it is used to keep track of the student's progress and forms the basis for the master portfolio. The study adviser will mediate when a student encounters problems in the interaction with the mentor.

## 2. Programme (Course and Examination Regulations chapter 3)

Students compose their own study programme (choice in core courses, electives and research training project) in consent with their mentor, who is a scientific staff member of the LIC. 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. The programme may be adjusted during the course of the MSc study.

Specialisation-specific components of the specialisations Life Science and Business Studies, Life Science and Science Communication and Society, and Life Science and Education are described separately in this Appendix. A 'double' specialisation should comprise a full programme of one specialisation plus the specialisation-specific components of the second specialisation, with the Research specialisation counting as the 'main' specialisation. The number of credits for 'double' specialisations thus must be at

least 150 EC (Research + EDU-30), 160 EC (Research + BS; Research + SCS; BS + SCS) or 180 EC (Research + EDU-60).

### **3. Admission to the Programme (Course and Examination Regulations chapter 5)**

#### **3.1 Confirmation of admission**

3.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 3.2 and 3.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 3.2.1, the proof of registration is also confirmation of admission.

3.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.<sup>34</sup>

#### **3.2 Admission to the programme**

3.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a) holders of a bachelor's degree in Life Science and Technology (LST) from any research university in the Netherlands, or
- b) holders of a bachelor's degree in an LST-related programme from a research university in the Netherlands or from a foreign research university of equal level, provided that the candidate has:
  - accumulated at least 150 EC (or the equivalence thereof) in courses/projects belonging to the domain of Life Science and Technology and
  - obtained the degree with an average final grade of at least 7.0 (Dutch grading system) and
  - a research project/internship grade of at least 7.5

such to be judged by the Board of Admissions,

Applicants as referred to in Article 3.2.1 subsection b are requested to provide the Board of Admissions with the following:

- A letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified in Article 3.2.1 subsection a,
- A curriculum vitae,
- Transcript of grades received in the previous education,
- Letter of recommendation preferably by the internship supervisor,

3.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in Article 3.2.1, subsections a and b, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified in Article 3.2.1, subsections a and b.

Article 3.2.2 may, amongst others, apply to holders of a degree from a foreign research university that does not meet the requirements specified in Article 3.2.1 subsection b or to a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo) in an LST-related programme provided that the candidate has:

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<sup>34</sup> [Regulations for Admission to Master's Programmes](#)

- obtained the degree with an average final grade of at least 7.5 (Dutch grading system) and
- a research project/internship grade of at least 8.0

Applicants as referred to in Article 3.2.2 are requested to provide the Board of Admissions with the following:

- A letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified in Article 3.2.1 subsection a,
- A curriculum vitae,
- Transcript of grades received in the previous education,
- Letter of recommendation preferably by the internship supervisor,
- Hbo students should also submit a letter of recommendation of the mentor ('studieoopbaanbegeleider') of the BAS programme.

### 3.2.3 Dutch and English languages<sup>35</sup>

3.2.3.1 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (or other with English A);
- A diploma of secondary or higher education completed in the US, the United Kingdom, Ireland, New Zealand, Australia or Canada (with the exception of French-taught education in Canada);
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A pre-university education (vwo) diploma.
- A high school (or higher) diploma determined by SEA (Admissions Office) in an EER country, where English has been studied up to and including the final year of the programme, and where the level of English can be considered comparable to Dutch vwo (pre-university education).

3.2.3.2 If a student who wishes to be admitted does not meet the requirements in 3.2.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5 (minimum score on each subtest: 6.0)
- TOEFL: internet based 90
- Cambridge Certificate of Advanced English (CAE), minimum grade C

3.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*. This condition applies to the Education specialisation of the master programme.

## 3.3 Deficiencies

3.3.1 Holders of a bachelor's degree from a research university, referred to in Article 3.2.1 subsections a and b, or an equivalent diploma with x (x may vary from 1 to 15) EC of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

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<sup>35</sup> Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

3.3.2 Students who still have the deficiencies referred to in Article 3.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

3.3.3 For the admission referred to in Article 3.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

3.3.4 If a student is admitted to the programme on the basis of Article 3.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

## 4. Specialisation Life Science Research and Development (RESEARCH)

### 4.1 Description (Course and Examination Regulations chapter 2)

The research specialisation offers the student the opportunity to spend two full years on training and specialisation not only to become an independent and creative researcher, but also someone who can use their analytical skills to resolve challenges in their career in science or in society. The majority of the students with an MSc in Research in LST will continue their career in a PhD position.

### 4.2 Programme (Course and Examination Regulations chapter 3)

The Life Science research and development programme (RESEARCH) consists of the parts specified in Table 2.

**Table 2:** Overview of the Life Science research and development programme

Catalog number	Component	Study load	Level
	Research training:	60 - 80 EC*	600
	Major research project	40-60 EC	600
	Minor research project (optional)	20-40 EC	600
4603SCMT4	Science Methodology <sup>33</sup>	4 EC	400
4423ACWR2	Academic Writing <sup>33</sup>	2 EC	400
4423ESCOLY	Essay and colloquium	6 EC	500
	Core courses	24 EC	400-500
	Electives	4-24 EC	400-600

\* The total weight of research projects may not exceed 80 EC.

### 4.3 Research Training Project

The (major) research-training project is carried out within LIC research groups, LACDR, or IBL. Our MSc students also have the opportunity to carry out pre-clinical master projects in biomedical research institutes, including the LUMC, NKI or Erasmus MC. The research-training project may be split into two research-training projects: the major and minor training project. The major research-training project is limited to a minimum of 40 and a maximum of 60 EC; an optional minor research-training project must comprise at least 20 EC. A minor research training project can be carried out in another research group, another institute (within the Netherlands or abroad), or in industry; in all cases a scientific staff member of the LIC must act as a (co) supervisor. Prior approval of the Board of Examiners is required for a research-training project outside the LIC, IBL, LACDR, LUMC, NKI, or Erasmus MC. Students can only start with an optional minor research training project (within or outside the LIC) when the major project has been successfully concluded with a grade (including a Thesis Talk).

Each research training project must be supervised and evaluated by two scientific staff members. Two LIC scientific staff members evaluate and grade the student for projects carried out in the LIC. Optional minor research training projects carried out within the LIC are evaluated and graded by two LIC scientific staff members, who were not involved in the major research training project. Research training projects carried out outside the LIC are evaluated and graded by one LIC scientific staff member and a staff member from the host institute. The LIC co-supervisor has the final responsibility for the creation of the research project agreement, grading of the research project report and creation and signing of the project evaluation form.

All research training projects are concluded with a written report; for the major research training this is the MSc thesis. Written reports are graded by the main supervisor and an independent second examiner who was not involved in the writing process. The final version of the report should be handed in within 3 months after the last day of practical work. The supervisor is allowed to limit the grade to a 6 if this deadline is exceeded.

The major research project is concluded with an oral presentation for an independent jury of two staff members, as well as an audience of interested students and staff members of the LIC (i.e. Thesis Talk). Students should attend at least 7 Thesis Talks during their MSc programme as part of their training. Students who started before September 2019 should attend at least 10 Thesis Talks. Students who started before September 2019, but take the co-curricular component 'WORK' (see below) should attend at least 7 Thesis Talks.

#### 4.4 Theoretical compulsory components

The compulsory theoretical component comprises a selection of four core courses, courses on academic skills (Science Methodology<sup>33</sup> and Academic Writing<sup>33</sup>), and a literature essay with a colloquium.

The colloquium supervisor cannot be the mentor, but students can discuss with their mentor possible topics and fields of study of interest. The final grade for the colloquium is determined by a colloquium jury, composed of two LIC staff members. The jury cannot include the mentor or colloquium supervisor. All students attend at least 7 colloquia during their MSc programme. Students who started before September 2019 should attend at least 10 colloquia. Students who started before September 2019, but take the co-curricular component 'WORK' (see below) should attend at least 7 colloquia.

The four core courses are chosen from the list described in Table 3. The LST master students have to choose one course from each of the series (Biomedical, Molecular, and Biophysical Sciences), plus one additional course from one of the three series.

**Table 3:** Core courses in the MSc Life Science and Technology. All courses encompass 6 EC.<sup>#,\*</sup>

	Level	Catalog number
<b>Biomedical Sciences</b>		
Biomedical Informatics	500	4423BMINF
In-vivo Biomolecular Interactions Underlying Diseases	500	4423IVBID
Chemical Immunology	500	4423CHEIM
<b>Molecular Sciences</b>		
Molecular Chemistry <sup>**</sup>	400	4423MOLC6
Chemical Biology	500	4423CHEMB
Metals and Life	500	4423METL6
<b>Biophysical Sciences</b>		
Bionanotechnology	500	4423BIONT
Enzyme Dynamics: NMR Spectroscopy and Kinetics	500	4423EDNMR
Biomaterials	500	4423BIOMA

<sup>#</sup> Students who started before February 2019 may compose their set of core courses as described in the OER of the year in which they started their MSc programme LST. Students who started per February 2019 are allowed to compose their set of core courses from either Table 3 above, or from Table 3 described in the OER of 2018-2019. In the latter case they are allowed to take Metals and Life as a core course in the set 'Molecular Sciences' instead of Molecular Chemistry or Chemical Genetics.

- \* Courses that were taken in the BSc programme cannot be taken again in the MSc programme.  
\*\* This course cannot be chosen in combination with the course Synthetic Organic Chemistry, (SOC), or when SOC was taken in the BSc programme.

#### 4.5 Compulsory co-curricular component

Students starting per September 2019 or later have to take the compulsory co-curricular component "WORK". Students will have to *Write* an application letter and CV, attend seminars and workshops for job market *Orientation*, and have to *Reflect* on their skills, strengths and weaknesses. After finalization of this component they will have acquired improved *Knowledge* of what they are good at and what kind of career they would like to pursue! This component comprises a number of activities and workshops to create awareness of the job market, and give students insight in their skills, abilities and weaknesses. During the two years of the MSc programme, a number of different activities will be offered, some of which will be compulsory, and others can be chosen. The activities will comprise: alumni-events (lectures, speed-dating), workshops offered by the Career Service, self-assessment and self-reflection tasks, participation in excursions to companies or a visit to the 'β-banenmarkt'. All students have to do a self-evaluation test at the start of their programme, take part in the workshop 'CV, LinkedIn profile and cover letter' during their studies, and write a self-reflection after their major research project. In addition students take at least 6 of the offered workshops or other activities that are offered by the programme or career service during their studies.

#### 4.6 Elective components

The elective component consists of a free choice of theoretical courses. A maximum of 20 EC can be used to extend the research training project, within the limitations described above.

Elective theoretical courses can be chosen from: the list of core courses, approved elective MSc courses of the Leiden University Faculty of Science published in the electronic study guide, the MSc courses offered in a Science Faculty of any Dutch or foreign university of level 400 or higher, or level 400 courses from the BSc MST or LST programmes. Elective theoretical courses can be taken provided that these courses were not part of the student's earlier studies, and do not overlap in content with other courses already taken as part of the MSc curriculum.

Prior to taking any theoretical courses offered by universities outside the Netherlands, as well as starting of any external research project (with the exception of the institutes listed above) students must apply for approval of the Board of Examiners.

