

**25th July 2023**

**Faculty of Applied Sciences at Delft University of Technology**

**Programme specific appendix MSc Life Science & Technology**

**to the Teaching and Examination Regulations for the MSc programmes of the Faculty of Applied Sciences**

**2023 - 2024**

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## **Administrative data**

1. Name of the programme: M Life Science and Technology
2. Croho: 21PF-66286
3. Level: WO- Master
4. Studyload: 120 EC
5. Specialisations: Cell factory; Biocatalysis; Biochemical engineering
6. Delft University of Technology
7. Government-Funded University
8. Result of review on university level: positive

Period of NVAO accreditation: the duration of the accreditation for an existing study programme is indefinite. Date of delivery of the next visitation report is 1 May 2028.

## **ARTICLE 1 - (in line with TER article 5) – The programme’s final attainment levels**

### **Master’s degree programme objectives**

The objectives of the Master’s degree programme in Life Science and Technology are:

- To instill scientific knowledge, insight, as well as methodical, technological and communicational skills that correspond to the specialized field of the degree programme
- To gain an academic attitude with a critical, scientific and creative way of thinking and the ability to engage in interdisciplinary work, based on awareness of the ethical and social aspects referring to one’s own research, and insight into one’s professional situation and into the consequences for others of one’s actions;
- To prepare for a scientific career and post-graduate education, especially for PhD education and to prepare for a career in society.

### **Exit qualifications Master’s graduates:**

#### **1. Competence in one or more scientific disciplines.**

Building on expected prior knowledge in the basic disciplines of biology, chemistry, physics, mathematics, and chemical engineering, the student develops, in the general compulsory modules, a thorough knowledge of the field of contemporary biotechnology at large and of the major interconnections between its founding sub-fields (e.g., cellular metabolism and industrial fermentation). Subsequently, the student takes a preferred orientation along one or two specialization(s) to develop mastery in relevant parts of the disciplines of (bio)chemistry (specialization biocatalysis) and/or industrial genomics, metabolic engineering and physiology (specialization cell factory) and/or biochemical engineering (specialization biochemical engineering). In these specialization-specific modules particular emphasis is placed on the latest results and methodologies and in the courses of their choice the student is stimulated to develop critical reading and interpretational skills with respect to the primary scientific literature.

#### **2. Competence in doing research.**

The student is expected to bring some prior experience in (supervised) research, e.g. the 3-months LS&T bachelor research project. The master research project (max. 8 months) is scheduled in the second year of the curriculum, to enable the student to maximally capitalize on previously acquired knowledge. The project is typically carried out in a Department of Biotechnology group with a research profile matching the student’s profile to assure a head-on start and expert guidance. A project is designed to be ‘integral’ i.e. it should trigger exploration of a range of scientific aspects and invoke a range of sufficiently different techniques to stimulate the student to develop intellectual flexibility and interdisciplinary orientation. As an example (for a biocatalysis project): an annotated but otherwise uncharacterized gene is cloned and expressed in a model organism; this species is grown in a fermentor; the expressed protein is purified; its catalytic activity is explored; prosthetic groups are spectroscopically characterized; a fine-chemical application is devised. The student is challenged to repeatedly formulate sub-research goals and to become acquainted with literature, experimental setups, paradigms in – in the example’s case – molecular biology, biochemistry, biophysics and white biotechnology.

#### **3. Competence in designing**

Based on a succinctly formulated industrial assignment a group of 3-5 students runs a two-months conceptual design project for a bioprocess or a bioproduct. Starting from incomplete information, the group reformulates the assignment and chooses for a limited set of options in the form of a Basis of Design which should be defensible before a coach and an industrial representative. The subsequent design development confronts the team with questions of integration of existing knowledge, exploration of new fields, making choices of limitation, and relating the results to a range of constraints (economic, environmental, societal acceptance, safety, validation, quality assurance). The design project is scheduled to run concurrently with the compulsory module ‘ethical, legal and social issues in biotechnology’, whose final assignment is to reflect upon the design outcome.

