M.Sc. in Nano Technology with specialisation in Nano Biotechnology

Nanotechnology is all about designing, fabricating and controlling materials, components and machinery with dimensions on the nanoscale, i.e. from 0.1 to 100 nm.

By constituting materials atom by atom or molecule by molecule it is possible to obtain decisive control over the properties and thereby construct unique materials with new and unexpected properties for applications within communication, data storage and -processing, (Bio)sensors, catalysis or medicine just to mention a few areas.

There are many challenges in nanotechnology and the area is very interdisciplinary. It is necessary to bring together expertise within physics, chemistry, biology, mathematics and materials science. Future engineers who hold an interdisciplinary education are therefore invaluable to solve the many challenging materials problems present on the nanoscale.

At the Department of Physics and Nanotechnology, Aalborg University we offer a unique education in nanotechnology with special focus on two areas, namely nanophysics and solid materials on the one side and nano biotechnology on the other.

Our students are taught in an innovative, dynamic and challenging environment through a combination of research-based courses, team-based project work and a high degree of interaction with industrial partners. We offer state of the art laboratory facilities including a class 100 clean room holding modern equipment for micro and nano scale fabrication and characterisation nanolab.aau.dk. Furthermore, a new well-equipped bio-chemistry lab including a class 1 area and state-of-the-art biophysical investigation equipment is available.

M.Sc. Specialisation: Nano Biotechnology

As a Master of Science in nano biotechnology, you have obtained the following:

Knowledge

Based on state-of-the-art international research within nano biotechnology, specifically advanced genetic technology, engineering of chemical and biological reactions, molecular simulation, molecular electronics, spectroscopy (NMR mass), self-organised bio structures and reactions to biological and inorganic interfaces.

Skills

You will master the scientific methods in nano biotechnology, and you will obtain general skills within problems associated with nano biotechnology.

You will be able to assess and choose among the scientific methods and theories for outlining new models for analysis and solutions.
You will be able to communicate research-based knowledge and discuss professional and scientific problems with both academic and laymen.

Competences
You will be able to control complex and unpredictable work- and development situations which presuppose new solutions.
You will be able to start and follow through academic and cross-disciplinary cooperation on an independent basis, and you will be able to take on professional responsibility.

Course overview:

Semester	Project theme	Courses	ECTS in all
NB1	Nano bio engineering	Advanced genetic engineering	30
		Reaction engineering	
		Molecular simulations	
		Molecular electronics	
NB2	Characterisation of nano bio structures	NMR spectroscopy	30
		Mass spectroscopy	
		Self-organised bio structures	
		Reactions at interfaces	
NB3	Advanced nano biotechnology		30
NB4	Master's Thesis		30

Description of Courses

Advanced Genetic Engineering
5 ECTS points.

Prerequisites: Course in genetic technology on B.Sc. level.

Purpose: For the student to obtain insight into design of biological "nano devices" and their applications within High Throughput Screening

Background: The student will learn how to produce biological nano devices and be introduced to state-of-the-art tools within genetic technology.

Aim: Upon the course, the student is able to:

- Apply his/her knowledge of genetic technology for production of DNA-based nano devices.
- Demonstrate knowledge of how these nano devices are applied in "High Throughput screening".

- Theoretically construct expression systems for all organisms, from one-celled to higher organisms.

Content: Methods and techniques in "library generation and screening", methods for "gene delivery" and transfer (gene therapy), new technologies in DNA-analysis, DNA-based "nano-devices", expression systems and High throughput screening methods in medicine and nano biotechnology.

Reaction Engineering
5 ECTS points.

Prerequisites: Courses in bio chemical reactions in the body as well as molecular bio physics.

Purpose: For the student to attain insight into design of chemical and biological reactions.

Background: This course further advances knowledge attained from courses in chemical reactions in the body and molecular bio physics; how to apply the knowledge attained through such courses for industrial production of new biological structures and materials.