## 5. Specialisation Life Science and Business Studies

### 5.1 Description (Course and Examination Regulations chapter 2)

The specialisation Life Science and Business Studies (BS) offers students the possibility to combine Life Science with knowledge, insights and skills in the area of Management, Business and Entrepreneurship.

Students are encouraged to broaden their horizon, to form an opinion on and prepare for a career in industry and to enhance competences for pursuing entrepreneurial business opportunities created in science and research.

### 5.2 Programme (Course and Examination Regulations chapter 3)

The Life Science and Business Studies (BS) programme consists of the parts specified in Table 4. A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

**Table 4:** Overview of the programme of the specialisation Life Science and Business Studies

Catalog number	Component	Study load	Level
	Research training	30 - 50 EC	600
4603SCMT4	Science Methodology <sup>33</sup>	4 EC	400
4423ACWR2	Academic Writing <sup>33</sup>	2 EC	400

Core courses (in research area)	24 EC	400-500
Electives	0-20 EC	400-600
<b>BS components (track 'Management' or 'New Technology Venture')</b>		
BS core courses	20 EC	400-500
BS internship	20-40 EC	600
BS elective courses	0-20 EC	400-500

### 5.3 Research Training Project

The research training project in LST should be carried out in one of the research groups of the LIC or other institutes specified above. It includes a written report (MSc thesis) and is finalised with a Thesis Talk (as described above). Students should attend at least 7 Thesis Talks. Students who started before September 2019 should attend at least 10 Thesis Talks. Students who started before September 2019, but take the co-curricular component 'WORK' (see below) should attend at least 7 Thesis Talks.

### 5.4 Theoretical compulsory components

The compulsory theoretical component comprises four core courses to be selected from Table 3 as described in the research specialisation, and courses on academic skills (Science Methodology<sup>33</sup> and Academic Writing<sup>33</sup>).

### 5.5 Compulsory co-curricular component

Students starting per September 2019 or later have to take the compulsory co-curricular component "WORK". See the description and specifications described in the research specialisation.

### 5.6 Elective components

Elective components may consist of additional theoretical courses, an extension of the research project or additional BS courses. Furthermore, the restrictions and conditions specified above for elective components apply.

### 5.7 BS components

A minimum of 40 EC and a maximum of 60 EC within the BS component is required to complete the BS specialisation. A specification of the 'BS Management' or 'BS New Technology Ventures track' is described [here](#).

## 6. Specialisation Life Science and Science Communication and Society

### 6.1 Description (Course and Examination Regulations chapter 2)

The specialisation Life Science and Science Communication and Society (SCS) offers students the possibility to combine life sciences and science communication. Students are prepared for a career in popularisation of science or for a career as a scientist with a communicating mind-set.

### 6.2 Programme (Course and Examination Regulations chapter 3)

The SCS programme consists of the parts specified in Table 5. A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

**Table 5:** Overview of the programme of specialisation Life Science and Science Communication and Society

Catalog number	Component	Study load	Level
	Research training	30 - 50 EC	600
4603SCMT4	Science Methodology <sup>33</sup>	4 EC	400
4423ACWR2	Academic Writing <sup>33</sup>	2 EC	400

	Core courses (in research area)	24 EC	400-500
	Electives	0-20 EC	400-600
<b>SCS components</b>			
	SCS internship	14-34 EC	600
	SCS theoretical courses	26-46 EC	400-500

### 6.3 Research Training Project

The research training project in LST should be carried out in one of the research groups of the LIC or other institutes specified above. It includes a written report (MSc thesis) and is finalised with a Thesis Talk (as described above). Students should attend at least 7 Thesis Talks. Students who started before September 2019 should attend at least 10 Thesis Talks. Students who started before September 2019, but take the co-curricular component 'WORK' (see below) should attend at least 7 Thesis Talks.

### 6.4 Theoretical compulsory components

The compulsory theoretical component comprises four core courses to be selected from Table 3 as described in the research specialisation, and courses on academic skills (Science Methodology<sup>33</sup> and Academic Writing<sup>33</sup>).

### 6.5 Compulsory co-curricular component

Students starting per September 2019 or later have to take the compulsory co-curricular component "WORK". See the description and specifications described in the research specialisation.

### 6.6 Elective components

Elective components may consist of additional theoretical courses, an extension of the research project or additional SCS courses. Furthermore, the restrictions and conditions specified above for elective components apply.

### 6.7 SCS components

A minimum of 40 EC and a maximum of 60 EC within the SCS component is required to complete the SCS specialisation. A specification of the SCS specialisation is described [here](#).

## 7. Specialisation Life Science and Education (NL)

### 7.1 Description (Course and Examination Regulations chapter 2)

The specialisation Life Science and Education (EDU) prepares students for a career as chemistry (scheikunde) or biology (biologie) teacher qualified to teach in Dutch secondary education.

### 7.2 Programme (Course and Examination Regulations chapter 3)

The Life Science and Education (EDU) programme consists of the parts specified in Table 6. The Life Sciences component of the programme must be followed during the first year of study, the Education component will be followed during the second year. A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found [here](#).

**Table 6:** Overview of the specialisation Life Science and Education

Catalog number	Component	Study load	Level
	Research training	30 EC	600
4603SCMT4	Science Methodology <sup>33</sup>	4 EC	400
4423ACWR2	Academic Writing <sup>33</sup>	2 EC	400
	Core courses (in research area)	24 EC	400-500

### **EDU components**

EDU internship	30 EC	600
EDU theoretical courses	30 EC	400-500

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### **7.3 Research Training Project**

The research training project in LST should be carried out in one of the research groups of the LIC or other institutes specified above. It includes a written report (MSc thesis) and is finalised with a Thesis Talk (as described above). Students should attend at least 7 Thesis Talks. Students who started before September 2019 should attend at least 10 Thesis Talks. Students who started before September 2019, but take the co-curricular component 'WORK' (see below) should attend at least 7 Thesis Talks.

### **7.4 Theoretical compulsory components**

The compulsory theoretical component comprises four core courses to be selected from Table 3 as described in the research specialisation, and courses on academic skills (Science Methodology<sup>33</sup> and Academic Writing<sup>33</sup>).

### **7.5 Compulsory co-curricular component**

Students starting per September 2019 or later have to take the compulsory co-curricular component "WORK". See the description and specifications described in the research specialisation.

### **7.6 Elective components**

When the student has passed the minor Education (30 EC) during their BSc programme, the compulsory Education component is reduced with 30 EC. The remaining 30 EC are added to the LST programme as elective courses. Elective components may consist of additional theoretical courses, or an extension of the research project. Furthermore, the restrictions and conditions specified above for elective components apply.

### **7.7 EDU components**

To complete the EDU specialisation 60 EC within the EDU component is required. If a minor EDU was successfully taken in the BSc programme the EDU component is limited to 30 EC. A specification of the EDU specialisation is described [here](#).

# MSc Mathematics

CROHO-number 66980

## 1. Description of the programme (Course and Examination Regulations chapter 2)

The programme is taught in Leiden by the Mathematisch Instituut (MI).

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. Exceptions to this are formed by the specialisations Business Studies, SCS, and EDU, which for the specialisation-specific part each have their own specialisation coordinator and a Board of Examiners appointed by the Faculty of Science.

### 1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

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

### 1.2 Specialisations (Course and Examination Regulations art. 2.2)

The Universiteit Leiden offers five specialisations of an MSc programme in mathematics. Two of these correspond to research specialisations in the Leiden Mathematisch Instituut. The remaining three specialisations combine research in mathematics with Business Studies (BS), Science Communication and Society (SCS) and Education (EDU).

### 1.3 Final qualifications/ final learning outcomes (Course and Examination Regulations art. 2.3)

Generic, for all specialisations

A *Knowledge and Understanding, and their Application*

Master graduates have:

- A1 knowledge and understanding of the core concepts and principles of the broad mathematics domain, and have thorough knowledge and understanding of at least one subdomain of mathematics which is related to one of the following topics:
  - for the specialisation Algebra, Geometry and Number Theory: algebra, algebraic and analytic number theory, algebraic and differential geometry, topology, cryptology, or combinatorics;
  - for the specialization Applied Mathematics: differential equations, dynamical systems, analysis of problems from industry and the life sciences, measure and integration theory, probability theory, statistics, functional analysis, numerical analysis, or operations research;
- A2 proficient skills in applying mathematical theory to concrete mathematical problems;
- A3 the ability to recognise the specific mathematical areas relevant to a problem;
- A4 the ability, under supervision, to formulate a research question in a mathematically rigorous way, and to set up and carry out the subsequent analysis of the problem.

### *B Making Judgements*

Master graduates are able to:

- B1 interpret and reflect on mathematical results;
- B2 act as professional academics with a sound ethical attitude, and they are aware of the societal role of a professional mathematician with a corresponding level of integrity and the according behaviour.

### *C Communication*

- C1 Master graduates are able to write a clear and unambiguous scientific report, and to communicate orally with mathematicians and non-specialists.

### *D Learning Skills*

Master graduates have:

- D1 the ability to acquire and integrate new [/additional] knowledge relevant to a mathematical problem;
- D2 sufficient mathematical knowledge and academic and general professional skills to become productive in industry, government, as a high school teacher, or as a PhD student in mathematics.

## **1.4 Start of the programme (Course and Examination Regulations art. 2.6)**

Starting the programme is possible throughout the year, but international students are strongly advised to start in September or February.

## **2. Admission to the programme (Course and Examination Regulations chapter 5)**

### **2.1 Confirmation of admission**

2.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 2.2 and 2.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 2.2.1, the proof of registration is also confirmation of admission .

2.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.<sup>36</sup>

### **2.2 Admission to the programme**

2.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a. holders of a bachelor's degree in Mathematics (Wiskunde) from a research university in the Netherlands, or
- b. holders of a bachelor's degree in a mathematics-related programme from a research university in the Netherlands or from a foreign research university of similar level, or in a related sciences

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<sup>36</sup>[Regulations for Admission to Master's Programmes](#)

- programme, provided the candidate has accumulated the mathematical background at least equivalent to a bachelor's degree in mathematics.
- c. students who have successfully met the requirements of the imposed bridging programme on the basis of Article 2.4.1

2.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in 5.2.1, sub-sections a and b, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 5.2.1, sub-sections a and b, possibly under further conditions.

#### *Admission process*

Applicants as referred to in Article 2.2.1. b and Article 2.2.2. are requested to provide the Board of Admissions with a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified in 2.2.1 a.

The admission process may include an interview with the Board of Admissions, should this be necessary to clarify whether the applicant has the same level of knowledge, understanding and skills as holders of a degree specified in 2.2.1.a.

#### 2.2.3 **Dutch and English languages**<sup>37</sup>

2.2.3.1 As further clarification of Article 2.8 (see Faculty part of these regulations) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (or other with English A);
- A diploma of secondary or higher education completed in the US, the United Kingdom, Ireland, New Zealand, Australia or Canada (with the exception of French-taught education in Canada);
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A pre-university education (vwo) diploma.
- A high school (or higher) diploma determined by SEA (Admissions Office) in an EER country, where English has been studied up to and including the final year of the programme, and where the level of English can be considered comparable to Dutch vwo (pre-university education).