#### **4. Scientific approach**

The curriculum in general is aimed at educating students to become independent, critical scientists and engineers. The student is exposed to, and trained to identify new developments especially in literature assignments in the profile-specific modules. At least during the period of his/her research project the student is strongly encouraged to attend the monthly ‘Kluyver colloquia’ of the Department of Biotechnology, where renowned national and international specialists from academia and industry elaborate on relevant topics. Doing a research project also implies participation in the regular work discussions of the hosting research group, where the student regularly presents intermediate results and puts interpretations to the test of a critical peer audience. All MSc students are

stimulated to adopt a 'bold and egalitarian' approach in scientific discussions with their peers, supervisors and teachers.

### 5. Basic intellectual skills

Extending the basic intellectual skills acquired, e.g., in the LS&T bachelor programme, the student is trained towards independence in assessing problems of increased complexity and in point-of-view adjustment. Decision making (reduction, elimination, re-orientation) is a key element in the design project. The concept of falsification (one original experiment calls for many control experiments) pervades the research project on a daily basis. Critical reading of literature is an integral part of the teaching in profile-specific modules. Modelling and numerical-analysis skills are also developed in several modules, and possible basic gaps in knowledge are remedied at the curriculum entry time.

### 6. Competence in co-operation and communication

Fruitful cooperation with equals, but also with external parties, is attained as *conditio sine qua non* for a successful design project. Choosing, assigning and accepting roles and responsibilities is an integral part of managing the project. Similarly, research projects by necessity provide many opportunities to develop professional cooperativity with technical assistants and with junior and senior scientists. In a different vein, cooperativity skills are obtained in the course of the 3-months industrial internship intended to be a 'culture shock' for the student to juxtapose 'the outside' versus academic life. Each of these parts of the curriculum call for formal verbal and written reporting usually in the English language.

### 7. Taking account of the temporal and social context.

With the compulsory general module 'Ethical, legal and societal issues in biotechnology' the student learns to choose his/her place as a professional in society. In the combination of this module with the Design project the student actualizes the integration of societal aspects in scientific work. Elements of contemporary interaction between society and science & technology also appear in several modules, e.g., atom efficient green chemistry (biocatalysis), toxic metals (advanced enzymology), products from waste (environmental biotechnology).

## ARTICLE 2 (in line with TER article 3) – Admission to the programme

2.1. Individuals holding one of the following degrees have access to the education of the Master's degree programme in Life Science & Technology on the condition that all of the stated requirements have been met.

#### a. Specific university Bachelor's degree:

Joint bachelor's degree in Life Science & Technology (Leiden/Delft) or equivalent. These equivalencies and a description of the entry levels, are laid down in the webpage '[transfer matrix](#)'.

#### b. Other university Bachelor's degree (not including those listed in Subsection a):

The following applies to this category:

- University Bachelor's degree [name, to be confirmed by the admission committee]
- In case required, successful completion of the stated (tailor-made) bridging programme for admission to the Master's degree programme. Bridging programme to be followed: S-LST.

#### c. Higher professional education degree

The following applies to this category:

- A Bachelor of Science degree in Life Science & Technology (HBO) or equivalent can be admitted to the programme. These equivalencies and a description of the entry levels, are laid down in the webpage [admission HBO](#).
- Students with a Bachelor of Science degree (HBO) can be admitted to the programme provided they have a minimum Grade Point Average of 75% and no delay of study (guideline). Before starting the (Bridging) Programme, students should have successfully passed the entrance exams for Mathematics and English. A tailor-made bridging programme may be part of the entrance requirements.
- In case required, successful completion of the stated (tailor-made) bridging programme for admission to the Master's degree programme. Bridging programme to be followed: S-LST.

#### d. Foreign degree

This category is subject to the general selection requirements of Delft University of Technology with regard to prior foreign education, based on a Cumulative Grade Point Average of at least 75% of the maximum number of points that could be earned, included in the table of countries ([see website](#)). A GPA of 75% for key subjects is also required. Students must meet the requirements for satisfactory linguistic mastery of English. One of the following certificates are accepted:

- A TOEFL iBT (Test of English as a Foreign Language internet-Based Test) with an overall band score of at least 90 and a minimum score of 21 for each section.
- An IELTS (academic version) with an overall Band score of at least 6.5 and a minimum of 6.0 for each section.
- A Cambridge Assessment English. Only the following are accepted:
  - C1 Advanced (Certificate of Advanced English) with an overall score of 176 and a minimum of 169 for each section.
  - C2 Proficiency (Certificate of Proficiency in English) with an overall score of 180 and a minimum of 169 for each section

Certificates older than two years are not accepted.

