



Curriculum for the Master's Programme in Sustainable Biotechnology

Aalborg University
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Preface:

Pursuant to Act 261 of March 18, 2015 on Universities (the University Act) with subsequent changes, the following curriculum for the Master's program in sustainable biotechnology is stipulated. The program also follows the Joint Programme Regulations and the Examination Policies and Procedures for The Technical Faculty of IT and Design, The Faculty of Engineering and Science, and The Faculty of Medicine.

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Chapter 1: Legal Basis of the Curriculum, etc.

1.1 Basis in ministerial orders

The Master's Programme in Sustainable Biotechnology is organised in accordance with the Ministry of Higher Education and Science's Order no. 1328 of November 15, 2016 on Bachelor's and Master's Programmes at Universities (the Ministerial Order of the Study Programmes) and Ministerial Order no. 1062 of June 30, 2016 on University Examinations (the Examination Order). Further reference is made to Ministerial Order no. 258 of March 18, 2015 (the Admission Order) and Ministerial Order no. 114 of February 3, 2015 (the Grading Scale Order) with subsequent changes.

1.2 Faculty affiliation

The Master's programme falls under the Faculty of Engineering and Science

1.3 Board of Studies affiliation

The Master's program falls under the Board of Studies for Biotechnology, Chemistry and Environmental Engineering

1.4. External Evaluation Corps

The programme falls under the external evaluator corps: Ingeniøruddannelsernes landsdækkende censorkorps – kemi.

Chapter 2: Admission, Degree Designation, Program Duration and Competence Profile

2.1 Admission

Applicants with a legal claim to admission (retskrav):

Applicants with one of the following degrees are entitled to admission:

- Bachelor in Sustainable biotechnology, Aalborg University

Applicants without legal claim to admission:

- Bachelor i Bioteknologi, Aalborg University

Students with another Bachelor's degree, upon application to the Board of Studies, will be admitted after a specific academic assessment if the applicant is deemed to have comparable educational prerequisites. The University can stipulate requirements concerning conducting additional exams prior to the start of study.

2.2 Degree designation in Danish and English

The Master's program entitles the graduate to the designation *civilingeniør, cand.polyt.* (*candidatus/candidata polytechnices*) i bæredygtig bioteknologi. The English designation is: Master of Science (MSc) in Engineering (Sustainable Biotechnology).

2.3 The program's specification in ECTS credits

The Master's program is a 2-year, research-based, full-time study program. The program is set to 120 ECTS credits.

2.4 Competence profile on the diploma

The following competence profile will appear on the diploma:

A Candidatus graduate has the following competency profile:

A Candidatus graduate has competencies that have been acquired via a course of study that has taken place in a research environment.

A Candidatus graduate is qualified for employment on the labour market on the basis of his or her academic discipline as well as for further research (PhD programmes). A Candidatus graduate has, compared to a Bachelor, developed his or her academic knowledge and independence so as to be able to apply scientific theory and method on an independent basis within both an academic and a professional context.

2.5 Competence profile of the program:

The graduate of the Master's program:

Knowledge	<ul style="list-style-type: none">• has knowledge within sustainable biotechnology on the use of state of the art biotechnological techniques and methods for process development and exploitation of renewable sustainable resources as replacements for fossil resources and mitigation of green-house gases• understand and reflect, on a scientific basis, over the knowledge associated with general biotechnology, microbiological production, sustainability, biomass conversion processes, biorefineries, production of biomaterials, biochemicals, and bioactive compounds, and be able to identify scientific problems related to these areas
Skills	<ul style="list-style-type: none">• can master the scientific methods and tools of the above-mentioned areas and master the general skills that are tied to work within sustainable biotechnology• are able to evaluate and select among the scientific theories, methods, tools and general skills of sustainable biotechnology, and set up, on a scientific basis, new analysis and solution models• can communicate research based knowledge and discuss professional and scientific problems with both peers and non-specialists
Competencies	<ul style="list-style-type: none">• can develop and design biotechnological processes and biorefineries for the sustainable conversion of biomass into valuable products and work with complex, unpredictable and new solutions• can independently initiate and carry out discipline specific and cross-disciplinary cooperation and to assume professional responsibility within the area of sustainable biotechnology.• can independently take responsibility for own professional development and specialization

Chapter 3: Content and Organization of the Program

The program is structured in modules and organized as a problem-based study. A module is a program element or a group of program elements, which aims to give students a set of professional skills within a fixed time frame specified in ECTS credits, and concluding with one or more examinations within specific exam periods. Examinations are defined in the curriculum.