2.2.3.2 If a student who wishes to be admitted does not meet the requirements in 2.3.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 95, with a minimum of 22 on each of the components Listening, Reading, Writing and Speaking
- Cambridge Certificate of Advanced English (CAE), minimum grade C

2.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*. This applies to the Education specialisation of this master's programme.

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<sup>37</sup> Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

## 2.4 Deficiencies

2.4.1 Holders of a bachelor's degree from a research university, referred to in 2.2.1, subsections a and b, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

2.4.2 Students who still have the deficiencies referred to in 2.4.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

2.4.3 For the admission referred to in 2.4.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

2.4.4 If a student is admitted to the programme on the basis of 2.4.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

## 3. Specialisation Algebra, Geometry and Number Theory (ALGANT)

### 3.1 Description (Course and Examination Regulations chapter 2)

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.

### 3.2 Programme (Course and Examination Regulations chapter 3)

For each student a programme will be tailored individually. It consists of

- a choice of at least 60 EC of advanced courses (at least 30 EC of these must be obtained via courses of Mastermath, the Dutch Master Programme in Mathematics) from algebra, algebraic and analytic number theory, algebraic and differential geometry, topology, cryptography, combinatorics, or related subjects, if agreed in advance with their study advisor;
- a research project in Mathematics of 40 EC (incl. a thesis and an oral presentation) in one of the research groups of the Leiden Mathematical Institute;
- a free choice of courses from any field as agreed with the study advisor, of maximally 20 EC.

Required is a total of at least 120 EC.

## 4. Specialisation Applied Mathematics

### 4.1 Description (Course and Examination Regulations chapter 2)

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.

### 4.2 Programme (Course and Examination Regulations chapter 3)

For each student a programme will be tailored individually. It consists of

- a choice of at least 60 EC of advanced courses (at least 30 EC of these must be obtained via courses of Mastermath, the Dutch Master Programme in Mathematics) from differential equations, dynamical systems, analysis of industrial problems, measure- and integration theory, probability theory, statistics, functional analysis, numerical analysis, operations research or related subjects, if agreed in advance with their study advisor;
- a research project in Mathematics of 40 EC (incl. a thesis and an oral presentation) in one of the research groups of the Leiden Mathematical Institute;
- a free choice of courses from any field as agreed with the study advisor, of maximally 20 EC.

Required is a total of at least 120 EC.

## 5. Specialisation Business Studies

### 5.1 Description (Course and Examination Regulations chapter 2)

The specialisation Mathematics and Business Studies (BS) offers students the possibility to combine mathematics with knowledge, insights and skills in the area of Management, Business and Entrepreneurship.

Students are encouraged to broaden their horizon, to form an opinion on and prepare for a career in industry and to enhance competences for pursuing entrepreneurial business opportunities created in science and research.

Students who complete the specialisation Mathematics and Business Studies are admissible to a PhD programme.

### 5.2 Programme (Course and Examination Regulations chapter 3)

The Mathematics and Business Studies programme consists of:

- a research project in Mathematics<sup>38</sup> of 30 EC (incl. a thesis and an oral presentation) in one of the research groups of the Leiden Mathematical Institute;
- 30 EC of courses to be selected in correspondence with the research topic;
- a maximum of 20 EC of electives within either Mathematics or the Business Studies component; and
- the Management or New Technology Ventures track<sup>39</sup> as described [here](#).

Required is a total of at least 120 EC.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

Students who started the master programme before 2018-2019 have the choice to follow the old programme consisting of a research project in Mathematics of 40 EC, with 20 EC of courses in correspondence with the research topic, or to opt for the new variant, as agreed with the study advisor.

## 6. Specialisation Science Communication and Society

### 6.1 Description (Course and Examination Regulations chapter 2)

The specialisation Mathematics and Science Communication and Society (SCS) offers students the possibility to combine mathematics and science communication.

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<sup>38</sup> For the programme Mathematics and Business Studies the BS internship should be connected to the research project in Mathematics.

<sup>39</sup> Completion of the specialisation Business Studies requires a minimum of 40 EC and a maximum of 60 EC within the Business Studies component.

Students are prepared for a career in popularisation of science or for a career as a scientist with a communicating mind-set.

Students who complete the specialisation Mathematics and Science Communication and Society are admissible to a PhD programme in mathematics or in science communication.

## 6.2 Programme (Course and Examination Regulations chapter 3)

The Mathematics and Science Communication and Society (SCS) programme consists of:

- a research project in Mathematics of 30 EC (incl. 7 EC for the master's thesis and an oral presentation) in one of the research groups of the Leiden Mathematical Institute;
- 30 EC of courses to be selected in correspondence with the research topic; and
- a maximum of 20 EC of electives within either Mathematics or the SCS component; and
- the Science Communication and Society component<sup>40</sup> as described [here](#).

Required is a total of at least 120 EC.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

Students who started the master programme before 2018-2019 have the choice to follow the old programme consisting of a research project in Mathematics of 40 EC, with 20 EC of courses in correspondence with the research topic, or to opt for the new variant, as agreed with the study advisor.

## 7. Specialisation Education

### 7.1 Description (Course and Examination Regulations chapter 2)

The specialisation Mathematics and Education (EDU) prepares students for a career as mathematics (wiskunde) teacher qualified to teach in Dutch secondary education.

Students who complete the specialisation Mathematics and Education are admissible to a PhD programme.

### 7.2 Programme (Course and Examination Regulations chapter 3)

The Mathematics and Education (EDU) programme consists of:

- a research project in Mathematics of 30 EC (incl. a thesis and an oral presentation) in one of the research groups of the Leiden Mathematical Institute;
- 30 EC of courses to be selected in correspondence with the research topic; and
- the Education component as described [here](#).

Required is a total of at least 120 EC.

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 Mathematics and Education component of the MSc programme.

A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found [here](#).

Students who started the master programme before 2018-2019 have the choice to follow the old programme consisting of a research project in Mathematics of 40 EC, with 20 EC of courses in correspondence with the research topic, or to opt for the new variant, as agreed with the study advisor.

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<sup>40</sup> Completion of the specialisation Science Communication and Society requires a minimum of 40 EC and a maximum of 60 EC within the SCS component.

## **8. Specialisation Statistical Science for the Life and Behavioural Sciences**

Since September 2016 the new MSc programme Statistical Science of the Life and Behavioural Sciences has started. The programme of the specialisation Statistical Science for the Life and Behavioural Sciences of the MSc programme Mathematics is identical to the MSc programme Statistical Science for the Life and Behavioural Sciences. For the description, qualifications of admission and programme of both the specialisation within Mathematics and the MSc programme Statistical Science for the Life and Behavioural Science.

As of September 1, 2016 no new students are admitted to the specialisation Statistical Science for the Life and Behavioural Sciences of the MSc programme Mathematics.

# MSc Media Technology

CROHO-number 60206

## 1. Description of the programme (Course and Examination Regulations chapter 2)

The Media Technology MSc Programme is part of the Leiden Institute of Advanced Computer Science (LIACS). In addition, it is affiliated with the Academy for Creative and Performing Arts.

Media Technology recognises creativity and playfulness as important factors in scientific innovation. It provides an environment where students 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. The programme encourages unusual questions, unconventional research methods and alternative forms of scientific output besides academic articles. This includes interactive installations, games, robots, books, and more, as results from research.

To achieve this, the curriculum focuses on creative exploration and on the understanding of (the fundamentals of) science and technology. In its elective space the programme encourages its students to draw from the knowledge available throughout Leiden University's various faculties and the ArtScience programme of the Royal Conservatoire and the Royal Academy of Arts in The Hague, or from courses offered at other universities in the Netherlands or abroad.

Besides completing the curricular and elective courses (see "Programme" below), each student must successfully complete an individual Graduation Project guided by two supervisors. It aims to answer a student's personally developed scientific question, possibly by creating a product or experience. A paper is written, presented and publicly defended as part of the Graduation Project. The paper generally takes the form of a scientific article, possibly augmented with alternative output such as a computer programme, installation, public performance, book, etcetera.

### 1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

The programme's goal is to stimulate innovation and creativity in scientific research by innovative application of technology. Media Technology students are trained as autonomous scientists, preparing students for a future career involving creative and critical thinking, for a future in scientific research.

### 1.2 Learning outcomes (Course and Examination Regulations art. 2.3)

Graduates of the MSc in Media Technology have attained the following general learning outcomes:

- a. theoretical and practical skills in more than one specialist area (including computer science/artificial intelligence, creative and performative arts, and relevant aspects of philosophy, cognitive science, and linguistics), such that they can carry out research under overall supervision;
- b. the ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, formulate verifiable hypotheses, and set up and carry out research and critical reflection on one's own research and that of others;
- c. the ability to interrelate and integrate various areas of computer science, artificial intelligence, creative and performative arts with relevant aspects of philosophy, cognitive science, and linguistics;
- d. the ability to present clearly, verbally as well as in writing, one's own research results, and the ability to communicate with colleagues and to present their research results as a contribution to a congress or as (part of) a scientific publication;
- e. sufficient understanding of the social and societal role of academia, especially computer science/artificial intelligence and the creative and performative arts, to be able to critically reflect upon it and in part consequently to come to an ethically sound attitude and corresponding execution of one's professional duties;
- f. have the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous.

In addition to the above general achievements, graduates of the MSc in Media Technology have understanding of the fundamental principles and organisation of academia, and of the importance of creativity and playfulness in academic research. They have knowledge and skills in computer programming and in the use of various media and technologies within virtual and physical environments. They have the ability to communicate with colleagues (via e.g. a conference contribution or scientific publication) as well as with a wider public (via e.g. an exhibition, performance, public event, or in popular-scientific writing). They have the ability to act as independent researchers and thinkers with a critical attitude.

### **1.3 Programme duration and completion Course and Examination Regulations art. 2.5)**

The duration of the programme is two years (120 EC). Students who complete the programme receive the degree 'Master of Science in Media Technology'.

### **1.4 Start of the programme(Course and Examination Regulations art. 2.6)**

Students can start their programme in September or February.

### **1.5 Language of the programme (Course and Examination Regulations art. 2.8)**

The programme is taught entirely in English.

## **2. Programme (Course and Examination Regulations chapter 3)**

The programme comprises 120 EC and consists of the following courses and components:

<i>Compulsory courses</i>	<b>Level</b>	<b>EC</b>
Visit to Ars Electronica Festival	400	1
Introduction to Programming	400	4
Human Computer Interaction & Information Visualization	400	6
Research Fundamentals	400	4
Playful & Creative Science	500	6
Essentials in Art & Music	500	2
Hardware & Physical Computing	400	3
Meta Media	500	2
New Media & New Technologies	500	5
Science & Humanities	400	4
Sound, Space & Interaction	500	5
Language Evolution	500	3
Non-Human Cognition	500	4
Research Seminar: Artificial Intelligence	500	6
Research Seminar: Social Technologies	500	5
Exhibition: Statement to Experience	500	12
Elective courses	400+	16
Portfolio	400	1
Graduation Lab	400	1
Graduation Project	600	30
		<b>120</b>

## 2.1 Substitution for compulsory courses

Students can qualify for substitution of certain compulsory courses (especially, but not exclusively, Introduction to Programming and Research Essentials I: Fundamentals) within their curriculum, when they can prove already having current knowledge of the topics dealt with. Substitution can be granted by the Board of Examiners, who consult the Media Technology Executive Committee and course lecturer. As a guideline, the student must participate in the first lecture and present some form of proof that the knowledge was already obtained elsewhere. The Executive Committee and/or lecturer may advise the Board of Examiners to honour or turn down requests for substitution, based on the material provided by the student and the evaluation of such.