2.2. Access to the education of the Master's degree programme in Life Science & Technology is open to individuals who have demonstrated to the admissions committee that they possess knowledge, insight and skills at the level of the Bachelor's degree mentioned Subsections 2a, or of a university Bachelor's degree, in addition to the further requirements mentioned in Subsections 2b and 2c.

2.3. All students are also subject to the following qualitative admission requirements:

Students who do not possess the degree mentioned in paragraph 1.a. are required to obtain proof of admission to the programme from the dean, who will seek the advice of the admissions officer on this matter. The levels and subjects for assessing previous education are a sufficient level in the following knowledge areas:

- a) Mathematics (differential equations, linear algebra)
- b) Chemistry (organic, inorganic, analytic, physical)
- c) Biology (i.e. biochemistry, molecular genetics, microbiology)
- d) (Bio) chemical engineering (including transport phenomena)
- e) Introduction to a programming language such as python.

#### **ARTICLE 3 (in line with TER art. 7) - The study load and academic year**

1. The study load for the Master's degree programme is 120 credits. None of the components of the programme may have formed part of the Bachelor's degree programme.
2. The Master's degree programme consists of 2 academic years.
3. One academic year is divided into two semesters, each containing 2 teaching periods.

#### **ARTICLE 4 (in line with TER art. 7) - The composition of the Master's programme**

4.1 The study programme is completed in the following way:

- a. In the first year: general compulsory courses (18 EC), specialisation courses (18 EC), electives (12 EC), the Design Project (12 EC).
- b. In the second year: master thesis project (45 EC) & company internship (15 EC).

