

PHD STUDY HANDBOOK FOR THE FACULTY OF NATURAL SCIENCES 2019-2020

The PhD programmes are standardized to 180 credits (3 years) including academic and methodological schooling, amounting to 30 credits. The residual 150 credits, which constitute by far the largest and most important part of the research education, are devoted to the research project carried out under academic supervision.

The Faculty of Natural Sciences offers the following PhD programmes:

- PhD in Biology
- PhD in Biophysics
- PhD in Biotechnology
- PhD in Chemistry
- PhD in Chemical Engineering
- PhD in Physics
- PhD in Materials Science and Engineering
- PhD in Medical Technology - Hosted by the Faculty of Medicine and Health Sciences. For more information about the programme: <http://www.ntnu.edu/studies/phmedt>

Admission requirements

Applicants for the PhD programmes at the Faculty of Natural Sciences must have a relevant master's degree or equivalent education, with a strong academic record.

Applicants are required to have a weighted average grade of B or higher (in accordance with NTNU's grading system) in the two last years of their master's degree (equivalent to 120 ECTS credits). Before you can apply for admission to one of the PhD programmes, the funding of the study period including running costs, must be confirmed.

Application for admission

All PhD candidates need to apply to be enrolled in a PhD programme by filling out an application form. The main supervisor and the Department give their recommendation before the application is approved by the PhD Programme Council. Admission to all the programmes is decided by the Faculty of Natural Sciences. It is required that you apply for admission no later than 3 months after you are employed. Applications to the PhD programmes can be submitted at any time.

Required coursework

The PhD education programme has a prescribed duration of three years of full-time study (180 ECTS credits). A minimum of 30 ECTS credits (equivalent to six months of fulltime study) have to be covered by required coursework. The training plan has to consist of courses within natural sciences or technology.

A minimum of 20 ECTS credits have to be [PhD courses at NTNU](#), or from equivalent programmes at other academic institutions in Norway or abroad.

The course MN8000 “Doing Science: Methods, Ethics & Dissemination” is mandatory for all PhD candidates at the Faculty of Natural Sciences.

Exception: this requirement is not applicable for the PhD candidates admitted to the PhD programme in Medical Technology.

The remaining 10 credits can consist of an Individual Study Syllabus or advanced-level Master's courses. An Individual Study Syllabus should have a minimum of 3 credits, and should not overlap with existing courses. The Syllabus must be on a PhD-level and should be within the Professor's subject area. The Syllabus is to be approved by the PhD Programme Council well before the planned examination.

Advanced courses with varying content (for example "Advanced Biology"), must in general be followed by minimum three candidates. Course description and examination will be the same in each realization. Several realizations with the same course code can be arranged simultaneously.

Courses must be weighted with a minimum of 3 credits to be approved as a part of the organized training plan for PhD.

Candidates must apply to make changes in the approved training plan. The application must be prepared together with the main supervisor and be recommended by the PhD Programme Council.

Assessment

All the courses or academic training approved for the PhD programmes require a final assessment in form of an exam, report or other assessments.

Examination of PhD courses at the Faculty is assessed by a mark passed/not passed, where passed correspond to a score of 70 points on a scale from 0 to 100. Approved courses from other faculties will follow the grading scale at those faculties.

Master courses must be passed with the grade A or B. A candidate who has passed the examination in a course with a grade lower than B is only entitled to retake the exam once.

Supervision

The main supervisor of the PhD candidate is normally employed at the Faculty of Natural Sciences, either as full or adjunct professor or as assistant professor. Any deviation from this regulation has to be recommended by the Research Committee at the Faculty for Natural Sciences and be approved by the Dean.

As a general rule, the PhD candidate is to have at least one co-supervisor. Co-supervisors must have a PhD degree. Post docs, researchers and professor emeritus may act as co-supervisors based on a recommendation from the Head of the Department where the PhD programme is based.

The Faculty may appoint one or more mentors who do not meet the qualification requirements for supervisors.

Other requirements

A project description, submitted no later than 6 months after enrolment in the PhD programme is mandatory for all PhD candidates.