In case the request for substitution is honoured, the student must obtain the required number of ECs through other ways, i.e. for every granted substitution students must follow another (elective) replacement 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 at least the same level.

## 2.2 Acceptance of elective Courses

Elective courses can be done throughout Leiden University's various faculties, and from any accredited institute of higher education in the Netherlands or abroad. For curricular acceptance of elective courses, permission must be obtained from the LIACS Board of Examiners. The decision to accept an elective course is based on course level, course load, course content and the student's personal statement of motivation. Practical guidelines for students and procedures to apply for curricular acceptance of elective courses are communicated via the programme's website. In addition, an annual "electives kick-off meeting" is organised in which students are timely informed about the possibilities and procedures.

## 2.3 Option for exchange and studying abroad

Students can apply for permission from the LIACS Board of Examiners to participate in an exchange (typically taking place in the student's 3<sup>rd</sup> semester). If this permission is granted, the study results obtained within the exchange replace the 12 EC course "Exhibition: Statement to Experience" and the 16 EC elective space. In consultation with the Executive Committee, the Board of Examiners takes the following criteria into consideration:

- the exchange must take place at a qualified institution and programme in The Netherlands or abroad;
- the exchange should consist of a coherent "package" of courses, all taken at one institution, and cover (at least) 30 EC;
- the exchange should take place at MSc level or equivalent;
- the student has a strong and content-driven motivation to participate in the exchange, reflected in the application submitted to the Board of Examiners and Executive Committee, as well as in the will and capacity to pro-actively organise the exchange in all its facets (courses, timeline, costs, housing, etc.).

Independent from this 30 EC exchange option, students can always apply for taking elective courses abroad. For this, the normal procedure for the acceptance of elective courses, as described above, applies.

## 3. Admission to the programme (Course and Examination Regulations chapter 5)

### 3.1 Confirmation of admission

3.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 3.2 and 3.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 3.2.1, the proof of registration is also confirmation of admission.

3.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.<sup>41</sup>

### 3.2 Admission to the programme

3.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a. holders of a bachelor's degree in a relevant discipline from a research university in the Netherlands, or from a foreign research university of similar level, such as computer science (informatica), artificial intelligence, communication and/or information science, cognitive science, biology, linguistics, or creative/performing arts; or
- b. students who have successfully met the requirements of the imposed bridging programme on the basis of Article 3.4.1

3.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in 3.2.1, sub-section a, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 3.2.1, sub-sections a and b, possibly under further conditions, without prejudice to the conditions specified in 3.2.4.

Article 3.2.2 may, amongst others, apply to holders of a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo). As a guideline for applicants with a Dutch hbo diploma, the hbo diploma has to be obtained within a maximum of five years and with an average final grade of at least 7.5. Eventual deficiencies up to 30 EC can be removed upon discussion with the study advisor using a bridging programme (see 3.4).

### 3.2.3 Dutch and English languages<sup>42</sup>

3.2.3.1 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (or other with English A);
- A diploma of secondary or higher education completed in the US, the United Kingdom, Ireland, New Zealand, Australia or Canada (with the exception of French-taught education in Canada);
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A pre-university education (vwo) diploma.
- A high school (or higher) diploma determined by SEA (Admissions Office) in an EER country, where English has been studied up to and including the final year of the programme, and where the level of English can be considered comparable to Dutch vwo (pre-university education).

3.2.3.2 If a student who wishes to be admitted does not meet the requirements in 3.2.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90
- Cambridge Certificate of Advanced English (CAE), minimum grade C

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<sup>41</sup>Regulations for Admission to Master's Programmes

<sup>42</sup> Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

3.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*.

### 3.2.4 Qualitative admission requirements

3.2.4.1 Alongside the requirements specified in 3.2.1.a. and 3.2.2, the following qualitative admission requirements apply for the programme pursuant to Article 7.30b (2) of the Act:

- Demonstrable affinity and experience with **fundamental and/or knowledge-driven research** that aims at contributing new insights to academic discourses and is not primarily directed at solving (engineering, societal, commercial etc.) problems;
- Demonstrable affinity and experience with **technology** and its embedding in the human context;
- A **creative** attitude towards science and research in the sense of the programme, i.e. not necessarily demonstrated by artistic creativity, but by the abilities to think and reason beyond disciplinary borders and/or be open to unconventional ways of producing and disseminating academic knowledge.

3.2.4.2 Applicants as referred to in Article 3.2.1.a and Article 3.2.2 need to provide the Board of Admissions with an application statement, curriculum vitae and two reference letters. These documents, together with a transcript of records of previous education, should explain that the applicant meets the requirements referred to in 3.2.1.a. and 3.2.4.1. The admission process may include an interview with the Board of Admissions should this be necessary to clarify whether the applicant meets the requirements referred to in 3.2.1.a and 3.2.4.1.

3.2.4.3 Applicants as referred to in Article 3.2.1.a. and Article 3.2.2 need to provide the Board of Admissions with the documents referred to in Article 3.2.4.2 before the application deadline.

## 3.3 Deficiencies

3.3.1 Holders of a bachelor's degree from a research university, referred to in 3.2.1, subsections a and b, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

3.3.2 Students who still have the deficiencies referred to in 3.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

3.3.3 For the admission referred to in 3.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

3.3.4 If a student is admitted to the programme on the basis of 3.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

## 3.4 Bridging programmes (Pre-master's)

3.4.1 The department has developed bridging programmes in order to resolve deficiencies. For students with bachelor's degrees in relevant discipline disciplines, but lacking a background certain knowledge/skills the Board of Admissions may impose a Pre-Master's programme, tailored to the individual background of the prospective student, before admission into the MSc programme.

3.4.2 Information on the bridging programmes can be requested from the LIACS Education Office.

# MSc Physics

CROHO-number 60202

## 1. Description of the programme (Course and Examination Regulations chapter 2)

Leiden University offers an MSc programme in Physics. Students who complete the programme receive the degree Master of Science in Physics, with specification of the specialisation. All specialisations have the same Director, the same Board of Examiners, and the same Departmental Teaching Committee. For the specialisation specific part the specialisations Business Studies (BS), Science Communication & Society (SCS), and Education (EDU), each have their own specialisation coordinator and a Board of Examiners appointed by the Faculty of Science.

### 1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

The programme offers a solid background and a thorough experience at the forefront of physics research in the respective specialisation, including practical training in communication and computational skills. The program aims at training students as independent researchers and provides them with the necessary skills to advance their career. Upon completion of the degree, the MSc graduate will be well equipped to start a PhD, work in research and development, or in other branches of the public and private sector that require strong analytical, computational, and problem-solving skills. The 'Casimir pre-PhD' specialisation puts special emphasis on the preparation for PhD research within the Casimir Research School and offers the opportunity to raise one's funding for a PhD.

### 1.2 Specialisations (Course and Examination Regulations art. 2.2)

The MSc programme in Physics has eight specialisations. Five of the eight specialisations are research specialisations in the Leiden Institute of Physics (LION), including one in collaboration with the Leiden Observatory and one in collaboration with the Delft University of Technology. These are:

- Research in Physics, Theoretical Physics
- Research in Physics, Biological and Soft Matter Physics
- Research in Physics, Quantum Matter and Optics
- Research in Physics, Cosmology
- Research in Physics; pre-PhD ('Casimir')

The full programme of these five research specializations is in English.

A short description of the five research specialisations follows:

- Theoretical Physics aims to describe and understand a broad range of physical phenomena through a variety of analytical and numerical tools and methods.
- Research within the Physics and Biological and Soft Matter specialisation is mainly experimental and is typically performed at the interface of medical, biological, chemical and physical sciences. Its study focus ranges from the physical processes of biomolecules, the emerging properties that evolve in cells, and the control of cell function by signalling, to the study of the mechanical and geometrical properties of soft media, such as granular matter or foam, and the self-assembly in soft-matter systems.
- Research in the Quantum Matter and Optics specialization is also mainly experimental. It covers research topics like: the emergence of material properties from a combination of quantum mechanical confinement, electron-electron interaction, and/or electron spin properties, photon-matter interaction, and the quantum properties of light.
- The Cosmology specialisation is offered in collaboration with the Leiden Observatory. Characteristic elements of this specialisation are theory, data handling, and numerical simulations. It covers research subject like: observations of the universe with state-of-the-art telescopes, supercomputer simulations of the structure of the universe, and theoretical physics studies of the hot big bang, the expanding universe, and inflation.
- The 'Casimir pre-PhD' specialisation is offered under the auspices of the Casimir Research School, a joint effort of the LION and various departments at the Delft University of

Technology. It prepares the student for scientific research in a PhD position and therefore puts extra emphasis on working in a research environment. This specialisation can be followed only after selection; students from any research specialisation of the Physics Programme can apply after the first semester of their studies and are selected on the basis of their course results (see below).

The remaining three specialisations combine research in physics with Business Studies (BS), with Science Communication & Society (SCS), or with Education (EDU). The research part of these MSc programs is in English, as is the Business and Communication Studies; the Education component is in Dutch. A more detailed description of these specialisations is given below.

### **1.3 Learning outcomes (Course and Examination Regulations art. 2.3)**

#### *(A) KNOWLEDGE AND UNDERSTANDING*

On completion of the programme, the student should:

- A1 have a good understanding of the important physical theories (logical and mathematical structure, experimental support, physical phenomena described).
- A2 be familiar with the most important areas of physics and with the common approaches, which span many areas in physics.
- A3 have a good knowledge of the state of the art in (at least) one of the presently active topics in physics research.

#### *(B) APPLYING KNOWLEDGE AND UNDERSTANDING*

On completion of the programme, the student should:

- B1 be able to frame, analyse and break down a problem in phases defining a suitable algorithmic procedure; be able to evaluate clearly the orders of magnitude in situations which are physically different, but show analogies, thus allowing the use of known solutions in new problems.
- B2 be able to identify the essentials of a process/situation and to set up a working model of the same; be able to perform the required approximations; i.e. critically think about how to construct physical models.
- B3 be able to understand and master the use of the most commonly used mathematical and numerical methods.
- B4 have become familiar with most important experimental methods and be able to perform experiments independently, as well as to describe, analyse and critically evaluate experimental data; and to be able to scientifically report the findings.
- B5 be able to use appropriate software, programming language, computational tools and methods in physical and mathematical investigations.
- B6 acquire an understanding of the nature and ways of physics research and of how physics research is applicable to many fields other than physics, e.g. engineering; be able to design experimental and/or theoretical procedures for: (i) solving current problems in academic or industrial research; (ii) improving the existing results.

