AALBORG UNIVERSITY

The Study Board of Chemistry,
Biotechnology and
Environmental Engineering

The Master's Programme in Medical Biotechnology

Study Regulations
1st to 4th Semester

The Faculty of Science and Engineering
Aalborg University
2010
(revised 2013)

Preface

Pursuant to Act 695 of June 22, 2011 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 Framework Provisions and the Examination Policies and Procedures for the Faculties of Engineering, Science and Medicine.

The Study Regulations are approved by the Study Board of Biotechnology, Chemistry and Environmental Engineering at Aalborg University. The study regulations cover the Master's Programme in Medical Biotechnology in Aalborg.

Aalborg University, 2010 (revised 2013)

Niels T. Eriksen

Chair of Study Board

Approval date: 2010 (revised 2013)

Dean of Faculty of Science and Engineering

Table of contents

Chapter 1. Legal basis of the Study Regulations

1.1 The Ministerial Order Basis

The Master's programme in Medical Biotechnology is organized in accordance with the Ministry of Science, Technology and Innovation's Ministerial Order no. 814 of June 29, 2010 on Bachelor's and Master's Programs at Universities (the Ministerial Order of the Study Programs) and Ministerial Order no. 857 of July 1, 2010 on University Examinations (the Examination Order) with subsequent changes. Further reference is made to Ministerial Order no. 233 of March 24, 2011 (the Admission Order) and Ministerial Order no. 250 of March 15, 2007 (the Grading Scale Order) with subsequent changes.

1.2 The Faculty of Science and Engineering affiliation

The Master's programme falls under the Faculty of Science and Engineering, Aalborg University.

1.3 The Study Board affiliation

The 1st to 4th semesters of the Master's programme fall under the Study Board for Biotechnology, Chemical and Environmental Engineering.

Chapter 2. Admission, title, programme duration and competence profile

2.1 Admission

Admission to the Master's programme in Medical Biotechnology requires a Bachelor's degree in Chemistry, Environmental Engineering, or Biotechnology (legal claim), or a similar degree.

2.2 Degree/title in Danish and English

Successful completion of a Master's programme entitles the student to use the Danish title civilingeniør, cand.polyt. i medicinsk bioteknologi. The corresponding English title is: Master of Science (MSc) in Engineering (Medical Biotechnology).

2.3 The programme's specification in ECTS

The Master's programmes are 2-year, research based, full-time study programmes. The programmes are set to 120 ECTS.

2.4 The programme's competence profile

The competence profile below will appear on the diploma:

A graduate of the Master's programme has competences acquired through a course of study that has taken place in a research environment.

The graduate of the Master's program can perform highly qualified functions on the labour market on the basis of the educational program. Moreover, the graduate has prerequisites for research (a Ph.D. program). Compared to the Bachelor's degree, the graduate of the Master's program has developed her/his academic knowledge and independence, so that the graduate can independently apply scientific theory and method in both an academic and occupational/professional contexts.

Description of qualifications:

Individuals who attain the MSc degree in Medical Biotechnology

Knowledge

- Have 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.
- Are 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
- Are 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.
- Are able to communicate research-based knowledge and discuss professional and scientific problems with both peers and non-specialists.

Competences

- Are 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.

- Are able to independently initiate and carry out discipline-specific and cross-disciplinary cooperation and to assume professional responsibility within the area of medical biotechnology.
- Are able to independently take responsibility for their own professional development and specialization.

Chapter 3. Content of the Study Programme

Outline of the Master's programme in Medical Biotechnology

Semester	Module		ECTS	Grading	Assessment
1.	Molecular Biology in Medical Biotechnology		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 Biotechnology		5	7-point scale	Internal
2.	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
3.	Elec-tives	Individual semester* External studies	30** 30	7-point scale	External
4.	Master's Thesis		30	7-point scale	External

* Aalborg University organizes a number of cross-disciplinary 5 ECTS modules at 3rd semester. If one or more of these are followed, the project module is reduced in size accordingly.