#### 4.2. General overview of the programme:

Course code	Course name	ECTS	Language	Education period(s)	Exam period(s)
<b>YEAR 1</b>					
<b>1. General mandatory modules</b>					
LM3331	Modelling and Computation for Life Science & Technology	5	EN	x/0/0/0	t/ht/0/0
LM3341	Microbial Omics	5	EN	x/0/0/0	t/ht/0/0
LM3451	Bioprocess Integration	5	EN	x/0/0/0	t/ht/0/0
LM3561	Ethical, Legal and Social Issues in Biotechnology	3	EN	0/0/0/x	0/0/0/x
LM3822	Design project	12	EN	0/0/0/x	0/0/0/x
	General Mandatory part of the exam programme	30			
<b>2. Specialisation courses (at least one full specialisation must be completed)</b>					
2.1 Cell Factory					
LM3442	Metabolic Reprogramming	6	EN	0/x/x/0	0/0/t/ht
LM3601	Molecular Biotechnology & Genomics	6	EN	0/x/x/0	0/0/t/ht
LM3432	Analysis of Metabolic Networks	6	EN	0/x/0/0	0/t/ht/0
2.2. Biocatalysis					
LM3701	Advanced Enzymology	6	EN	0/x/x/0	0/0/t/ht
LM3731	Advanced Biocatalysis	6	EN	0/x/x/0	0/0/t/ht
LM3434	Advanced Protein Chemistry and Analysis	6	EN	0/0/x/0	0/0/t/0/ht
2.3. Biochemical Engineering					
LM3741	Fermentation Technology & Environmental Biotechnology	6	EN	0/x/x/0	0/0/t/ht
LM3751	Transport & Separation	6	EN	0/0/x/0	0/0/t/ht
	<i>Choice out of the 2 courses: LM3611 or LM3432</i>				
LM3611	Microbial Community Engineering	6	EN	0/0/x/0	0/0/t/ht
LM3432	Analysis of Metabolic Networks	6	EN	0/x/0/0	0/t/ht/0
	Specialization courses	18 EC			
<b>3. Elective part</b>					
<i>A list of preferred electives for each specialization and the corresponding procedures for choosing electives is published on Brightspace MSc Life Science &amp; Technology, accessible with a TUD NetID, or on demand through info-LST@tudelft.nl. Specific LST electives are:</i>					
LM3771	Protein Engineering	3	EN	0/x/0/0	0/t/ht/0
LM3311	Green Chemistry & Sustainable Technology	3	EN	0/0/0/x	0/0/0/t/ht
LM3581-NB	Metabolic Systems Biology	3	EN	0/0/x/0	
LM3351	Topics in Biotechnology - Theory*	3-5	EN	0/0/x/0	0/0/t/ht
LM3356	Topics in Biotechnology - Practical*	10-12	EN	0/0/x/x	0/0/0/t/ht
LM3692	iGEM ( <b>this is not a regular elective! Check the study guide</b> )	15	EN	x/0/x/x	x/0/0/0
TPM041a	Diversity and inclusion in Science, Technology, Engineering & Mathem.	3	EN	0/x/0/0	0/t/ht/0
	Elective courses	12 EC			
	<i>* These courses are only for February starters, exchange, and honours students</i>				
	<b>Total year 1</b>	<b>60 EC</b>			
<b>YEAR 2</b>					
<b>4. PROJECTS</b>					
LM3901	Master Thesis Project (MEP)	45	EN	not applicable	
1. We expect MSc students LST to perform a COMPANY INTERNSHIP (LM3803, 15 EC), preferably after the MEP (thesis project).					
2. An alternative is participation in the JOINT INTERDISCIPLINARY project (TUD4040, 15 EC).					
3. <b>In exceptional cases</b> , the programme coordinator may allow a student to carry out a non-industrial internship project (LM3804, 15 EC), with learning outcomes equivalent to those of the Company Internship (LM3803, 15 EC).					
A: LM3803	Company Internship	15	EN	not applicable	
B: TUD4040	Joint Interdisciplinary Project	15	EN	x/0/0/0	
C: LM3804	Non-industrial Internship project	15	EN	not applicable	
	<b>Total year 2</b>	<b>60 EC</b>			
	<b>Total EC MSc-LST</b>	<b>120 EC</b>			

#### 4.3 MSc - thesis project (MEP) – LM3901 – 45 EC

- a. **Entry requirement** for the MEP project: one retake for a single compulsory / elective course is allowed (mark should be at least 4.5 for the failed exam), not taking into account the Design project & the Company Internship (which are not required to start the MEP).
- b. **Approval** of the supervisor **and** specialization coordinator is needed.
- c. **Students** need to deliver a transcript along with their MEP application form to the specialization coordinator.
- d. **Projects in the Faculty of Applied Sciences are allowed.** Each review committee should have a BT-supervisor, *who also surveys the deadlines of the project.*
- e. For proper assessment of **projects in the research section 'Biotechnology & Society'**, a 4<sup>th</sup> reviewer should be appointed in the review committee, being an expert in the field of environmental, societal or economic analysis.
- f. Projects on 'Waste Water Treatment' and 'Environmental Engineering' (section Sanitary Engineering, Dept. of Water Management, Faculty of Civil Engineering & Geosciences) and in the Bio-Informatics Lab (Faculty of Electrical Engineering, Mathematics & Computer Science) are also permitted. Each review committee should have a BT-supervisor, *who also surveys the deadlines of the project.*
- g. Under exceptional circumstances supervisor and specialization coordinator can deviate from these rules, but only after approval by the sub-board of examiners.

#### 4.4 Company internship – LM3803 – 15 EC

- a. Students perform their Company Internship preferably after the thesis project.
- b. The duration of an industrial internship is no longer than **3 months (= 15 EC)**.
- c. The industrial internship is carried out in a **company**, or in exceptional cases in a **research institution in the private sector**.
- d. In case a student has accepted a longer duration of the internship (i.e. a longer duration at 'own risk and no income') a report on the internship should be handed in within the 3 months of the nominal duration of the internship.
- e. Before the start of the Internship, students have to register their internship at the Internship Office (online registration Onstage).
- f. The courses **TUD 4040 (Joint Interdisciplinary Project)** and **LM3804 non-industrial internship** are considered to be equivalent to the **Company Internship LM3803**.