The program is based on a combination of academic, problem-oriented and interdisciplinary approaches and organized based on the following work and evaluation methods that combine skills and reflection:

- lectures

- classroom instruction
- project work
- workshops
- exercises (individually and in groups)
- teacher feedback

Overview of the program:

All modules are assessed through individual grading according to the 7-point scale or Pass/Fail. All modules are assessed by external examination (external grading) or internal examination (internal grading or by assessment by the supervisor only).

Semester	Module	ECTS	Assessment	Exam
1st	Advanced Microbiological Production	15	7-point scale	Internal
	Biorefinery Principles	5	7-point scale	Internal
	Systems and synthetic biology	5	7-point scale	Internal
	Biological production processes	5	7-point scale	Internal
2nd	Biomass Conversion Processes	15	7-point scale	Internal
	Microbiological Discovery	5	7-point scale	Internal
	Advanced Kinetics and Modelling of Bioprocesses	5	7-point scale	Internal
	Anaerobic and Fungal Biotechnology	5	7-point scale	Internal
3rd	Electives <ul style="list-style-type: none"> • Project Work in an External Organisation 	30	Pass/fail	Internal
4rd	<ul style="list-style-type: none"> • Master's Thesis in Sustainable Biotechnology • Master's Thesis in Sustainable Biotechnology 	30	7-point scale	External
3rd-4th		60	7-point scale	External
Total		120		

3.1 Descriptions of modules. 1st semester. Advanced microbiological production

Title: **Advanced Microbiological Production**
Avanceret mikrobiel produktion

Objective: Students who complete the module must be able to:

Knowledge

- demonstrate basic understanding and overview of different biological and biochemical processes that occur in microbiological fermentation and production.
- explain plant cell walls and the structure of plant material in general

Skills

- select relevant enzymes for processing of specific biomasses
- suggest genetic modifications of microorganisms of relevance to their project
- write a project report following the standards of the field of study, include relevant original scientific literature, use the correct terminology, and communicate the research-based foundation, problem and results of the project in writing, graphically and orally in a coherent way
- assess and select relevant original scientific literature and current scientific methods, models and other tools used in the project and asses

the problem of the project and results in relevant scientific contexts and social conditions

Competencies

- handle the planning, implementation and management of complex and unpredictable research and/or developmental tasks and take professional responsibility for implementing academic assignments and interdisciplinary collaborations
- take responsibility for own professional development and specialization

Type of instruction: Project work

Exam format: Oral examination based on a written report.

Evaluation criteria: As stated in the Joint Programme Regulations

Title: **Biorefinery Principles**
Bioraffinaderier

Objective: Students who complete the module must be able to:

Knowledge

- account for existing biorefinery concepts and technologies
- compare different types of biorefineries with each other and oil refineries
- outline possible technological couplings and combinations with other process industry

Skills

- evaluate biomasses with respect to their applicability in biorefineries and outline which qualities that are associated with applicability
- identify and analyze the limitations by existing physical-chemical, thermochemical, and biological methods for biomass conversion
- set up mass and energy balances for different biomass conversions
- apply one or more of the general calculation models for estimation of costs and energy efficiency in the conversion of different biomasses into different products

Competencies

- devise a suitable biorefinery technique for the conversion of a given biomass into a specific product
- Evaluate the environmental consequences of biorefinery activities

Type of instruction: Lectures and theoretical exercises

Exam format: Written or oral examination

Evaluation criteria: As stated in the Joint Programme Regulations

Title: **Systems and Synthetic Biology**
Systembiologi og syntetisk biologi

Objective: Students who complete the module must be able to:

Knowledge

- explain and process information from “omics” technologies

Skills

- elaborate simple metabolic models and use tools for genome-scale modelling
- design metabolic and evolutionary engineering strategies
- apply molecular tools for synthetic biology

Competencies

- evaluate and address ethical questions in the synthetic biology field

Type of instruction	Lectures and theoretical exercises
Exam format:	Written or oral examination
Evaluation criteria:	As stated in the Joint Programme Regulations

Title: **Biological Production Processes**
Biologische produktionsprozesse

Objective: Students who complete the module must be able to:

Skills

- use basic molecular biology tools for genetic engineering
- suggest and apply usable enzymes for biomass degradation
- differentiate between main groups of microorganisms and their use in a production process.

Competencies

- compare the most important types of bioreactors and suggest the optimal type for a specific production process.