**cf. Framework Provisions section 9.4.1, students are given several choices of composing an individual planned semester, including extending the master's thesis to up to 60 ECTS.

The study board can cancel modules if the number of enrolled students is low.

A compulsory course in Problem based learning (PBL) and student responsibility is offered as an integrated part of all project modules to students not acquainted with PBL at Aalborg University.

3.1 1st semester – Molecular Biology

3.1.1 Molecular Biology in Medical Biotechnology

English title	*Molecular Biology in Medical Biotechnology*
Danish title	*Molekylærbiologi i medicinsk bioteknologi*
Placement	Autumn, 1st semester
Prerequisites	
Aim	To give the student insight into the molecular fundament of modern biotechnology and its application in medically relevant model and production systems. How analyses of entire genomes (genomics), full complements of active genes (transcriptomics), and utilization of modern molecular biology data repositories are integrated in the development of novel inventions and medical biotechnological products such as pharmaceuticals and fine chemicals for diagnostics.
Learning outcomes	After completion of the project the student should be able to Knowledge • account for the central molecular biology of humans and commonly used model- or production systems (e.g. mouse, yeast, *E. coli*) Skills • describe and apply molecular biology techniques used in research and industrial development of pharmaceuticals and fine chemicals • account for transgenic techniques and design of relevant

	recombinant biotechnological products, including safety issues Competences • employ a comprehensive repertoire of bioinformatics analysis tools and databases • evaluate pros and cons of different production systems and organisms for pharmaceutical products
Content	The project will be anchored in ongoing research projects at Section of Biotechnology. Projects proposals will be available at the beginning of the semester and will contain a wet experimental molecular biology part as well as a bioinformatics component.
Duration	15 ECTS
Language	English
Assessment	Oral examination based on a written report
Grading	7-point scale
Assessment Criteria	As stated in the framework provisions. It is a pre-condition for students who have not studied the Aalborg PBL model at Aalborg University that they have passed the course in Problem-based Learning (PBL) and Student Responsibility at Aalborg University prior to the project examination.

3.1.2 Molecular Biology and Bioinformatics

English title	*Molecular Biology and Bioinformatics*
Danish title	*Molekylærbiologi og bioinformatik*
Placement	Autumn, 1st semester
Prerequisites	-
Aim	To give the student understanding of molecular biology of living organisms and of bioinformatics tools, databases and their limitations
Learning outcomes	After completion of the course the student should 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 Competences • interpret the central dogma of molecular biology

Content	• Methods in recombinant DNA technology • Genes, genomes and genomics • Transcripts, gene expression regulation, transcriptomics • Mutations, recombination and repair of DNA. • Sequence databases, their structure and content. • Sequence search tools • Phylogeny, sequence alignment and comparison tools • Genome browsing • Transcriptome analysis • Data mining using advanced algorithms • Databases, annotation and prediction of biological function of proteins
Duration	5 ECTS
Language	English
Assessment	Written or oral examination
Grading	7-point scale
Assessment Criteria	As stated in the framework provisions

3.1.3 Cell Biology, Immunology and Genetics

English title	*Cell Biology, Immunology and Genetics*
Danish title	*Cellebiologi, immunologi og genentik*
Placement	Autumn, 1st semester
Prerequisites	Microbiology, Biochemistry
Aim	To give the student a thorough insight in eukaryotic cell biology and genetics and an overview of immunology
Learning outcomes	After completion of the course the student should 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
Content	• Eukaryotic cell compartments, organelles, membranes and transport mechanisms • Cytoskeleton, cell-cycle, cell-division, mitosis and meiosis • Signal transduction • Mendel's laws • Chromosomes and heredity • Genotype, phenotype, and their correlation • Genetic variability and diseases • The composition and function of the immune system • The role of the immune system in preventing and fighting, but also in causing disease • Cell biologic, genetic, and immunologic methods
Duration	5 ECTS

Language	English
Assessment	Written or oral examination
Grading	7-point scale
Assessment Criteria	As stated in the framework provisions