#### ARTICLE 5 – Scientific & Social Orientation

Students are allowed to substitute 30 EC of the afore-mentioned MSc programme LST by the following Special Programmes. They substitute the elective part (12 EC), the company internship (15 EC) and 3 EC of their MSc End Project (MEP), resulting in a 42 EC MEP (LM3902).

*These special programmes must be approved by the coordinator of the specialization and the sub-Board of Examiners MSc LST.*

<b>5. Scientific &amp; Social Orientation</b>		30	
Students are allowed to substitute 30 EC of the above-mentioned MSc programme LST by the following Special Programmes. They substitute the elective part (12 EC), the company internship (15 EC), and 3EC of their MSc End Project (MEP).			
<b>Study abroad</b>		30	Contact: Andrea Witkam
This programme consists of 30EC of courses and/or a research project at a foreign university. The programme has to be approved by the Board of Examiners in advance.			
<b>Science Education (in Dutch!)</b>		30	Contact: Mahsa Hajivandi
<b>Deadlines for application: 15th November (for semester 2) and 1st of May (for semester 1)</b>			
<b>Choice of 30 EC out of the following courses</b>			
Education Basisdeel (Ed 1)		30	
SL3462	Onderwijskunde		
SL4202	Professionele Leergemeenschap		
SL4201	Inleiding betadidactiek		
SL4230	Vakdidactiek Basis Scheikunde		
SL4235	Schoolpracticum Basis Scheikunde		

Education Verdieping (Ed2)		30	
SL3012	Personal Professional Development		
SL4301	Implementatie van Onderwijs		
SL4330	Vakdidactiek Verdieping Scheikunde		
SL4335	Schoolpracticum Verdieping Scheikunde		
<b>Management of Technology</b>		30	Contact: Andrea Witkam
<b>Only limited number of places available. Choice for semester 1 or semester 2.</b>			
<b>Deadlines for application: 15th November (for semester 2) and 1st of July (for semester 1)</b>			
<b>1<sup>st</sup> SEMESTER MoT Modules</b>		30	
MOT111a	Financial Management		
MOT112a	Economic Foundations		
MOT121a	Leadership & Techn. Management		
MOT131a	Emerging Breakthrough Technologies		
MOT141a	Research Methods		
MOT142a	Social and Scientific Values		
<b>2<sup>nd</sup> SEMESTER MoT Modules</b>		30	
MOT113a	Technology Dynamics		
MOT122a	Digital Business Process Management		
MOT123a	Inter- and intra-organisational decision making		
MOT132a	Technology Strategy and Entrepreneurship		
MOT133a	High-tech Marketing		
MOT143a	Business Analytics		

## ARTICLE 6 - Honours programme

Regulations on the Honours programme are described in *article 10 of the Teaching & Examination Regulations* of the Master's degree programmes Applied Sciences 2022-2023.

The honours programme is a challenging additional programme for students with higher than average performance ( $\geq 7.5$  weighted average). The honours programme consists of at least 20 EC on top of the regular master programme of 120 EC. The full Master's programme LST, including the additional honours programme, should be finished according to nominal duration, with again a weighted average of  $\geq 7.5$ .

***Each individual honours programme needs to be discussed with and approved by Director of Studies (prof. dr. Ulf Hanefeld) before the start of the honours programme!***

HONOURS PROGRAMME		20 EC
The Honours Track consists of 20 EC <u>on top of</u> the regular master programme of 120EC and should be finished within the standard two years.		
<b>COLLECTIVE PART, choice out of collective courses</b>		5
UD2010	Technological expertise in public debate	5
UD2012	Business Leadership for Engineers	5
IFHPM0000	Entrepreneurship and innovation	5
IFHPM0010	Materials in a sustainable society	5
IFHPM0020	Leadership Skills for Engineers	5
<b>INDIVIDUAL PART: 4 options</b>		15
<b>1. Company Oriented HPM</b>		
AS1011HPM	Applied Sciences Company Project	12
AS1021HPM	Applied Sciences Honours Classes	3