Type of instruction	Lectures and theoretical exercises
Exam format:	Written or oral examination
Evaluation criteria:	As stated in the Joint Programme Regulations

3.2 Descriptions of modules. 2nd semester. Biomass conversion processes

Title: **Biomass Conversion Processes**

Processering og omsætning af biomasse

Objective: Students who complete the module must be able to:

Knowledge

- explain how biomass is analyzed, characterized, treated and converted
- explain the possibilities and techniques that are available for process control

Skills

- select appropriate analyses for the characterization of a specific biomass considering the subsequent use in a biorefinery
- analyze and quantify the content of relevant components and compounds in a specific biomass
- design and perform experiments to evaluate the potential of a specific biomass in a biorefinery:
- test and evaluate pre-treatment techniques
- perform bench-scale fermentations
- purify intermediate and end products
- write a project report following the standards of the field of study, include relevant original scientific literature, use the correct terminology, and communicate the research-based foundation, problem and results of the project in writing, graphically and orally in a coherent way
- assess and select relevant original scientific literature and current scientific methods, models and other tools used in the project and assess the problem of the project and results in relevant scientific contexts and social conditions

Competencies

- devise the most appropriate process scheme including pre-treatment process, fermentation, purification, and down-stream processing for common types of biomass.
- handle the planning, implementation and management of complex and unpredictable research and/or developmental tasks and take professional responsibility for implementing academic assignments and interdisciplinary collaborations
- take responsibility for own professional development and specialization

Type of instruction Project work

Exam format: Oral examination based on a written report.

Evaluation criteria: As stated in the Joint Programme Regulations

Title:	Microbiological Discovery Mikrobiel 'discovery'
Objective:	Students who complete the module must be able to: Knowledge <ul style="list-style-type: none"> • describe different screening strategies and their benefits and limitations. • devise and describe relevant classical screening strategies for microorganisms with specific capabilities. • devise and describe relevant advanced molecular screening strategies for identification of specific genes or gene products
Type of instruction	Lectures and theoretical exercises
Exam format:	Written or oral examination
Evaluation criteria:	As stated in the Joint Programme Regulations

Title:	Advanced Kinetics and Modelling of Bioprocesses Avanceret kinetik og modellering af bioprocesser
Objective:	Students who complete the module must be able to: Skills <ul style="list-style-type: none"> • estimate the kinetic parameters of a biological process and choose the key process variables for the development of a suitable process model • derive the mathematical model of a bioprocess • apply mathematical and kinetic models for different types of bioreactors. • interpret and evaluate modelling data from bioreactors
Type of instruction	Lectures and theoretical exercises
Exam format:	Written or oral examination
Evaluation criteria:	As stated in the Joint Programme Regulations

Title: **Anaerobic and Fungal Biotechnology**
Anaerob bioteknologi og mycobioteknologi

Objective: Students who complete the module must be able to:

Knowledge

- describe important groups of anaerobic bacteria, archaea, and fungi
- describe the use of fungi in research and industry with emphasis on heterologous gene technology.
- describe the use of yeasts and filamentous fungi for different biotechnological purposes.

Skills

- compose and prepare media for the cultivation of anaerobic microorganisms
- enrich, isolate and cultivate anaerobic microorganisms
- suggest and apply fungal biotechnological methods.
- utilize relevant genetic technological and bioinformatic methods

Type of instruction Lectures and theoretical exercises

Exam format: Written or oral examination

Evaluation criteria: As stated in the Joint Programme Regulations

3.3 Descriptions of modules. 3rd-4th semester. Master's thesis

Title: **Project Work in an External Organisation**
Projektarbejde i en ekstern organisation

Objective: Students who complete the module must be able to:

Knowledge

- explain the scientific basis of the work carried out by the external organisation

Skills

- master the scientific methods and general skills related to the project work in the external organisation
- write a report following the standards of the field of study, use the correct terminology and document extensive use of relevant and original scientific literature, and communicate and discuss the project's foundation, problem and results in writing, graphically and verbally in a coherent way
- critically assess and select relevant original scientific literature and current scientific methods, models and other tools used in the project and assess and discuss the problem of the project and results in relevant scientific contexts and social conditions
- evaluate the potential of the project for further development, assessing and incorporating relevant economic, ethical, environmental and other socially relevant factors

Competencies

- participate in development, innovation, and research and use scientific

- methods to solve complex tasks
- take professional responsibility to implement independent assignments and interdisciplinary collaborations
- independently take responsibility for own professional development and specialization

Type of instruction Project work, supervised by an external supervisor in collaboration with an internal supervisor at Aalborg University
Project work in an external organisation must be in areas of relevance to the competence profile of the program

Exam format: Oral examination based on a written report.