3.1.4 Microbial Biotechnology

English title	*Microbial Biotechnology*
Danish title	*Mikrobiel bioteknologi*
Placement	Autumn, 1st semester
Prerequisites	Mathematics, chemistry and microbiology at B.Sc. level
Aim	The aim is to provide a fundamental understanding of how to identify prokaryotes using molecular techniques, how prokaryotes form biofilms, how to combat pathogenic and unwanted biofilms, the use of mixed microbial communities for solving environmental problems and use of microorganisms (bacteria, yeast and fungi) in the biotechnological industry.
Learning outcomes	At the end of the course the student should be able to Knowledge • account for the formation, composition, growth and activity of mixed microbial communities • describe growth of pathogenic bacteria in medical biofilms • give details for methods to control unwanted biofilms • explain the use of mixed communities to clean soil, water and air for C, N and P • explain the use of recombinant microorganisms (bacteria, yeast, fungi) in the biotechnological industry Skills • apply molecular databases and account for molecular techniques used for identification of microorganisms
Content	• Identification of microorganisms using molecular and bioinformatics approaches • Use of advanced microscopy for quantification of microorganisms in mixed cultures • Methods to determine activity of microorganisms directly in biofilm • Biofilm formation, composition, microbial communication and microbial communities • Pathogenic bacteria in biofilms – e.g. on implants and in wounds • Control of unwanted prokaryotes, biofouling and biocorrosion • Transformation of micropollutants • Transformation of C, N and P in mixed communities • Use of mixed communities to purify soil, water and air • Use of mixed communities and recombinant pure bacterial cultures in biotech productions • Use of recombinant yeast and fungi in the biotech industry
Duration	5 ECTS
Language	English
Assesment	Written or oral examination

Grading	7-point scale
Assesment Criteria	As stated in the framework provisions

3.2 2nd semester – Protein Science

3.2.1 Medical Protein Science

English title	*Medical Protein Science*
Danish title	*Medicinsk Proteinteknologi*
Placement	Spring, 2nd semester
Prerequisites	-
Aim	To give the student basic and advanced insight into the chemistry, structure, stability, modifications, turnover, and usage of proteins, and also experience with production, purification, analysis and quality assessment of proteins with known or novel applications. Special emphasis is given to techniques for production, purification, characterization, structural determination, and design of proteins with medical relevance.
Learning outcomes	After completion of the project the student should be able to Skills • design, produce, purify, and characterize proteins, including determination of activity and stability of enzymes and other biotechnological relevant proteins, including antibodies, anti-microbial peptides, and other therapeutic proteins • describe, model, and evaluate protein structures • compare and substantiate the choice of protein producing organisms for medical products Competences • account for the scientific basis of selected preparative and analytical methods • develop new preparative and analytical methods in protein science • compare and explain theoretical and practical results within the field of protein science
Content	The project subject will have clear medical relevance (therapeutic, diagnostic or investigation of the molecular mechanism of a pathologic condition). Most projects will include protein purification from a biological source, e.g. tissue, fluid, or cell culture, followed by biophysical and functional characterization. Determination of protein structure, stability, and biologic or enzymatic activity and the physical-chemical basis for the reaction mechanisms is described. Protein-design and molecular modelling will be a part of the project. Results are presented, explained and discussed in the context of published and theoretically predicted data.
Duration	15 ECTS
Language	English or Danish
Assessment	Oral examination based on a written report
Grading	7-point scale
Assessment	As stated in the framework provisions. It is a pre-condition for students who have not studied the Aalborg PBL model at Aalborg

criteria	University that they have passed the course in Problem-based Learning (PBL) and Student Responsibility at Aalborg University prior to the project examination.