#### *(C) JUDGEMENT*

On completion of the programme, the student should:

- C1 be able to develop a personal sense of responsibility; be able to gain professional flexibility through the wide spectrum of scientific techniques offered in the curriculum; be able to organize the personal learning process, evaluate personal work, consult experts for information (e.g. about career opportunities) and support when appropriate; have had the opportunity to take courses that prepare for teaching physics at secondary school, as well as the opportunity to gain in-depth interdisciplinary skills.
- C2 have become familiar with highly regarded research in the field, thus developing an awareness of the highest standards.

- C3 be able to understand the socially related problems related to the profession, and to comprehend the ethical characteristics of research and of the professional activity in physics and its responsibility to society; be able to conduct processes of decision making and inspect the consequences of actions taking into account principles, norms, values and standards both from a personal and a professional standpoint.
- C4 be able to work with a high degree of autonomy, even accepting responsibility in (project) planning, and in the managing of structures.

(D) COMMUNICATION

On completion of the programme, the student should:

- D1 be able to listen carefully and to present difficult ideas and complex information in a clear and concise manner to a professional as well as to lay audiences; be able to work in a multidisciplinary or in an interdisciplinary team.
- D2 be able to read, speak, and write in technical English.

(E) LEARNING SKILLS

On completion of the programme, the student should:

- E1 be able to search for and use physical and other technical literature, as well as any other sources of information relevant to research work and technical project development.
- E2 be able to enter new fields through independent study; have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy (lifelong learning).
- E2 enjoy the facility to remain informed of new developments and methods, and be able to provide professional advice on their possible impact or range of applications.

The aforementioned qualifications, which are derived from the international domain-specific reference framework for Physics, apply to all specializations of the MSc Physics. For the five research-oriented specialization they are complete. The three society-oriented specializations have the following additional qualifications:

Business Studies
BS1- Insight in managerial issues related to knowledge-intensive businesses and basic theoretical skills in business disciplines most relevant to working in these businesses; BS2- The ability to make a plan for a new business or an innovation project; BS3- Experience with performing business activities in an existing company or organization or directed towards technology-based business creation.
Science Communication and Society
SCS1- Knowledge of and skills in science communication theory and methods ; SCS2- Experience in science communication practice; SCS3- Knowledge of ethical, historical and social aspects in the area of the natural sciences.
Education
EDU1- all qualifications necessary for teaching all years of secondary education and technical and vocational training (students from 12 to 18 years old);

The general qualifications of Faculty of Science are linked to the final learning outcomes of the programme as depicted below:

Final qualifications of Faculty of Science	Final learning outcomes MSc Physics
A. Knowledge and understanding	
A graduate has: * the ability to interrelate and integrate various areas of the discipline;	A1, A2, and A3

<b>B. Applying knowledge and understanding</b>	
* theoretical and/or practical skills in more than one specialist area of the discipline such that they can carry out research under overall supervision; * the ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, formulate verifiable hypotheses, and set up and carry out research and critical reflection on one's own research and that of others;	B1, B2, B3, B4, B5, and B6
<b>C. Judgement</b>	
* sufficient understanding of the social role of the natural sciences to be able to reflect upon them and in part consequently to come to an ethically sound attitude and corresponding execution of one's professional duties;	C1, C2, C3, and C4
<b>D. Communication</b>	
* the ability to present clearly, verbally as well as in writing, one's own research results, and the ability to communicate with colleagues and to present their research results as a contribution to a congress or as (part of) a scientific publication;	D1 and D2
<b>E. Learning (Skills)</b>	
* the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous.	E1, E2, and E3

#### **1.4 Start of the programme (Course and Examination Regulations art. 2.6)**

The standard program starts at the beginning of the academic year in September. Late admission in February is possible for those students who are able to show that they are proficient in the required courses for the relevant specialization, but it is usually not possible to complete the studies in two years when the program is started in February. The specialisations 'Cosmology' and 'Casimir pre-PhD' always start in September only.

## **2. Programme (Course and Examination Regulations chapter 3)**

The duration of the programme is two years (120 EC). The eight specialisations are distinguished by a programme and a curriculum that emphasize the intended perspective and goal of the specialisation. Each programme consists of two components: a set of courses and one or more research projects. The selection of courses differs per specialisation and always comprises a mandatory part and an elective part. For the elective part, a minimum number of ECs has to be selected from lists of pre-approved courses. Other electives can be selected from either the pre-approved courses or from other courses offered within all specialisations within our MSc Physics programme. Students can also take certain elective courses from the physics MSc program at the Technical University of Delft and -if appropriate- from other Dutch Universities, subject to approval from the Study Advisor and the Board of Examiners. Up to one course from a different MSc programme outside Physics can also be selected, subject to approval from the Study Advisor and the Board of Examiners. Details about the programme of each specialisation are given below.

The course programme selected by each individual student is set in a study plan that is discussed and agreed with the Study Advisor at the start of the studies. Approval of the study plan by the Study Advisor expresses the approval by the Board of Examiners. Students are allowed to change their study plan, but should again ask formal approval via the same route.

## **3. Admission to the programme (Course and Examination Regulations chapter 5)**

### **3.1 Confirmation of admission**

3.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 3.2 and 3.3, as long as the maximum number of students that the

Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 3.2.1, the proof of registration is also confirmation of admission.

3.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.<sup>43</sup>

### 3.2 Admission to the programme

3.2.1 In accordance to Article 7.30b (1) of the Act, the following candidates may be admitted to the programme and one of its specialisations:

- a. holders of a bachelor's degree in Physics (Natuurkunde) from a research university in the Netherlands, or
- b. holders of a bachelor's degree in a Physics-related programme from a research university in the Netherlands or from a foreign research university of similar level, under the provisions mentioned below. For any of the five specialisations in "Research in Physics" this is under the provision that the bachelor's programme has provided the candidate with in-depth knowledge of undergraduate courses of the Physics curriculum (referred to under a.) with a theoretical and mathematical emphasis, including quantum physics, electrodynamics, statistical physics, and complex analysis, or,
- c. students who have successfully met the requirements of the imposed bridging programme on the basis of Article 3.4.1

3.2.2 The Board of Admissions may, upon request, admit persons to the programmes who do not meet the requirements specified in 3.2.1, sub-sections a and b, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 3.2.1, sub-sections a and b, possibly under further conditions, without prejudice to the conditions specified in 3.2.4.

#### *Admission process*

Applicants as referred to in Article 3.2.1. b and Article 3.2.2 are requested to provide the Board of Admissions with a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified 3.2.1.a.

The Board of Admissions reserves the option to interview the candidate.

### 3.2.3 Dutch and English languages<sup>44</sup>

3.2.3.1 As further clarification of Article 2.8 (see Faculty part of these regulations) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (or other with English A);
- A diploma of secondary or higher education completed in the US, the United Kingdom, Ireland, New Zealand, Australia or Canada (with the exception of French-taught education in Canada);
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A pre-university education (vwo) diploma.
- A high school (or higher) diploma determined by SEA (Admissions Office) in an EER country, where English has been studied up to and including the final year of the programme, and

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<sup>43</sup>[Regulations for Admission to Master's Programmes](#)

<sup>44</sup> Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

where the level of English can be considered comparable to Dutch vwo (pre-university education).

3.2.3.2 If a student who wishes to be admitted does not meet the requirements in 3.2.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90
- Cambridge Certificate of Advanced English (CAE), minimum grade C

3.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*. This applies to the Education specialisation of this master's programme.

### 3.2.4 Qualitative admission requirements

3.2.5.1 In addition to the requirements specified in 3.2.1 and 3.2.2, the following qualitative admission requirements apply for the programme pursuant to Article 7.30b (2) of the Act:

1. For the specialisation "Research in Physics, Cosmology" knowledge of 'Physics of Elementary Particles' at undergraduate level is required.
2. The Casimir pre-PhD specialization is an honor's track that students can enter only after the first semester. For this specialization the following admission requirements apply:
  - A grade point average of 7.5 in the first semester of the Physics programme is required.
  - Admission to the second year is on the condition that all courses of the first year (60 EC) have been successfully completed.

## 3.3 Deficiencies

3.3.1 Holders of a bachelor's degree from a research university, referred to in 3.2.1, subsections a and b, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

3.3.2 Students who still have the deficiencies referred to in 3.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

3.3.3 For the admission referred to in 3.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

3.3.4 If a student is admitted to the programme on the basis of 3.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

## 3.4 Bridging programmes (Pre-master's)

3.4.1 The department has developed the following bridging programmes (for the following target groups) in order to remove deficiencies:

For students with bachelor's degrees other than Physics or Astronomy the Board of Admissions may impose a Pre-Master's programme, tailored to the individual background of the prospective student, before admission into the MSc programme. This Pre-master's programme consists of maximally 60 EC and is agreed with the Board of Admission, via the Study Adviser. It will cover and/or enhance any deficiencies from the following list of required 2<sup>nd</sup> year BSc Leiden Physics courses:

- Linear Algebra 2NA (with prerequisite of Linear Algebra 1NA), 6 EC
- Analysis 3NA (with prerequisites of Analysis 1NA + 2NA), 6 EC
- Quantum Mechanics 1 + 2, 12 EC
- Statistical Physics 1, 6 EC
- Classical Electrodynamics (with prerequisite of Electromagnetic Fields), 4 EC
- Classical Mechanics B (with prerequisite of Classical Mechanics A), 3 EC
- Introduction to Solid State Physics, 3 EC
- Physics Experiments 1 + 2 + 3, 10 EC

and may include a selection of elective courses. Students should be familiar with computer programming, preferably in Python, at the level of the Programming Methods NA. BSc program,

## 4. Specialisation Research in Physics, Theoretical Physics

### 4.1 Programme (Course and Examination Regulations chapter 3)

	<b>Level</b>	<b>EC</b>
Academic and Professional Skills	400	3
Effective Field Theory	500	3
Quantum Information	400	3
Quantum Theory	400	6
Statistical Physics a + b	400	9
Topics in Theoretical Physics	400	6
Elective courses from MSc Physics programme, with $\geq 12$ EC from list of preapproved electives presented below, and max. 6 EC from other MSc programmes	400-600	42
Physics research project in Theoretical Physics @ LION (division: research=36 EC, thesis=8 EC, and presentation=4 EC)	600	48

<b>Preapproved electives: Theoretical Physics</b>	<b>Level</b>	<b>EC</b>
Advanced Topics in Theoretical Physics I	600	6
Advanced Topics in Theoretical Physics II	600	6
Applied Quantum Algorithms	500	6
Black Holes and Gravitational Waves *	500	3
Complex Networks	400	6
Computational Physics	400	6
Computational Physics (short version)	400	3
Origin and Structure of the Standard Model	500	3
Particle Physics and the Early Universe	500	3
Quantum Field Theory	500	6
Soft and Bio-matter Theory	500	6
<i>The origin of Life (TU Delft)</i>	400	6
Theoretical Biophysics	500	6
Theoretical Cosmology *	500	3
Theory of Condensed Matter	500	6
Theory of General Relativity	400	6

Most courses (including those mandatory) are offered every year. The rest (indicated with \*) are offered in alternate years. The course offering is subject to change.