As a part of the quality assurance of the PhD programmes, the PhD candidates are also required to respond to an annual progress report to address possible deviation in the progress.

Other information

Admission must be formalised in a written agreement: [“Agreement concerning admission to the organised PhD programme”](#). The agreement should be signed by the candidate, supervisors, the Department, the Faculty and by any external institutions involved.

Compulsory for all the PhD candidates is a PhD information day arranged in the beginning of each semester. Relevant topics for this seminar are: Ethics, Human-Resources, PhD-studies – the administrative process and Popular disseminations.

The Research Committee at the Faculty of Natural Sciences

The Research Committee serves as an advisory body for the Dean and the Faculty Board. The primary task of the Committee is the following-up of the Faculty’s research strategy, serving as an advisory body for grants of research sabbaticals and prioritizing applications for research equipment.

The Research Committee has an overall responsibility for the PhD education, including quality control of admission and implementation of candidates in the PhD programmes.

PhD Programme Council

The PhD Programme Councils are primarily an advisory commission for the Dean, the Head of Department and The Research Committee. The PhD Programme Council is responsible for suggesting the academic content, structure and implementation of relevant study programmes within the adopted guidelines and directions, delegated from the Dean.

The PhD Programme Councils are chaired by:

- PhD Programme in Biology: Associate Professor Thorsten Hamann
- PhD Programme in Biotechnology: Professor Berit Løkensgard Strand
- PhD Programme in Biophysics: Professor Catharina de Lange Davies
- PhD Programme in Chemistry: Professor Øyvind Mikkelsen
- PhD Programme in Chemical Engineering: Professor Magnus Rønning
- PhD Programme in Materials Science and Engineering: Professor Knut Marthinsen
- PhD Programme in Medical Technology: Professor Hans Torp
- PhD Programme in Physics: Professor Catharina de Lange Davies

Information, forms, rules and regulations concerning the PhD education at the Faculty of Natural Sciences: <http://www.ntnu.edu/nv/phd>

Contact information:

PhD Programme in Biology and Biotechnology:
Executive Officer Maja C. Haaker, maja.haaker@ntnu.no

PhD Programme in Chemistry and Chemical Engineering:
Higher Executive Officer Lise Skorstad, lise.skorstad@ntnu.no

PhD Programme in Materials Science and Engineering:
Higher Executive Officer Elin S. I. Kaasen elin.s.kaasen@ntnu.no

PhD Programme in Physics and Biophysics:
Senior Executive Officer Anne Sæther, anne.sether@ntnu.no

The Faculty of Natural Sciences:
Senior Executive Officer Anne Sæther, anne.sether@ntnu.no
Higher Executive Officer Elin S. I. Kaasen, elin.s.kaasen@ntnu.no

Description of the PhD programme in Biology:

Programme description
<p>The main purpose of the PhD programme in Biology is to educate independent researchers at an international level in collaboration with national and international research groups. The department has a broad academic profile in biology, with interactions between organisms and their natural environment as an overriding focus. We have a special responsibility for basic biological research and the broad application of knowledge in social and economic development. The department has extensive research activities, within many biological disciplines, including several internationally leading research programmes.</p> <p>The PhD programme aims to meet current and future needs for expertise in research, development and dissemination in the university sector and in other public and private institutions, businesses and organizations. The programme in Biology will produce qualified candidates for research activities and other work that requires a high level of scientific understanding. The candidate completes an independent research project leading to a thesis at a high professional level and quality. The candidate will learn critical thinking, communication of knowledge and collaboration.</p>
Areas of research
<p>Doctoral work at the institute for Biology provides expertise in the following research areas: Molecular biology, cell biology, biotechnology, systems biology, plant physiology, animal physiology, environmental toxicology, ecotoxicology, ethology, evolutionary biology, aquatic or terrestrial ecology, biodiversity, natural resources, population genetics, aquaculture, marine biology and systematics.</p> <p>See the department's website for more information about research and expertise in the department: http://www.ntnu.edu/biology/research</p>
General learning outcome of the programme
<p>The PhD programme will provide training in how to generate and publish new knowledge and strengthen candidates' professional expertise in their respective fields.</p>
Learning outcome
<p>A candidate who has completed a PhD degree in Biology will have the following learning outcomes established through knowledge, skills and general abilities:</p> <p>Knowledge</p> <p>Upon completion of the PhD programme in biology, it is expected that the candidate</p> <ul style="list-style-type: none">• is at the forefront of knowledge in their biological field of specialization, and can assess the limitations of current knowledge in the field of research critically• master relevant theory, issues and methods• assess the appropriateness and application of various methods and processes in research and professional development• contribute to the development of new knowledge, new theories, methods, interpretations and documentation in biology.

