The Faculty of Engineering and Science
The Study Board of Biotechnology, Chemistry and Environmental Engineering

AALBORG UNIVERSITY
DENMARK

Curriculum for the Master's Programme in Biotechnology

Including the specialisation in Medical Biotechnology

Aalborg University
September 2017

Campus Aalborg

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 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 Biotechnology and the Master's Programme in Biotechnology with Specialisation in Medical 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 i Bioteknologi, Aalborg University

Applicants without legal claim to admission:

- Bachelor in Sustainable biotechnology, 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 bioteknologi. The English designation is: Master of Science (MSc) in Engineering (Biotechnology).

The Master's program with specialisation in Medical Biotechnology entitles the graduate to the designation civilingeniør, cand.polyt. (candidatus/candidata polytechnices) i bioteknologi med specialisering i medicinsk bioteknologi. The English designation is: Master of Science (MSc) in Engineering (Biotechnology with specialisation in Medical 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	• Has in-depth knowledge of biotechnology. In selected areas, such as cellular and molecular biology, protein biotechnology, bioinformatics and genetic engineering, knowledge is based on the latest international research. • Is able, on a scientific basis, to understand and contemplate the knowledge in the above-mentioned areas and be able to identify scientific problems.
Skills	• Master the scientific methods and tools of the above-mentioned areas and master the general skills that are central to work within biotechnology. • Is able to evaluate and select among the scientific theories, methods, tools and general skills of biotechnology, and establish new analysis and solution models on a scientific basis. • Is able to communicate research-based knowledge and discuss professional and scientific problems with both peers and non-specialists.
Competencies	• Is able to carry out research and development in the area of microbiology and microbial products and processes, development and quality analyses of recombinant products, modified proteins and pharmaceutical products, following GLP and GMP principles and proper safety regulations. • Is able to independently initiate and carry out discipline-specific and cross-disciplinary cooperation and to assume professional responsibility within the area of biotechnology. • Is able to independently take responsibility for own professional development and specialization.

The graduate of the Master's program with specialization in medical biotechnology:

Knowledge	• Has in-depth knowledge of biotechnology and medical biotechnology. In selected areas, such as cellular and molecular biology, protein biotechnology, bioinformatics and genetic engineering, knowledge is based on the latest international research. • Is able, on a scientific basis, to understand and contemplate

	the knowledge in the above-mentioned areas and be able to identify scientific problems.
Skills	• Master the scientific methods and tools of the above-mentioned areas and master the general skills that are central to work within medical biotechnology • Is able to evaluate and select among the scientific theories, methods, tools and general skills of biotechnology, and establish new analysis and solution models on a scientific basis. • Is able to communicate research-based knowledge and discuss professional and scientific problems with both peers and non-specialists.
Competencies	• Is able to carry out research and development in the area of microbiology and microbial products and processes, development and quality analyses of recombinant products, modified proteins and pharmaceutical products, following GLP and GMP principles and proper safety regulations. • Is able to independently initiate and carry out discipline-specific and cross-disciplinary cooperation and to assume professional responsibility within the area of medical biotechnology. • Is able to 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	Experimental Molecular Biology	15	7-point scale	Internal
	Molecular Biology and Bioinformatics	5	7-point scale	Internal
	Cell Biology, Immunology and Genetics	5	7-point scale	Internal
	Microbial Diversity and Activity	5	7-point scale	Internal
2nd	Protein Science	15	7-point scale	Internal
	Protein Chemistry	5	7-point scale	Internal
	Protein Structure	5	7-point scale	Internal
	Carbohydrate Chemistry	5	7-point scale	Internal
3rd	Electives • Project Work in an External Organisation	30	Pass/fail	External
4th	• Master's Thesis in Biotechnology	30	7-point scale	External
3rd-4th	• Master's Thesis in Biotechnology	60	7-point scale	External
Total		120		

Specialization in Medical Biotechnology

Semester	Module	ECTS	Assessment	Exam
1st	Experimental Molecular Biology	15	7-point scale	Internal
	Molecular Biology and Bioinformatics	5	7-point scale	Internal
	Cell Biology, Immunology and Genetics	5	7-point scale	Internal
	Microbial Diversity and Activity	5	7-point scale	Internal
2nd	Medical Protein Science	15	7-point scale	Internal
	Protein Chemistry	5	7-point scale	Internal
	Protein Structure	5	7-point scale	Internal
	Carbohydrate Chemistry	5	7-point scale	Internal
3rd	Electives • Project Work in an External Organisation	30	Pass/fail	External
4th	• Master's Thesis in Medical Biotechnology	30	7-point scale	External
3rd-4th	• Master's Thesis in Medical Biotechnology	60	7-point scale	External
Total		120		

3.1 Descriptions of modules. 1st semester. Experimental molecular biology

Title: **Experimental Molecular Biology**
Eksperimentel molekylærbiologi

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

Knowledge
- account for the central molecular biology
- describe molecular biology techniques used in research and industry
- account for transgenic techniques and design of relevant recombinant biotechnological products, including safety issues

Skills
- apply molecular biology techniques used in research and industry
- employ a comprehensive repertoire of bioinformatics analysis tools and databases
- 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
- evaluate pros and cons of different production systems and organisms for biotechnological products
- 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: **Molecular Biology and Bioinformatics**
Molekylærbiologi og bioinformatik

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

Knowledge
- account for the molecular mechanisms involved in the synthesis, structure and replication of DNA, transcription of genes, and translation of mRNA
- account for the structure of prokaryotic and eukaryotic genomes
- account for commonly used databases and use common search tools for retrieving data and linking data from public databases