## 5. Specialisation Research in Physics, Biological and Soft Matter Physics

### 5.1 Programme (Course and Examination Regulations chapter 3)

Academic and Professional Skills	400	3
Quantum Information	400	3
Statistical Physics a	400	6
Soft and Bio-matter Theory	400	6
Elective courses from MSc Physics programme, with $\geq 12$ EC from list of preapproved courses presented below, and max. 6 EC from other MSc programmes	400-500	42
Research project in Physics 1 (division: research=20 EC, thesis=3 EC, and presentation=1 EC)	600	24
Research project in Physics 2 (division: research=30 EC, thesis=4 EC, and presentation=2 EC)	600	36

All research projects are performed under responsibility of a LION staff member. Up to one project can be carried out outside LION. The 24 EC project can be either experimental or theoretical, but if theoretical it must have a tangible connection to experiment. This means either (a) partly (>15%) experimental, (b) modelling/design of an experiment (c) performed as part of team where data is generated and analysed interactively.

<b>Preapproved Electives: Biological and Soft Matter Physics</b>	<b>Level</b>	<b>EC</b>
Biophysics	500	6
Advanced Optics	500	6
Computational Physics	400	6
Computational Physics	400	3
<i>Evolution and Engineering of Living Systems (TU Delft)</i>	400	6
Frontiers of Measurement Techniques	400	3
<i>Imaging Systems (TU Delft)</i>	400	6
Magnetic Resonance Physics *	500	3
Mechanical Metamaterials *	400	6
Molecular Electronics ( <i>together with TU Delft</i> )	500	6
<i>Nanotechnology (TU Delft)</i>	400	6
Single Molecule Optics *	500	6
Technological Biophysics *	500	3
Statistical Physics b	400	3
Theoretical Biophysics	500	6
<i>The origin of Life (TU Delft)</i>	400	6
Topics in Theoretical Physics	400	6

Most courses are offered every year. The rest (indicated with \*) are offered in alternate years. The course offering is subject to change.

Transitional arrangements: The course 'Biophysics' replaces the old course 'Advanced Biophysics'. Students who started before September 2019 should fulfil the requirements of the OER of 2018/2019, which included the required course 'Quantum Theory' instead of the present combination of 'Quantum Information' and either 'Biophysics' or 'Soft and Bio-Matter Theory' as required courses, unless decided otherwise by the Board of Examiners.

## 6. Specialisation Research in Physics, Quantum Matter and Optics

### 6.1 Programme (Course and Examination Regulations chapter 3)

	Level	EC
Academic and Professional Skills	400	3
Quantum Information	400	3
Quantum Theory	400	6
Statistical Physics a	400	6
Elective courses from MSc Physics programme, with $\geq 12$ EC from list of preapproved courses presented below, and max. 6 EC from other MSc programmes	400-500	42
Research project in Physics 1 (division: research=20 EC, thesis=3 EC, and presentation=1 EC)	600	24
Research project in Physics 2 (division: research=30 EC, thesis=4 EC, and presentation=2 EC)	600	36

All research projects are performed under responsibility of a LION staff member. Up to one project can be carried out outside LION. The 24 EC project can be either experimental or theoretical, but if theoretical it must have a tangible connection to experiment. This means either (a) partly (>15%) experimental, (b) modelling/design of an experiment (c) performed as part of team where data is generated and analysed interactively.

<b>Preapproved electives: Quantum Matter and Optics</b>	Level	EC
Advanced Optics	500	6
Computational Physics	400	6
Computational Physics	400	3
Condensed Matter Physics	500	6
Effective Field Theory	500	3
Frontiers of Measurement Techniques	400	3
Magnetic Resonance Physics *	500	3
Molecular Electronics ( <i>together with TU Delft</i> )	500	6
<i>Nanotechnology (TU Delft)</i>	400	6
Quantum Optics	400	6
Single Molecule Optics *	500	6
Statistical Physics b	400	3
Superconductivity *	500	3
<i>Surface Science (Chemistry) *</i>	500	6
Theory of Condensed Matter	500	6
Topics in Theoretical Physics	400	6

Most courses (including those mandatory) are offered every year. The rest (indicated with \*) are offered in alternate years. The course offering is subject to change.

Transitional arrangement: Students who started before September 2019 are exempt from the requirement to pass the course 'Quantum Information'.

## 7. Specialisation Research in Physics, Cosmology

### 7.1 Programme (Course and Examination Regulations chapter 3)

	Level	EC
Academic and Professional Skills	400	3
Large Scale Structure and Galaxy Formation	500	6
Origin and Evolution of the Universe	500	6
Origin and Structure of the Standard Model	400	3
Particle Physics and the Early Universe	500	3

Quantum Theory	400	6
Theory of General Relativity	400	6
Elective courses from the MSc Physics or MSc Astronomy programme, of which $\geq 12$ EC must be Cosmology courses, and max. 6 EC from other MSc programmes	400-500	27
Research project in Cosmology 1	500	30
Research project in Cosmology 2 (Master's project)	600	30
<b>Preapproved electives: Cosmology</b>	<b>Level</b>	<b>EC</b>
Black Holes and Gravitational Waves *	500	3
Computational Astrophysics ( <i>Astronomy</i> )	400	6
Modern Astrostatistics ( <i>Astronomy</i> ) *	500	3
Effective Field Theory	500	3
Gravitational Lensing ( <i>Astronomy</i> ) *	500	3
Observational Cosmology ( <i>Astronomy</i> ) *	400	3
Statistical Physics a	400	6
Theoretical Cosmology *	500	3

Most courses (including those mandatory) are offered every year. The rest (indicated with \*) are offered in alternate years. The course offering is subject to change.

Transitional arrangement: Students who followed the old 6 EC course on 'Particle Physics of the Early Universe' have covered the same study material as currently offered in the combination of the two 3 EC courses 'Origin and Structure of the Standard Model' and 'Particle Physics of the Early Universe'. The course 'Modern Astrostatistics' replaces the old course 'Databases and Data Mining'.

## 8. Specialisation Research in Physics, pre-PhD ('Casimir')

### 8.1 Description (Course and Examination Regulations chapter 2)

The 'Casimir pre-PhD' specialisation is offered under the auspices of the Casimir Research School, a joint effort of the LION, and various departments at the Delft University of Technology. It prepares the student for scientific research in a PhD position and therefore puts extra emphasis on working in a research environment in the member departments. This specialisation offers research projects in both Leiden and Delft and requires students to participate in at least one research project at each location.

The programme follows a strict schedule, with the first year devoted to laying the theoretical basis, and the second year to a combination of short intensive research projects and a long MSc thesis project, culminating in the writing of a research proposal for a potential PhD project. The short projects and the proposal writing are special characteristics of the programme, aimed at broadening the research experience of the student.

In the second year of the programme, students will be given the opportunity to attend a Summer School at the start of the academic year. The study projects and MSc research project, scheduled for the second year, are to be carried out in different groups. Writing a PhD research proposal is the last item in the programme. A limited number of these proposals will be awarded funding for the proposed PhD topic. Details can be found on the website of the Casimir Research School.

### 8.2 Programme (Course and Examination Regulations chapter 3)

	<b>Level</b>	<b>EC</b>
Academic and Professional Skills	400	3
Quantum Information	400	3
Quantum Theory	400	6
Statistical Physics a	400	6
Elective courses from the MSc Physics programme in Leiden or from the list of Casimir pre-PhD courses in Delft presented below, and max. 6 EC from other MSc programmes	400-500	42
Research project in Physics	600	36

(division: research=30 EC, thesis=4 EC, and presentation=2 EC)

Study projects (2x), two 8 EC projects	500	2 x 8
Writing Research Proposal	500	8

One of the 2 study projects must be experimental, the other must be theoretical/mixed theoretical-experimental. The thesis project may be either experimental or theoretical.

<b>Course list; Coherent mix of MSc Physics courses from Leiden and the following courses from TU Delft</b>	<b>Level</b>	<b>EC</b>
<b>Foundational courses</b>		
Advanced Electrodynamics	400	6
Advanced Solid State Physics	400	6
Continuum Physics	400	6
<b>Topical Courses</b>		
Evolution and Engineering of living systems	500	6
Fundamentals of Quantum Information	400	6
Mesoscopic Physics	400	6
Molecular Electronics ( <i>Leiden/Delft</i> )	500	6
Physics of Semiconductor Nanodevices	400	3
Quantum Communication and Cryptography	400	5
Quantum Hardware	400	6
Quantum Optics and Lasers	500	6
The Origins of Life	500	6
Topology in Condensed Matter	500	6
<b>Methods</b>		
Computational Physics	400	6
Computational Physics	400	3
Electronics for Quantum Computing	400	5
Molecular Electronics ( <i>Leiden/Delft</i> )	500	6
Nanotechnology	400	6

It is unavoidable that the study material of certain courses in Delft and Leiden show significant overlap. To avoid redundancy in the study program, the combinations of courses given below are mutually exclusive:

- Advanced Solid State Physics (Delft) ⇔ Condensed Matter Physics (Leiden)
- Fundamentals of Quantum Information (Delft) ⇔ Quantum Information (Leiden)
- Physics of Semiconductor Nanodevices (Delft) ⇔ Condensed Matter Physics (Leiden)
- Quantum Optics and Lasers (Delft) ⇔ Quantum Optics (Leiden)
- Computational Physics (Delft) ⇔ Computational Physics (Leiden)

Transitional arrangement: Students who started before September 2019 are exempt from the requirement to pass the course 'Quantum Information'.

### 8.3 Additional qualifications for admission (Course and Examination Regulations chapter 5)

The Casimir pre-PhD specialisation can be followed only after selection. Students admitted to the Physics Programme can apply during the first semester of their studies through the Study Advisor and are selected on the basis of the results in the first semester of the MSc programme. A grade point average of 7.5 in the first semester is required. Formal admission takes place at the start of the second semester. Admission to the second year is on the condition that all 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 specialisations of the Physics Master. Students who are declined entry either after the first semester or after the first year can continue with the regular programme without incurring delays.

## 9. Specialisation Business Studies

### 9.1 Description (Course and Examination Regulations chapter 2)

The specialisation Physics and Business Studies offers students the possibility to combine physics with knowledge, insights, and skills in the area of Management, Business and Entrepreneurship.

Students are encouraged to broaden their horizon, to form opinions, to prepare for a career in industry, and to enhance competences in pursuing entrepreneurial business opportunities stemming from research disciplines.

Students who complete the specialisation Physics and Business Studies are also admissible to a PhD programme.

### 9.2 Programme (Course and Examination Regulations chapter 3)

	Level	EC
Academic and Professional Skills	400	3
Quantum Information	400	3
Statistical Physics a	400	6
<i>Elective courses related to the research project</i>	400-500	12
Research project in Physics	600	36
Division: research=30 EC, thesis=4 EC, and presentation=2 EC		
Business Studies component, as described <a href="#">here</a> .		40-60
Electives from either the MSc Physics or Business Studies offerings	400-500	20-0

Transitional arrangements: Students who passed the course 'Quantum Theory' are exempt from the requirement to pass the course 'Quantum Information'. Students who started before 2019 are allowed to have 9 EC in 'Elective courses related to the research project' (old regulation) instead of 12 EC.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

## 10. Specialisation Science Communication and Society

### 10.1 Description (Course and Examination Regulations chapter 2)

The specialisation Physics and Science Communication and Society (SCS) offers students the possibility to combine physics with science communication.