Knowledge is generated by:

- attending courses equivalent to 30 credits
- reading and keeping abreast of the literature in the field
- the PhD dissertation, where the candidate has independently written an introduction that provides background for the research, discusses and justifies the choice and use of methods, and puts the results as a whole in an international and scientifically relevant perspective.

Skills

Upon completion of the PhD programme in biology, it is expected that the candidate can

- formulate research questions and plan and implement research
- conduct research at a high international level
- handle complex technical issues and challenge established knowledge and practice in the field
- combine insights from several disciplines

Skills are achieved through:

- supervision and independent research
- work with publications, submission to international journals and experience with the review process
- the dissertation
- presentation of results at national and international meetings and conferences

General competence

Upon completion of the PhD programme in biology, it is expected that the candidate can

- identify relevant ethical issues and pursue research with professional integrity
- risk assess their operations and maintain health, safety and environment
- manage complex multidisciplinary assignments and projects
- disseminate research and development by recognized national and international channels
- participate in debates in international fora
- assess the need for, initiate, and drive innovation
- conduct original research at a high international level
- transfer and apply their knowledge to meet the needs of the community
- establish professional networks

Admission requirements

Admission to the PhD programme requires a broad academic background in biology and other relevant subjects. In line with the requirement for a "strong academic background" it is required that both the bachelor's programme (similar to the first three years of technology studies) and the master's programme (similar to the last two years of technology studies) are conducted with satisfactory results.

More information, application form, PhD agreement etc. <http://www.ntnu.edu/nt/phd/admission>

The applicant must have average grades of B or better in the master's degree (or equivalent qualification).

Funding

Financing of the PhD study must be established prior to admission to the PhD Programme in Biology.

Required coursework or other academic training

The course component corresponds to at least one semester of full-time study (30 credits). The main purpose is to give the student general, theoretical knowledge in biology, as well as to provide the theoretical scientific basis needed for the dissertation.

The course MN8000 Doing Science: Methods, Ethics and Dissemination constitutes a compulsory part of the training component.

The Faculty provides basic training in ethics, safety and innovation through a mandatory introduction programme for PhD candidates.

Description of the PhD programme in Biotechnology:

Description
<p>The PhD programme in Biotechnology is organized research training (doctoral programme), educating independent researchers at an international level in cooperation with national and international research groups and institutions.</p> <p>The Faculty has a broad academic profile in biotechnology. Research is conducted in collaboration within and between research groups at the faculty, in both basic and applied research. The academic community has an extensive and broad research activity, where several disciplines within biotechnology are represented, including some international cutting-edge areas.</p> <p>The PhD programme aims to meet current and future needs for competence in research, development and dissemination at the university, public and private institutions, businesses and organizations.</p> <p>The PhD programme in Biotechnology qualifies for research activities and related work that requires a high level of scientific understanding. The candidate performs an independent research project leading to a thesis at a high professional level. The candidate will learn critical thinking, dissemination of knowledge and collaboration.</p>
Research areas
<p>Doctoral work provides core expertise in one of the following research areas:</p> <ul style="list-style-type: none">• Biopolymers and Biomaterials• Microbial Biotechnology• Food Science• Analysis and Control of Microbial Systems <p>See the department's website for further information about the subject areas:</p>
Overall learning objectives for the PhD programme
<p>The PhD programme will provide training in how to generate and publish new knowledge, and strengthen the candidates' professional expertise within their academic field.</p> <p>The organized research training (doctoral programme) will be at a recognized and international level. It will provide direct personal experience in relevant experimental research, and specialization within key areas of biotechnology.</p>
Learning outcome
<p>A candidate with a completed PhD degree should have the following learning outcomes defined by knowledge, skills and general competence:</p>