3.2.2 Protein Chemistry

English title	*Protein Chemistry*
Danish title	*Proteinkemi*
Placement	Spring, 2nd semester
Prerequisites	Biochemistry
Aim	To give the student extensive knowledge of amino acid, peptide and protein reactivity, structure, dynamics, stability, function, interaction with other macromolecules, and important analytical methods within the field. To give the student a deep understanding of the chemistry, thermodynamics and reaction kinetics which determine protein properties, functions and applications, along with the capabilities of the accompanying techniques.
Learning outcomes	After completion of the course the student should 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 and produce recombinant proteins • explain, use and document the effect of different preparative and analytical methods, including different forms of chromatography and electrophoresis Competences • read and understand advanced scientific articles in structural and analytical protein chemistry
Content	• Amino acid properties and modifications • Protein structure classes and the forces that contributes to protein folding and stability • Enzymes, antibodies, therapeutic peptides, proteins, protein ligands, and protein inhibitors • Methods for protein production, purification and analysis
Duration	5 ECTS
Language	English
Assessment	Written or oral examination
Grading	7-point scale
Assessment criteria	As stated in the framework provisions

3.2.3 Protein Structure

English title	*Protein Structure*
Danish title	*Proteinstruktur*
Placement	2nd semester
Prerequisites	Protein Chemistry and NMR & MS must either have been passed or

	be followed in the same semester.
Aim	To give students an understanding of macromolecular structures and the various techniques applied to determine these and their vital importance to protein science and technology, and to enable students to predict, model, determine, and validate biomolecular structures and use structural data to solve a given biotechnological problem.
Learning outcomes	After completion of the course the student should 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 Competences • read and understand scientific articles on the determination, interpretation and application of biomolecular structures
Content	• Prediction and modelling of protein structure • Experimental techniques to determine and characterise biomolecular structures, both in low- and high-resolution • Description, visualization, validation and application of biomolecular structures • Public Data Sharing of structure information (databases)
Duration	5 ECTS
Language	English
Assessment	Written or oral examination
Grading	7-point scale
Assessment Criteria	As stated in the framework provisions

3.2.4 Carbohydrate Chemistry

English title	*Carbohydrate Chemistry*
Danish title	*Kulhydratkemi*
Placement	Spring, 2nd semester
Prerequisites	Organic chemistry and biochemistry
Aim	The student will obtain basic knowledge of the chemistry, biology and biosynthesis of carbohydrates as well as carbohydrate active enzymes and their catalytic reaction mechanisms. Furthermore the student will obtain knowledge of the structure, function and technical utilization of oligo- and polysaccharides regarding industrial production and biomedical applications.
Learning outcomes	After completion of the course module the student should 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 methods of carbohydrate synthesis and modification to solve problems in industrial processes and applications • carry out enzyme catalysed starch liquefaction and saccharification • carry out enzyme catalysed organic synthesis of glycoconjugates • perform viscosimetric analysis • perform preparative solid phase separation of glycoconjugates and their characterisation
Content	The course consists of lectures, theoretical exercises and individual studies focused on the following topics • Nomenclature, structure and isomers of pentoses and hexoses • Conformation of monosaccharides • Structure, chemical and physical properties of mono-and disaccharides, oligo- and polysaccharides • Technical and industrial utilization of carbohydrates including hydrocolloids • Glycosylation • Structure, function and catalytic mechanism of glycoside hydrolases • The cellulosome • Pectinolytic enzymes • Glycoside transferase and glucosidase catalysed reactions • Regioselective synthesis of sugar derivatives and glycoconugates
Duration	5 ECTS
Language	English
Assessment	Written or oral examination
Grading	7-point scale
Assessment Criteria	As stated in the framework provisions

3.3 3rd & 4th semester – Master's Thesis

3.3.1 Master's Thesis

English title	*Master Thesis*
Danish title	*Kandidatspeciale*
Placement	3. and 4. semesters (long Master's thesis), 4. semester (short Master's thesis)
Prerequisites	1st and 2nd semester Medical Biotechnology
Aim	To plan, conduct and report on a larger scientific research project within medical biotechnology