Students are prepared for a career in the popularisation of science or for a career as a scientist with a communication focus.

Students who complete the specialisation Physics and Science Communication and Society are also admissible to a PhD programme in physics or in science communication.

### 10.2 Programme (Course and Examination Regulations chapter 3)

Academic and Professional Skills	400	3
Quantum Information	400	3
Statistical Physics a	400	6
<i>Elective courses related to the research project</i>	400-500	12
Research project in Physics	600	36
Division: research=30 EC, thesis=4 EC, and presentation=2 EC		
Science Communication and Society component, as described <a href="#">here</a> .		40-60
Electives from either MSc Physics or SCS offerings	400-500	20-0

Transitional arrangements: Students who passed the course 'Quantum Theory' are exempt from the requirement to pass the course 'Quantum Information'. Students who started before 2019 are allowed to have 9 EC in 'Elective courses related to the research project' (old regulation) instead of 12 EC.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

## 11. Specialisation Education

### 11.1 Description (Course and Examination Regulations chapter 2)

The specialisation Physics and Education (EDU) prepares students for a career as a physics (Natuurkunde) teacher qualified to teach at the Dutch secondary education .

Students who complete the specialisation Physics and Education are also admissible to a PhD programme.

### 11.2 Programme (Course and Examination Regulations chapter 3)

	Level	EC
Academic and Professional Skills	400	3
Quantum Information	400	3
Statistical Physics a	400	6
<i>Elective courses related to the research project</i>	400-500	12
Research project in Physics Division: research=30 EC, thesis=4 EC, and presentation=2 EC	600	36
Education component, as described <a href="#">here</a> .		60

The Physics component of the programme is followed during the first year of study, the Education component during the second year.

For students who have completed the minor in Education (30 EC) during the BSc programme, the compulsory Education component is reduced by 30 EC. The freed up 30 EC can be filled by courses from either the Physics or Education offerings.

Transitional arrangements: Students who passed the course 'Quantum Theory' are exempt from the requirement to pass the course 'Quantum Information'. Students who started before 2019 are allowed to have 9 EC in 'Elective courses related to the research project' (old regulation) instead of 12 EC.

A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found [here](#).

# MSc Statistical Science for the Life and Behavioural Sciences

CROHO-number 60957

## 1. Description of the programme (Course and Examination Regulations chapter 2)

The MSc programme Statistical Science for the Life and Behavioural Sciences is taught in Leiden by the following institutes:

- Mathematical Institute;
- Department of Biomedical Data Sciences – Leiden University Medical Center;
- Methodology and Statistics – Institute of Psychology – Faculty of Social and Behavioural Sciences;
- Biometris – Wageningen UR;
- Leiden Institute for Advanced Computer Science.

The duration of each programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Statistical Science for the Life and Behavioural Sciences. The two specialisations have the same Director, the same Board of Examiners, and the same Department Teaching Committee. A Board of Admissions will advise on admissions.

### 1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

The goal of each programme is to provide the student with a broad training in statistics and its role in science and society. The graduate will be able to apply his/her knowledge and understanding critically, creatively, independently, and systematically to model and evaluate complex phenomena arising in a variety of situations. Qualification to become a PhD candidate is a definite possibility.

### 1.2 Specialisations (Course and Examination Regulations art. 2.2)

Leiden University offers two specialisations of the MSc programme Statistical Science for the Life and Behavioural Sciences. The first focuses on the Life and Behavioural Sciences, and the second focuses on Data Science.

### 1.3 Start of the programme (Course and Examination Regulations art. 2.6)

The scheduled program starts in September. For starting dates other than in September, the Board of Admissions will judge whether the candidate's academic background provides sufficient confidence that the candidate will be able to complete the Master's programme in two years.

## 2. Specialisation Statistical Science

### 2.1 Description (Course and Examination Regulations chapter 2)

The MSc specialisation in the Life and Behavioural Sciences focuses on statistics in the broad sense, with biostatistics (for general medicine and life sciences) and statistics in the behavioural sciences. Some of the key words are longitudinal analysis, genomics, genetics, high dimensional data, medical imaging, psychometrics and sensometrics. The emphasis is on application in multidisciplinary environments of the life and behavioural sciences.

Students will gain a thorough knowledge and understanding of statistical models and techniques, which will allow them to develop new statistical methods with application to a broad range of research fields.

Students learn practical skills such as statistical programming, statistical consultation, and written and oral presentation of analysis and research results.

## 2.2 Programme (Course and Examination Regulations chapter 3)

The courses from the core programme and the specialisation courses (see below) are compulsory and count for 62 EC. At least 12 EC should come from the elective courses within the programme, leaving 12 EC free of choice.

<b>Core Programme</b>	<b>EC</b>	<b>Level</b>
Statistics and probability	9	400
Mathematics for Statisticians	3	300
Statistical Computing with R	6	400
Linear & Generalized Linear Models and Linear Algebra	9	400
Multivariate and Multidimensional Data Analysis	6	500
Bayesian Statistics	6	500
Mixed and Longitudinal Modelling	6	500
Statistical Consulting	5	500
Advanced Statistical Computing	3	500
	<b>53</b>	
<b>Specialisation Courses</b>		
Study Designs in the Life and Behavioural Sciences	6	400
Introduction to the Life and Behavioural Sciences	3	400
	<b>9</b>	
<b>Elective Courses</b>		
<i>Choose from the following 9 courses a total of 24 EC</i>		
Statistical Learning	6	500
Psychometrics and SEM	6	500
High-Dimensional Data Analysis	6	500
Statistical Genetics	6	500
Survival Analysis	6	500
Survey Methodology	6	500
EMOS Core Module	12	500
Optional Course 1	6	
Optional Course 2	6	
	<b>24</b>	
<b>Internship, Thesis</b>		
Internship	10	600
Thesis	24	600
	<b>34</b>	
<b>Total</b>	<b>120</b>	

## 2.3 Examinations, Final Examination (Course and Examination Regulations chapter 4)

### Obligatory sequence (Course and Examination Regulations art. 4.2)

2.3.1 Students may only take the following courses and sit their attendant examinations once they have passed the examinations for one or more other components:

<i>Programme component:</i>	<i>Follow course and sit its attendant examination after having passed:</i>
EMOS Core Module	Survey Methodology

<i>Programme component:</i>	<i>Follow course and sit its attendant examination after having obtained:</i>
Statistical Consulting	45 EC from the programme
EMOS Core Module	42 EC from the programme
Internship	42 EC from the programme
Thesis	74 EC from the programme to start the Thesis, and 96 EC from the programme to sit its attendant final examination.

2.3.2 For the components and their attendant examinations, which must be completed in a given sequence, the Board of Examiners may in special cases, and following a substantiated written request by the student, agree to an alternative sequence.

### 3. Specialisation Data Science: Statistical Science

#### 3.1 Description (Course and Examination Regulations chapter 2)

The MSc specialisation Data Science equips students with a broad basis in statistics combined with state-of-the-art knowledge in Data Science through collaboration between the Mathematical Institute and the Leiden Institute for Advanced Computer Science. Some of the key words are Databases, Advances in Data Mining, Networks, Pattern Recognition, and Deep Learning.

Students will gain a thorough knowledge and understanding of statistical models and techniques in relation to Data Science. This will allow the student to develop new statistical methods with application to a broad range of research fields.

Students learn practical skills such as statistical programming, statistical consultation, data base management and written and oral presentation of analysis and research results.

#### 3.2 Programme (Course and Examination Regulations chapter 3)

The courses from the core programme and the specialisation courses (see below) are compulsory and count for 84 EC. At least 6 EC should come from the elective courses within the programme, leaving 6 EC free of choice

<b>Core Programme</b>	<b>EC</b>	<b>Level</b>
Statistics and probability	9	400
Mathematics for Statisticians	3	300
Statistical Computing with R	6	400
Linear & Generalized Linear Models and Linear Algebra	9	400
Multivariate and Multidimensional Data Analysis	6	500
Bayesian Statistics	6	500
Mixed and Longitudinal Modelling	6	500
Statistical Consulting	5	500
Advanced Statistical Computing	3	500
	<b>53</b>	

### Specialisation Courses

Databases	6	200
Introduction to Data Science	3	400
Advances in Data Mining	6	500
Statistical Learning	6	500
	<b>21</b>	

### Elective courses

*Choose from the following 5 courses a total of 12 EC*

High-Dimensional Data Analysis	6	500
Neural Networks	6	500
Survey Methodology	6	400
EMOS Core Module	12	500
Optional Course	6	
	<b>12</b>	

### Internship, Thesis

Internship	10	600
Thesis	24	600
	<b>34</b>	

**Total** **120**

## 3.3 Examinations, Final Examination (Course and Examination Regulations chapter 4)

### Obligatory sequence (Course and Examination Regulations art. 4.2)

3.3.1 Students may only take the following courses and sit their attendant examinations once they have passed the examinations for one or more other components:

<i>Programme component:</i>	<i>Follow course and sit its attendant examination after having passed:</i>
EMOS Core Module	Survey Methodology

<i>Programme component:</i>	<i>Follow course and sit its attendant examination after having obtained:</i>
Statistical Consulting	45 EC from the programme
EMOS Core Module	42 EC from the programme
Internship	42 EC from the programme
Thesis	74 EC from the programme to start the Thesis, and 96 EC from the programme to sit its attendant final examination.

3.3.2 For the components and their attendant examinations, which must be completed in a given sequence, the Board of Examiners may in special cases, and following a substantiated written request by the student, agree to an alternative sequence.

## 4. Admission to the programme (Course and Examination Regulations chapter 5)

### 4.1 Confirmation of admission

4.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 4.2 and 4.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 4.2.1, the proof of registration is also confirmation of admission.

4.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.<sup>45</sup>

### 4.2 Admission to the programme

4.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a) holders of a bachelor's degree from a research university in the Netherlands or from a foreign research university of similar level, provided that the candidate has:
  - o basic knowledge of calculus (equivalent to the Dutch: vwo Wiskunde B), and
  - o accumulated at least 20 EC (or the equivalence thereof) in courses/projects in statistics/ methodology and/or (higher) mathematics,
- b) the courses/projects referred to in 5.2.1 sub-section a, must have been concluded with an average mark of at least 7.5/10 (or  $GPA \geq 3.4$ ), or,
- c) students who have successfully met the requirements of the imposed bridging programme.

Students with a bachelor's degree in mathematics, psychology, computer science, or econometrics from a research university in the Netherlands will typically fulfil the requirements with respect to statistics/ methodology and/or mathematics.

4.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in 3.4.2.1, sub-section a, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 3.4.2.1, sub-section a, possibly under further conditions.

#### *Admission process*

Applicants as referred to in Article 4.2.1., subsections a and b, and Article 4.2.2 are requested to provide the Board of Admissions with a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified 4.2.1, subsections a and b.

The admission process may include an interview with the Board of Admissions, should this be necessary to clarify whether the applicant has the same level of knowledge, understanding and skills as holders of a degree specified in 4.2.1, subsections a and b.