Knowledge

Upon completion of the PhD programme in Biotechnology, it is expected that the candidate;

- is in the forefront of knowledge in their field of specialization in biotechnology, and can assess the limitations of current knowledge within this academic field
- can master scientific theory, problems and methods within the academic field of biotechnology
- can assess the appropriateness and application of relevant methods and processes in research and development projects
- can contribute to the development of new knowledge, new theories, methods, interpretations and methods of documentation within this academic field

Knowledge obtained through:

- *the programme's mandatory course component of 30 credits (ECTS)*
- *read and keep themselves updated on the literature in the academic field*
- *thesis summary; the candidate has independently written an introduction that provides the background of the research, discusses and justifies the choices and use of methods, and puts the completed results into an international perspective*

Skills

Upon completion of the PhD programme in biotechnology, it is expected that the candidate;

- can formulate problems, plan and conduct research and development within biotechnological issues
- can perform relevant experimental research and development in biotechnology at a high, international level
- can deal with complex scientific issues and challenge established knowledge and practices within the academic field

Skills obtained through:

- *supervision and own research*
- *work on publications, submission to international journals and experience with referee statements*
- *dissertation*
- *presentation of results at national and international meetings / conferences*

General knowledge

Upon completion of the PhD programme in biotechnology, it is expected that the candidate;

- can identify new relevant ethical issues, and perform their research with professional integrity
- can risk assess their operations and maintain health, safety and environment
- can handle scientific issues where the candidate works in scientific team
- is able to establish professional networks with both Norwegian and international researchers
- can convey research and development by publishing in recognized international journals within the academic field and at national and international conferences
- can participate in debates within the academic field in international fora
- can assess the need for, initiate and drive innovation
- is able to establish professional networks

General competence achieved through:

- *supervision and own research*
- *work with publications and thesis*

- *trial lecture; acquire knowledge about a given topic within a short time, scheduling, search / select / evaluate / process information, oral presentation*

Admission requirements

Admission to the PhD programme requires a broad professional background in biotechnology and other relevant subjects. In line with regulation requirements for a "strong academic background", both the Bachelor's programme (or the first three years of an integrated, five-year master) and the Master's degree (or the last two years of an integrated, five-year master) must be completed with satisfactory results; the applicant must have an average grade of B or better in the master's degree (or equivalent qualification).

Funding requirements

The financing of the PhD study must be established prior to admission to the PhD programme in Biotechnology

Mandatory course component

The course component corresponds to at least one semester full-time study (30 credits). The main purpose is to give the student general, scientific theoretical knowledge in biotechnology, as well as to provide the theoretical scientific basis needed for the dissertation.

At least one of the courses offered by the Department of Biotechnology and Food Science must be chosen as part of the programme's course component. The course MN8000 Doing Science: Methods, Ethics and Dissemination constitute a compulsory part of the training component.

The faculty provides an introduction to ethics, HSE and innovation through a mandatory introduction one-day programme for PhD candidates.