Learning outcomes	After completion of the project the student should be able to Skills • conduct technological development and academic research, and solve complicated technical problems using scientific methods Competences • plan, execute and report an extensive individual research project within an agreed time frame • compare and critically evaluate the results of the project in relation to existing knowledge and accepted theories within the subject area • consider economic consequences and impact on society, environmental and safety issues related to the project • communicate a balanced view of the results and conclusions of the project in well-organized written and oral presentation
Content	MSc projects will usually be related to on-going research at the Section of Biotechnology, often in collaboration with a pharmaceutical company, a hospital, or a foreign research institution. The MSc project will normally be carried out individually and contain both theoretical and experimental parts. The project outcome must be presented in an MSc thesis or a scientific paper in agreement with accepted scientific principles, written by the student
Duration	30-60 ECTS
Language	English
Assessment	Oral examination based on a written report
Grading	7-point scale
Assessment criteria	As stated in the framework provisions. It is a pre-condition for students who have not studied the Aalborg PBL model at Aalborg University that they have passed the course in Problem-based Learning (PBL) and Student Responsibility at Aalborg University prior to the project examination.

3.4 Problem-based Learning (PBL) and Student Responsibility at Aalborg University

3.4.1 Problem-based Learning (PBL) and Student Responsibility at Aalborg University

English title *Danish title*	*Problem-based Learning (PBL) and Student Responsibility at Aalborg University* *Problembaseret læring og studerendes ansvar for læring på Aalborg University*
Placement	Spring, 2nd semester
Prerequisites	None, but the course is compulsory for students not acquainted with the Aalborg PBL model
Aim	To introduce the students majoring in chemistry or engineering a broad knowledge of polymer chemistry, such as principles of polymerization, polymer morphologies, polymer properties and so on. Meanwhile, some basic experimental techniques will be included in the lab course.
Learning outcomes	After completion of the course the student should

	Knowledge • know about the organization at Aalborg University and where to ask for help in different matters • know about how to communicate both in the project groups and during courses • know how a semester is structured and for the different examination forms used at Aalborg University • know how project work and laboratory work are carried out at Aalborg University including safety issues in the laboratories • know about issues concerning plagiarism and its consequences • know about the software which is used during the study • know about the IT systems used and how to get started • know about the specialist student counselors and how they may provide assistance Skills • be able to use problem-based learning and group work in project and courses at Aalborg University • be able to use Moodle to find lecture plans, timetables, and other relevant information Competences • be able to apply the concepts, theories and methods for problem-based learning and group work • be able to account for the considerations involved in the process of formulating project reports in practice.
Content	Lectures, discussions and group work. The course will take place during two Wednesday afternoons.
Duration	
Language	English
Assessment	Internal assessment during the course/class participation according to the rules in the Examination Policies and Procedures, Addendum to the Framework Provision of the Faculty of Engineering and Science, Aalborg University. In this case the assessment is primarily based on the oral performance during the course. This 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 and a precondition for participation in the project examination for those who are not acquainted with the Aalborg PBL model. Consequently, no diploma will be issued for the course nor will it appear on the academic transcripts.
Grading	Passed/failed
Assessment criteria	As stated in the framework provisions

Chapter 4. Entry into force, interim provisions and revision

The study regulations are adopted by the Study Board of Biotechnology, Chemical and Environmental Engineering, approved by the Dean of the Faculties of Engineering, Science and Medicine and take effect from 1st September, 2013.

Students who wish to complete their studies under the former study regulations from 2007 must conclude their education by the summer examination period 2010 at the latest, since examinations under the former study regulations are not offered after this time.

In accordance with the Framework Provisions and the Handbook on Quality Management for the Faculties of Engineering, Science and Medicine at Aalborg University, the study regulations must be revised 5 years at the latest after their taking effect.

The current, valid version of the study regulations is published at www.ses.aau.dk.

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.[1] If the project is written in English, the summary must be in Danish.[2] 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 Framework Provisions 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 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.

5.6 Completion of the Master's program

The Master's program must be completed no later than four years after it was begun.

[1] Or another foreign language (upon approval from the Board of Studies).
[2] The Board of Studies can grant exemption from this.

5.7 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..