Evaluation criteria: As stated in the Joint Programme Regulations

Title: **Master's Thesis in Sustainable Biotechnology**
Kandidatspeciale i bæredygtig bioteknologi

Objective: Students who complete the module must be able to:

Knowledge

- explain the scientific basis and scientific issues in sustainable biotechnology
- explain the highest international research within the thesis subject area

Skills

- master the scientific methods and general skills related to the thesis subject area
- write a project report following the standards of the field of study, use the correct terminology and document extensive use of relevant and original scientific literature, and communicate and discuss the project's research-based foundation, problem and results in writing, graphically and verbally in a coherent way
- critically assess and select relevant original scientific literature and current scientific methods, models and other tools used in the project and assess and discuss the problem of the project and results in relevant scientific contexts and social conditions
- evaluate the potential of the project for further development, assessing and incorporating relevant economic, ethical, environmental and other socially relevant factors

Competencies

- participate in and independently implement technological and scientific development and research, develop and implement experimental work and solve complex tasks using scientific methods
- handle the planning, implementation and management of complex and unpredictable research and/or developmental tasks and take professional responsibility to implement independent academic assignments and interdisciplinary collaborations
- independently take responsibility for own professional development and specialization

Type of instruction Project work.
A long Master's thesis of more than 30 ECTS must include work of experimental nature to an extent that corresponds to the ECTS load of the thesis.

Exam format: Oral examination based on a written report.

Evaluation criteria: As stated in the Joint Programme Regulations

Title: **Problem Based Learning and Project Management**
Problembaseret læring og projektledelse

Objective: Students who complete the module must be able to:

Day 1

- describe and discuss the Aalborg PBL model based on the three key words: group work, project work, problem orientation
- identify an initial individual challenge when using a PBL approach

Day 2

- develop and practice peer feedback skills
- practice collaborative learning in a group
- design a plan of action to deal with an initial individual PBL challenge or curiosity

Day 3

- practice presentation skills
- practice critical skills when giving feedback to peers
- reflect on own and peer skills in relation to PBL practice

Type of instruction Lectures and theoretical exercises

Exam format: Internal assessment during the course/class participation according to the rules in the Examination Policies and Procedures of Faculty of Engineering and Science, Aalborg University. In this case the assessment is based on the oral performance during the course, which means that the student has to be active during the course time and participate in discussions. The course is an integrated part of the project for those not acquainted to the Aalborg PBL model, and is a precondition for participation in the project examination. In this way there will be no diploma for the course and it will not be visible on the academic transcripts

Evaluation criteria: As stated in the Joint Programme Regulations

Chapter 4: Entry into Force, Interim Provisions and Revision

The curriculum is approved by the Dean of the Faculty of Engineering and Science and enters into force as of 2017.

Students who wish to complete their studies under the previous curriculum from 2014 must conclude their education by the summer examination period 2018 at the latest, since examinations under the previous curriculum are not offered after this time.

Chapter 5: Other Provisions

5.1 Rules concerning written work, including the Master's thesis

In the assessment of all written work, regardless of the language it is written in, weight is also given to the student's spelling and formulation ability, in addition to the academic content. Orthographic and grammatical correctness as well as stylistic proficiency are taken as a basis for the evaluation of language performance. Language performance must always be included as an independent dimension of the total evaluation. However, no examination can be assessed as 'Pass' on the basis of good language performance alone; similarly, an examination normally cannot be assessed as 'Fail' on the basis of poor language performance alone.

The Board of Studies can grant exemption from this in special cases (e.g., dyslexia or a native language other than Danish).

The Master's thesis must include an English summary (or another foreign language upon approval by the Studyboard). If the project is written in English, the summary must be in Danish (the Studyboard can grant exemption from this). The summary must be at least 1 page and not more than 2 pages. The summary is included in the evaluation of the project as a whole.

5.2 Rules concerning credit transfer (*merit*), including the possibility for choice of modules that are part of another program at a university in Denmark or abroad

In the individual case, the Board of Studies can approve successfully completed (passed) program elements from other Master's programs in lieu of program elements in this program (credit transfer). The Board of Studies can also approve successfully completed (passed) program elements from another Danish program or a program outside of Denmark at the same level in lieu of program elements within this curriculum. Decisions on credit transfer are made by the Board of Studies based on an academic assessment. See the Joint Programme Regulations for the rules on credit transfer.

5.3 Rules for examinations

The rules for examinations are stated in the Examination Policies and Procedures published by the Faculties of Engineering, Science and Medicine on their website.

5.4 Exemption

In exceptional circumstances, the Board of Studies study can grant exemption from those parts of the curriculum that are not stipulated by law or ministerial order. Exemption regarding an examination applies to the immediate examination.

5.5 Rules and requirements concerning the reading of texts in foreign languages and a statement of the foreign language knowledge this assumes

It is assumed that the student can read academic texts in modern Danish, Norwegian, Swedish and English and use reference works, etc., in other European languages.

5.6 Additional information

The current version of the curriculum is published on the Board of Studies' website, including more detailed information about the program, including exams.