Description of the PhD programme in Biophysics

Description of the academic programme
<p>The PhD programme in biophysics aims to educate independent researchers at a high international level in cooperation with national and international research communities, thereby fulfilling both current and future requirements for competence in research, development, and dissemination at universities, other public and private institutions, companies, and organizations.</p>
Subject areas
<p>The physics department covers a broad range of research subjects. We have a particular responsibility for fundamental research, as well as applications of knowledge within the development of industry and society.</p> <p>The programme provides opportunities for various specializations within the fields of biophysics and medical technology, including biopolymers, bionanotechnology, microfluidics, Monte Carlo simulation of biophysics systems, radiation biophysics, nanoparticles and cancer therapy, clinical use of multiphoton microscopy, magnetic resonance imaging.</p> <p>For a more detailed description of research areas, see the department website: https://www.ntnu.edu/physics</p>
Overall learning goals
<p>The PhD programme aims to train the candidates in producing and publishing new knowledge, strengthen the professional expertise in the specific and general fields, and enable the candidates to contribute to the advancement of the field.</p>
Learning outcome
<p>A candidate who has completed the PhD programme in biophysics should have the following learning outcomes defined in terms of knowledge, skills, and general competence:</p> <p>Knowledge</p> <p>The candidate:</p> <ul style="list-style-type: none">• is at the forefront of knowledge within his or her field of biophysics• has a broad physics background as well as basic knowledge in molecular and cellular biology, to allow for future flexibility in the field <p><i>The knowledge is gained through:</i></p> <ul style="list-style-type: none">• <i>formal training of 30 credits</i>• <i>reading and keeping up to date on the literature within the field.</i> <p>Skills</p> <p>The candidate:</p> <ul style="list-style-type: none">• can formulate problems for, plan and carry out research and scholarly development work• can use the research methods of the field to create new knowledge, new theories and methods

- can carry out research and scholarly research work of a high international standard
- can handle complex academic issues and challenge established knowledge and practice in the field
- can evaluate the expediency and application of different methods and processes in research and scholarly development projects

The skills are achieved through:

- *formal training of 30 ECTS credits*
- *guidance and own research*
- *preparing publications, submitting them to international journals, and gaining experience with referee reports*
- *writing the thesis and placing the results in a broader context.*

General competence

The candidate:

- can identify new relevant ethical issues and carry out his or her research with scholarly integrity
- can assess the risks involved in the work, and safeguard HSE
- can manage complex interdisciplinary assignments and projects
- can communicate research and development work through recognized national and international channels
- can participate in debates in the field in international forums
- can quickly acquire new knowledge
- can establish academic networks

General competence is acquired through:

- *various courses, especially the compulsory course Doing Science: Methods, Ethics and Dissemination*
- *a basic training in ethics, HSE and innovation*
- *own research*
- *working with publications and writing the thesis*
- *presenting results at national and international meetings and conferences*
- *giving a trial lecture on an assigned topic*

Requirements for admission

To be admitted to the PhD programme a broad background in physics and other relevant fields is required. A Master of Physics or equivalent is required. At least 135 credits within physics or physics-related subjects at the university level are required. An additional 15 credits are required within biology-related subjects.

In accordance with the regulations' requirement of a "strong academic background" it is required that both the previous bachelor studies (equivalent to the first three years of the technology programme) and the master studies (equivalent to the final two years of the technology programme) are completed with satisfactory results. Normally an average grade of B or better for the master degree (or equivalent).

Finances

Funding for the studies must be available before admission to the PhD programme in biophysics.

Required courses

The course part of the programme is equivalent to one full semester of courses (30 credits). The main goals of this part are to give the candidate a general, scientific background in physics and biophysics, and to give the theoretical background required to perform the work.

Normally, a minimum of 15 credits should be within biophysics- or physics-related courses.

PhD candidates within biophysics perform their research within very varied fields. It is therefore important that all the candidates have a background that is relevant and sufficient for their research. It is recommended that the courses are selected so that the candidates get both a breadth within biophysics, as well as course work relevant for their particular research.

The Faculty provides training in ethics, HSE and innovation, through a mandatory introduction programme for PhD candidates. In addition, the course MN8000 Doing Science: Methods, Ethics and Dissemination constitutes a compulsory part of the training component.