Skills

- evaluate the use of a variety of central molecular biology techniques
- account for possibilities and limitations in sequence comparison algorithms and use these algorithms for the analysis of molecular evolution of genes and proteins
- recite the principles behind advanced algorithms for data mining: e.g. Neural Networks, Hidden Markov Chains and Support Vector Machines
- analyse simple data from microarray and sequence tag based gene expression analysis
- produce a strategy for the physical cloning of a gene using information retrieved from databases

Competencies

- interpret the central dogma of molecular biology

Type of instruction: Lectures and theoretical exercises

Exam format: Written or oral examination

Evaluation criteria: As stated in the Joint Programme Regulations

Title: **Cell Biology, Immunology and Genetics**
Cellebiologi, immunologi og genentik

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

Knowledge

- account for the composition of the eukaryotic cell
- account for the composition and function of the organelles of the eukaryotic cell
- describe inter and intra cellular communication
- account for the background for inheritance
- account for the theory on heredity and evolution
- account for and evaluate selected cell biologic, genetic, and immunologic methods and techniques
- account for central elements of the immune system
- account for the basic mechanisms of the immune system, including the potential pathologic developments

Type of instruction: Lectures and theoretical exercises

Exam format: Written or oral examination

Evaluation criteria: As stated in the Joint Programme Regulations

Title: **Microbial Diversity and Activity**
Mikrobiel diversitet og aktivitet

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

Knowledge

- account for the formation, composition, growth and activity of mixed microbial communities
- describe growth of human-related and pathogenic bacteria in biofilms
- explain the use of mixed communities to clean soil, water and air for C, N and P
- explain the use of mixed communities for nutrient recovery and bioenergy production

Skills
- apply bioinformatic databases and account for molecular techniques used for identification of microorganisms

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. Protein science

Title: **Protein Science**
Proteinteknologi

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

Knowledge
- account for how to design, produce, purify, and characterize proteins
- describe how activity and stability of enzymes and other biotechnological relevant proteins can be determined
- account for the development of new preparative and analytical methods in protein science

Skills
- describe, model, and evaluate protein structures
- compare and substantiate the choice of protein producing organisms for technical 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 asses the problem of the project and results in relevant scientific contexts and social conditions

Competencies
- account for the scientific basis of selected preparative and analytical methods
- compare and explain theoretical and practical results within the field of protein science
- 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: **Medical Protein Science**
Medicinsk Proteinteknologi

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

Knowledge
- account for how to design, produce, purify, and characterize proteins
- describe how activity and stability of enzymes and medical relevant proteins, including antibodies, anti-microbial peptides, and other therapeutic proteins can be determined
- account for the development of new preparative and analytical methods in protein science

Skills
- describe, model, and evaluate protein structures
- compare and substantiate the choice of protein producing organisms for medical 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 asses the problem of the project and results in relevant scientific contexts and social conditions

Competencies
- account for the scientific basis of selected preparative and analytical methods
- compare and explain theoretical and practical results within the field of protein science
- 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: **Protein Chemistry**
Proteinkemi

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

Knowledge
- account for the chemistry and thermodynamics behind protein structure, folding, stability and function, including the effect of protein modifications
- account for central elements of protein biosynthesis and processing
- account for protein evolution and homology

Skills
- design recombinant proteins and processes for their purification
- explain, use and document the effect of different preparative and analytical methods, including different forms of chromatography and electrophoresis

Competencies
- read and understand advanced scientific articles in structural and analytical protein chemistry

Type of instruction Lectures and theoretical exercises

Exam format: Written or oral examination

Evaluation criteria: As stated in the Joint Programme Regulations

Title: **Protein Structure**
Proteinstruktur

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

Skills
- predict and model protein structures from sequence data
- give an account of state-of-the-art techniques for the investigation and determination of structure, including the procedures involved, prerequisites and the advantages and shortcomings of each of these techniques
- extract and model biomolecular structural data from relevant databases
- visualize structures and utilize structural data to explain biomolecular function
- give an account of classification of protein structures

Competencies
- read and understand scientific articles on the determination, interpretation and application of biomolecular structures

Type of instruction Lectures and theoretical exercises

Exam format: Written or oral examination

Evaluation criteria: As stated in the Joint Programme Regulations

Title: **Carbohydrate Chemistry**
Kulhydratkemi

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

Knowledge
- explain and show in depth understanding of the structure and chemical properties of mono- and disaccharides as well as oligo- and polysaccharides
- demonstrate knowledge of industrially important carbohydrates including hydrocolloids and their gelation properties
- explain essential aspects of glycobiology
- demonstrate in depth knowledge of the substrate specificity, regio- and anomeric selectivity as well as the function and catalytic mechanisms of carbohydrate active enzymes
- demonstrate knowledge of the enzymology related to degradation and modification of plant based biomass including starch, cellulose and pectin

Skills
- apply and suggest methods of carbohydrate synthesis and modifications to solve problems in industrial processes and applications
- apply knowledge to evaluate structure in relation to functional properties of carbohydrates
- carry out calculations on basic carbohydrate chemical concepts
- perform theoretical analyses of chemical and physical methods in carbohydrate chemistry
- suggest relevant chemical and enzyme catalysts for chemical reactions in carbohydrate chemistry

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 asses 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 Biotechnology**
Kandidatspeciale i bioteknologi

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

Knowledge

- explain the scientific basis and scientific issues in 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 asses 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 extend 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: **Master's Thesis in Medical Biotechnology**
Kandidatspeciale i medicinsk bioteknologi

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

Knowledge
- explain the scientific basis and scientific issues in medical 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 asses 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 extend 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 September 1, 2017.

Students who wish to complete their studies under the previous curriculum from 2016 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.