2. Consistent package of challenging courses		
	A consistent package of challenging courses, to be approved by the programme director	15
3. Highlights in Biotechnology		
LM3351	Topics in Biotechnology - Theory	3-5
LM3356	Topics in Biotechnology - Practice	10-12
4. Research Oriented HPM		
AS1031HPM	Applied Sciences Research Project	9-15
	Project related course	0-6
4TU Responsible Sustainability Challenge		
IF3ME40000	4TU Responsible Sustainability Challenge	15

#### ARTICLE 7 - Education track of the MSc-programme Science Education & Communication (only Dutch-speaking students)

Students in the MSc-programme Life Science & Technology can do educational modules.

**The coordinator of the specialisation has to approve this.**

The educational programme is aimed at Dutch-speaking students with a BSc-background in (applied) physics, chemistry, life science & technology, applied mathematics and computer science only, because they are oriented towards the Dutch school system and because it includes internships (Schoolpracticum) at Dutch secondary schools. Consequently, the educational specialisation modules are taught in Dutch. The programme consists of Basisdeel/Ed1 (30 EC) and Verdiepingsdeel/Ed2 (30 EC).

- The minor Education (Basisdeel/Ed1) can be done during the bachelor programme and leads to qualification as a *tweede graads* secondary school teacher with limited qualification (*beperkte bevoegdheid*).
- If a student has done the minor Education, only the Verdiepingsdeel/Ed2 of 30 EC remains for the master programme specialisation. The combination of the minor Education and Ed2 specialisation leads to qualification as a fully-qualified *eerste graads* (grade-one) secondary school teacher. The qualification will be mentioned on the master diploma. These students can do the Verdiepingsdeel/Ed2 also as a second master.
- Students that did not take the minor Education can follow the Basisdeel/Ed1 specialisation as part of their master programme and then do the Verdiepingsdeel/Ed2 as a second master in order to become fully qualified.

**The educational programme should be approved by the SEC-coordinator, Mahsa Hajivandi**

#### ARTICLE 8 - Double degree

Students who opt for an **individual double degree** (second master) and have obtained permission, are allowed to spend the Scientific and Social Orientation on modules from the second master programme.

Double degree programmes combining Life Science & Technology with other master programmes, such as Management of Technology, are always subject to the restrictions imposed by the university. The main restrictions are that the double degree programme comprises at least 180 EC and that there are two identifiable final project reports for both degrees. The LST final project may be reduced to 30 EC (LM3995), only if the other final project is also at least 30 EC. Formal permission from the Boards of Examiners of both faculties is required.

**After approval of the two Boards of Examiners, the approved application has to be sent to the Student Programme Administration, SPA-TNW@TUDelft.nl.**

#### **ARTICLE 9 - Explanation of programme components**

Every year, the digital study guide includes a description of the various programme components, along with the criteria for assessing these components if assessment is different from that applied for interim examinations (reports, presentations, etcetera).

#### **ARTICLE 10 - Deviations from the programme**

Only in exceptional cases, a deviation from the programme is possible. Such deviations need prior approval by the sub-Board of Examiners; for this reason a student should send a legitimate request to the sub-Board of Examiners after consultation with the coordinator of the specialisation.

If students participate in iGEM (LM3692 - 15 EC) as part of their regular programme, they can apply for an exemption for the Design project (LM3822 - 12 EC). The remaining 3 EC are extracurricular.

#### **ARTICLE 11 – Transition regulations & equivalencies**

A renewed curriculum of the Master's degree programme Life Science & Technology is offered to students of cohorts 2021 and later, as described in article 4.

A transitional exam programme will be offered to students who do not study nominally. This individual examination programme is based on personal progress and choice of specialization. The programme is compiled in consultation with the study programme coordinator, whereby the final attainment levels of the study programme, as set out in ARTICLE 1 of this appendix (in line with TER article 5) are guaranteed. These individual examination programmes require approval from the sub-Board of Examiners MSc LST.

Equivalencies:

LM3581 Systems Biology – 3 EC	LM3581-NB Metabolic Systems Biology – 3 EC
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