For starting dates other than in September, the Board of Admissions will judge whether the candidate's academic background provides sufficient confidence that the candidate will be able to complete the Master's programme in two years.

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<sup>45</sup>[Regulations for Admission to Master's Programmes](#)

#### 4.2.3 Dutch and English languages<sup>46</sup>

4.2.3.1 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (or other with English A);
- A diploma of secondary or higher education completed in the US, the United Kingdom, Ireland, New Zealand, Australia or Canada (with the exception of French-taught education in Canada);
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A pre-university education (vwo) diploma.
- A high school (or higher) diploma determined by SEA (Admissions Office) in an EER country, where English has been studied up to and including the final year of the programme, and where the level of English can be considered comparable to Dutch vwo (pre-university education).

4.2.3.2 If a student who wishes to be admitted does not meet the requirements in 3.4.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90
- Cambridge Certificate of Advanced English (CAE), minimum grade C

4.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*.

### 4.3 Deficiencies

4.3.1 Holders of a bachelor's degree from a research university, referred to in 3.4.2.1, subsection a, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

4.3.2 Students who still have the deficiencies referred to in 3.4.5.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

4.3.3 For the admission referred to in 3.4.5.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

4.3.4 If a student is admitted to the programme on the basis of 3.4.5.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

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<sup>46</sup> Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

# Specialisation Business Studies

## 1.1 Description (Course and Examination Regulations chapter 2)

The specialisation Business Studies is for MSc students in the sciences and biomedicine who are interested in management or a career in industry. The objective of the specialisation is to teach students basic analytical frameworks and skills to analyse business-related problems and to contribute to managerial decision making within the context of established knowledge-intensive organisations or new technology ventures.

The specialisation provides an introduction to general management theory and practice. In addition, students will gain practical experience in applying their business knowledge and skills through working as an intern in a knowledge-intensive organisation.

After completion of this specialisation you will have developed:

- Familiarity with the ‘managerial toolbox’ – a basic understanding of foundational concepts and frameworks from different business disciplines.
- Practical skills and experience in applying the ‘managerial toolbox’ in the context of knowledge-intensive organisations.
- Basic skills in conducting business research.

The specialisation emphasises interactive teaching that connects with management practice. This means opportunities for students to learn through real-life business case discussions, guest speakers and hands-on business experience in internships.

## 1.2 Qualifications for Admission (Course and Examination Regulations chapter 5)

Admissible to the specialisation Business Studies 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.

## 1.3 Programme (Course and Examination Regulations chapter 3)

The MSc programme in combination with the Business Studies specialisation consists of two components<sup>47</sup>:

- a component within the chosen MSc programme:
  - [Mathematics](#);
  - [Computer Science](#);
  - [Astronomy](#);
  - [Physics](#);
  - [Chemistry](#);
  - [Bio-Pharmaceutical Sciences](#);
  - [Biology](#); or
  - [Life Science and Technology](#).
- a Business Studies component.

The Business Studies component comprises at least 40 EC, of which 20 EC should consist of master courses from the Business Studies programme (as listed in the overview on the next page) and minimally 20 EC of the business internship. An additional maximum of 20 EC of electives can be chosen from the listed courses and electives, or from the MSc programme of choice. The choice of courses and electives should be made in consultation with a study adviser, mentor, or specialisation coordinator.

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<sup>47</sup> In 2019-2020, the business specialisation for Computer Science students is integrated in the programme ICT in Business and the Public Sector.

## 1.4 Programme Business Studies (Course and Examination Regulations chapter 3)

The specialisation encompasses minimally the following modules:

	Level	EC
Strategy	500	5
Marketing	500	3
Financial Management	500	3
Technology and Operations Management	500	4
Research Methods	500	5
Business Internship	600	20/30/40 <sup>48</sup>

In addition, the following course modules can be included in the Business Studies tracks:

	Level	EC
Systems Optimisation <sup>†</sup>	500	3
Leading & Managing People <sup>†</sup>	500	5
Lean Six Sigma <sup>†</sup>	500	3
Accounting <sup>†</sup>	500	3
Business Intelligence <sup>†</sup>	500	4
Managing the Digital Business <sup>†</sup>	500	3
Managing Innovation <sup>†49</sup>	500	3
Marketing Analytics <sup>†</sup>	500	3
Corporate Entrepreneurship <sup>50</sup>	500	3
Corporate Decision Making <sup>51</sup>	500	3
Electives <sup>52</sup>	variable <sup>53</sup>	variable

## 1.5 Exemptions

Students with prior education in management, business and entrepreneurship may – depending on the contents and extent of said education – be exempted from following (parts of) one or more of the courses. These courses need to be substituted such that their master programme contains at least 20 EC of business courses as mentioned in the overview above and an internship of at least 20 EC. Decisions on exemptions and substitutions are taken by the Board of Examiners.

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<sup>†</sup> These courses are part of the curriculum from the master programme ICT in Business and the Public Sector.

<sup>48</sup> The Business Internship is worth 20, 30 or 40 EC, depending on the type and duration of the internship. This is further specified in the e-Prospectus.

<sup>49</sup> This elective cannot be chosen by students who have followed the SBB minor because of overlap in course content.

<sup>50</sup> This elective will be offered for a minimum of 20 registered students.

<sup>51</sup> This elective will be offered for a minimum of 20 registered students.

<sup>52</sup> Electives can either be courses from the SBB Business Studies portfolio or courses that are offered as electives elsewhere, always to be approved by SBB Business Studies staff.

<sup>53</sup> For courses with a level <400 or unspecified levels the approval of the Board of Examiners is required next to the approval of SBB Business Studies staff. Students are allowed to include a maximum of 12 EC in courses with a level <400 in their total MSc programme.

# Specialisation Science Communication and Society

## 1.1 Description (Course and Examination Regulations chapter 2)

The specialisation Science Communication and 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 or health communication officer, or for a career as a scientist with a communicating mind-set.

Students with an MSc specialisation Science Communication and Society are admissible to a PhD programme in their MSc research field or in Science Communication.

## 1.2 Qualifications for admission (Course and Examination Regulations chapter 5)

Admissible to the specialisation SCS 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. Preferably, the BSc programme has included some coursework in (science) communication.

In addition, international applicants must provide proof of proficiency in English with an IELTS  $\geq 6.5$

## 1.3 Programme (Course and Examination Regulations chapter 3)

The MSc programme in combination with the Science Communication and Society (SCS) specialisation consists of two components:

- a component within the chosen MSc programme:
  - [\*Mathematics\*](#);
  - [\*Computer Science\*](#);
  - [\*Astronomy\*](#);
  - [\*Physics\*](#);
  - [\*Chemistry\*](#);
  - [\*Bio-Pharmaceutical Sciences\*](#);
  - [\*Biology\*](#);
  - [\*Life Science and Technology\*](#); or
  - [\*Biomedical Sciences \(LUMC\)\*](#).
- a Science Communication and Society component<sup>54</sup>.

Preferably, the component within the chosen MSc programme should be followed during the first year of study, the Science Communication and Society component should be followed during the second year.

The SCS specialisation programme comprises at least 40 EC. A maximum of 20 EC of electives can be filled in with either SCS courses, or with components within the MSc programme of choice. The choice of electives should be made in consultation with a study adviser, mentor, or specialisation coordinator.

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<sup>54</sup> Completion of the specialisation Science Communication and Society requires a minimum of 40 EC and a maximum of 60 EC within the SCS component.

The Science Communication and Society component consists of the following:

	<b>Level</b>	<b>EC</b>
Science Communication and Society Fundamentals	400	19
Scientific Narration and Visualization	500	4
SCS Project Proposal	600	3
SCS Internship(s)	600	14-34
<b><u>Electives</u></b>		
SCS Elective	500	1-10
Science Journalism	400	3

The internship will be in the field of science communication (e.g. science journalism, museology, new media, health communication). The total internship period may consist of one internship, or can be divided into 2 smaller internships. Each internship includes a written report and an oral presentation. The total internship period includes a minimum of 10 EC of research in science communication.

The choice of internships should be approved beforehand by the coordinator of the specialisation and if applicable by the MSc programme coordinator. A plan for the optional SCS Elective (e.g. book exam, product development) should be approved beforehand by the SCS coordinator. Science Journalism is an elective course available for students outside the specialisation (for SCS specialisation students, this course is part of SCS Fundamentals).

# Specialisation Education

The specialisation Education is taught in Leiden by the Leiden University Graduate School of Teaching (ICLON)

## 1.1 Description (Course and Examination Regulations chapter 2)

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 as indicated in the table below.

Master programme	Qualifies for school subject
Mathematics	Wiskunde (Mathematics)
Physics	Natuurkunde (Physics)
Astronomy	Natuurkunde (Physics)
Chemistry	Scheikunde (Chemistry)
Bio-Pharmaceutical Sciences	Scheikunde (Chemistry) <sup>55</sup> or Biologie <sup>56</sup> (Biology)
Life Science and Technology	Scheikunde (Chemistry) or Biologie <sup>56</sup> (Biology)
Biology	Biologie (Biology)
Computer Science	Informatica (Computer science)

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

## 1.2 Qualifications for admission (Course and Examination Regulations chapter 5)

Students should be admitted to an MSc programme within the Faculty of Science. The teacher educator of the subject matter will assess if there are deficiencies in the prior education of the student. When deficiencies are identified, the teacher educator will propose how these can be solved.

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 (Toelatingsexamen Universiteit Leiden – gevorderd, met spreekvaardigheid minimaal een 7 ½).

## 1.3 Programme (Course and Examination Regulations chapter 3)

The MSc programme in combination with the Education (EDU) specialisation consists of two components:

- a component within the chosen MSc programme (60 EC):
  - [Mathematics](#),
  - [Astronomy](#),
  - [Physics](#),
  - [Chemistry](#),
  - [Bio-Pharmaceutical Sciences](#),
  - [Biology](#),
  - [Life Science and Technology](#),
  - [Computer Science](#)
- An Education component (60 EC).

The component within the chosen MSC programme should be followed during the first year of study, the Education component should be followed during the second year.

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<sup>55</sup> Students Bio-Pharmaceutical Sciences wishing to qualify for the school subject “Chemistry”, need to solve their deficiencies in concert with the *teacher educator Chemistry* of the ICLON.

<sup>56</sup> Students Bio-Pharmaceutical Sciences and Life Science and Technology wishing to qualify for the school subject “Biology”, need to solve their deficiencies in concert with the *teacher educator Biology* of the ICLON.

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:

	<b>Level</b>	<b>EC</b>
Educational Theory	400	5
Learning and Instruction 1	300	3
Innovations in Education	400	3
Teaching Methodology 1	400	5
Teaching Methodology 2	500	5
Subject-specific research project	600	7
Teaching Practice 1		17
Teaching Practice 2		15

For students who passed the minor Education (30 EC) during the BSc programme, the programme consists of the following:

	<b>Level</b>	<b>EC</b>
Learning and Instruction 2	400	3
Teaching Methodology 2	500	5
Design Research	600	7
Teaching Practice 2		15

The remaining 30 EC can be used for both the education specialisation and the research component of the MSc programme. For LST and Chemistry the remaining 30 EC are restricted to the MSc programme.