Aim: Upon the course, the student is able to:

- Calculate biologically catalysed chemical reactions and their applications in micro reactors.

Content: The course includes advanced subjects in chemistry such as chemical reaction design, practical engineering and modelling of chemical and biochemical reactors.

Molecular Simulations
3 ECTS points.

Prerequisites: Courses in quantum mechanics and statistical mechanics.

Purpose: For the student to obtain knowledge of state-of-the-art methods and tolls within molecular simulations.

Background: In the course of this course, the student will learn how biological systems may be treated theoretically on basis of quantum mechanics and statistical mechanics.

Aim: Upon the course, the student is able to:

- Show abilities within set-up and application of various force field methods in simulation.
- To generate a system for simulation of molecular dynamics in proteins.
- Analyse data from molecular dynamic data.

Content: The course focuses on simulation of large bio molecules such as proteins. Relevant force field methods as well as various dynamic and static methods of modelling are included.

Molecular Electronics
2 ECTS points.

Prerequisites: Courses in quantum mechanics, materials structure and organic chemistry.

Purpose: For the student to obtain knowledge of the fast growing research area within molecular electronics and its practical application.

Background: This course links together the subjects of quantum mechanics, materials structure and organic chemistry showing their applications within molecular electronics.

Aim: Upon the course, the student is able to:

- Demonstrate knowledge of the principles within molecular electronics
- Demonstrate overview of various applied molecules and their function.

NMR Spectroscopy
3 ECTS points.

Prerequisites: Course in organic chemistry.

Purpose: For the student to obtain knowledge of the theoretical background for NMR spectroscopy as well as practical skills in measuring and evaluating NMR data from organic molecules and larger bio molecules.

Aim: Upon the course, the student is able to:

- Account for the theoretical background to NMR spectroscopy
- Account for the relation between the structure of a molecule and its NMR signals
- Interpret both 1D- and 2D-NMR spectrums
- Account for the most frequently applied types of NMR experiments and what information may be deducted from them
- Account for NMR spectroscopy applications.

Content:

- The physical background for NMR spectroscopy
- Chemical shift, scalar coupling, dipolar coupling
- 1H-NMR, 13C-NMR, DEPT, INEPT
- Relaxation, NOE
- 2D-NMR (COSY, TOCSY, NOESY, HSQC)
- MR Imaging
- Application of NMR in various scientific and industrial relations.

Mass Spectroscopy
3 ECTS points.

Prerequisites: Courses in organic chemistry and bio chemical reactions in the body.

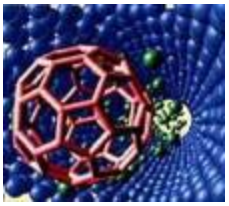
Purpose: For the student to obtain basic understanding of fundamental principles and practical application of mass spectroscopy within biotechnology with focus on protein structure determination.

Aim: Upon the course, the student is able to:

- Account for the physical background for mass spectroscopy, including ionisation techniques, the function of mass analysers and ion detection.
- Account for and exemplify the sensitivity, resolving capability and applications of various mass spectroscopies
- Interpret mass spectroscopy spectrums and be familiar with its nomenclature
- Account for principles for fragmentation of bio molecules and deduction of amino acid sequential information
- Apply bio informatics analyses and databases for identification and characterisation of peptides and proteins.

Content:

- The historical development of mass spectroscopy
- The physical principles behind mass spectroscopy; matrix assisted laser desorption ionisation, electro-spray and mass analysers; time-of flight, quadrupole, ion traps
- MS/MS sequencing, ion detection
- Application of online chromatography (HPLC, GC, CE) in relation to mass spectroscopy
- Concrete application of various mass spectroscopy, ex. MALDI-TOF-MS and nano spray followed by MS/MS for protein analyses
- Interpretation of spectrums of organic molecules, proteins, peptides, DNA sequences and carbohydrates
- Introduction to mass spectroscopy-based bio informatics.



Self Organising Bio Structures
5 ECTS points.

Prerequisites: Courses in solid state physics and -chemistry, genetic technology, applied micro biology and engineering of reactions.

Purpose: For the student to obtain insight into self organising biological systems and the basic principles for self organising.

Background: This course provides the student with an overview of the relevant tools for self organising in biological systems, and how these concepts may be applied in medicinal, pharmaceutical and nano technological relations.

Aim: Upon the course, the student is able to:

- Demonstrate theoretical knowledge of self-assembling systems and how they are applied in medicine and nano technology
- Demonstrate knowledge of drug delivery systems based on lipids, polymers, proteins, bacterial ghosts and viral systems
- Build competence in application of macro molecules such as DNA, RNA, proteins, lipids for production of various artificial nano structures (DNA origami, molecular electronics).

Content: During the course, self organising in biological systems will be treated. The course covers subjects such as membranes and their characteristics, self organizing systems within cells such as DNA and self organising of proteins carrying out various reactions in the cells in order to provide a reaction diagram.

Reactions at Interfaces
5 ECTS points.

Prerequisites: Courses in solid state physics and –chemistry, statistical mechanics and physical chemistry as well as engineering of reactions.

Purpose: For the student to obtain insight into all aspects of physics, chemistry and bio chemistry in relation to reactions at interfaces.

Background: Most reactions in biological and physical systems are at interfaces. This course presents the relevant models and theories as well as how these phenomena may be described.

Aim: Upon the course, the student is able to:
- Demonstrate his/her attained knowledge of organic reactions at biological and inorganic interfaces.
- Build competence within application of the presented theories.

Content: The course includes structure of solid surfaces, absorption and diffusion on surfaces, agglomeration processes, chemical reactions on surfaces and advanced methods for exploring these surfaces.

4th semester: M.Sc. Thesis.
30 ECTS points.

Purpose: The Master's Thesis is carries out as problem-oriented project work aiming towards:

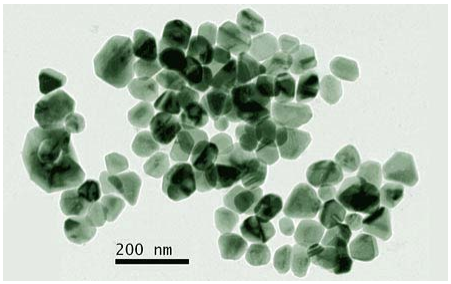
- The student attaining either specialist knowledge within a few chosen elements of the field
- Or broad insight into the field regarding its theories, methods and central elements and their internal relations
- Or relevant competences supplementing the given competence profile.

Aim: No matter the chosen aim, the student must be able to:
- Through independent, systematic and critical analysis be able to identify, formulate and analyse the chosen problem

- To relate the problem to the field of nano biotechnology, including accounting for the choices made when defining the problem
- Make and substantiate decisions for methods of scientific, theoretical and/or experimental character on an individual basis
- Critically be able to on an individual basis assess the chosen theories and methods on which the analyses, results and conclusions in the Thesis is based – both during the making of the thesis and after it is finished
- Communicate relevant academic and professional aspects of the work in a clear and systematic manner.

Admission

Admission to the Master Programme in Nanotechnology with specialisation in Nano Biotechnology presupposes a relevant Bachelor of Science degree in natural sciences, materials science, or biotechnology.



All international applicants (Scandinavian students exempted) must document basic written and spoken English by taking a test. You must complete and pass one of the following:
The IELTS test (International English Language Testing System).
The TOEFL test (Test of English as a Foreign Language)
The Cambridge ESOL test (Examinations for Speakers of Other Languages)

International students may gain admission upon Aalborg University's assessment of the individual applicant.

More information

If you are interested in studying for your Master Degree in Nano Biotechnology, you are welcome to contact our International Office:

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We look forward to seeing you in Aalborg!