Description of the PhD programme in Physics

Description of the academic programme
<p>The PhD programme in physics aims to educate independent researchers at a high international level in cooperation with national and international research communities, thereby fulfilling both current and future requirements for competence in research, development, and dissemination at universities, other public and private institutions, companies, and organizations.</p>
Subject areas
<p>The physics department covers a broad range of research subjects. We have a particular responsibility for fundamental research, as well as applications of knowledge within the development of industry and society.</p> <p>Our PhD programme provides opportunities for specializations within various fields, including condensed matter physics, physics of porous media, astrophysics, particle physics, quantum field theory, quantum spintronics, numerical physics, optics, energy and environmental physics, and physics of complex systems.</p> <p>For a more detailed description of research areas, see the department website: https://www.ntnu.edu/physics</p>
Overall learning goals
<p>The PhD programme aims to train the candidates in producing and publishing new knowledge, strengthen the professional expertise in the specific and general fields, and enable the candidates to contribute to the advancement of the field.</p>
Learning outcome
<p>A candidate who has completed the PhD programme in physics should have the following learning outcomes defined in terms of knowledge, skills, and general competence:</p> <p>Knowledge</p> <p>The candidate:</p> <ul style="list-style-type: none">• is at the forefront of knowledge within his or her field of physics;• has a broad physics background, to allow for future flexibility. <p><i>The knowledge is gained through:</i></p> <ul style="list-style-type: none">• <i>formal training of 30 ECTS credits;</i>• <i>reading and keeping up to date on the literature within the field.</i>

Skills

The candidate:

- can formulate problems for, plan, and carry out research and scholarly development work;
- can use the research methods of the field to create new knowledge, theories, and methods;
- can carry out research and scholarly research work of a high international standard;
- can handle complex academic issues and challenge established knowledge and practice in the field;
- can evaluate the expediency and application of different methods and processes in research and scholarly development projects.

The skills are achieved through:

- *formal training of 30 ECTS credits;*
- *guidance and own research;*
- *preparing publications, submitting them to international journals, and gaining experience with referee reports;*
- *writing the thesis and placing the results in a broader context.*

General competence

The candidate:

- can identify new relevant ethical issues and carry out his or her research with scholarly integrity;
- can assess the risks involved in the work, and safeguard HSE;
- can manage complex interdisciplinary assignments and projects;
- can communicate research and development work through recognized national and international channels;
- can participate in debates in the field in international forums;
- can quickly acquire new knowledge;
- can establish academic networks.

General competence is acquired through:

- *various courses, especially the compulsory course Doing Science: Methods, Ethics and Dissemination;*
- *a basic training in ethics, HSE and innovation;*
- *own research;*
- *working with publications and writing the thesis;*
- *presenting results at national and international meetings and conferences;*
- *giving a trial lecture on an assigned topic.*

Requirements for admission, from § 5 in the regulations

To be admitted to the PhD programme, a candidate should have a solid background in physics and other relevant fields. We require:

- a Master of Physics (or equivalent);
- at least 150 ECTS credits in physics and physics-related topics at university or college level.

Both the previous bachelor studies (equivalent to the first three years of the technology programme) and the master studies (equivalent to the final two years of the technology programme) should have

been completed with satisfactory results. Normally an average grade of B or better is required for the master degree (or equivalent).

It is further assumed that candidates who are admitted have, in addition to training in basic topics in classical and modern physics, an education that has given experience with both theoretical and experimental physics, and covered key areas such as quantum mechanics, statistical mechanics, and electromagnetic theory. If the previous education did not include such central subjects, the candidate may be required to take additional exams prior to being admitted, or during the doctoral programme, preferably during the first three semesters of study. This coursework cannot be included in the formal course requirements of the PhD programme, and examination in such courses must be passed with a grade of C or better.

Finances

Funding for the studies must be available before admission to the PhD programme in Physics.

Required courses

The course part of the programme is equivalent to one full semester of courses (30 ECTS credits). The main goals of this part are to strengthen the candidate's general scientific background in physics, and to give him or her the theoretical background required to perform the work.

Normally, a minimum of 22.5 credits should be within physics or physics-related courses. It is recommended that these courses are chosen such as to provide a diverse overview of topics in physics, thus developing the candidate's flexibility in the field.

The Faculty provides training in ethics, HSE and innovation, through a mandatory introduction programme for PhD candidates. In addition, the course MN8000 Doing Science: Methods, Ethics and Dissemination constitutes a compulsory part of the training component.

Description of PhD programme in Chemistry:

Description of academic content
<p>The PhD programme in Chemistry has as aim to educate independent researchers on an international level, in collaboration with national and international research institutions.</p> <p>The programme has a broad profile, including several disciplines in chemistry. The activity is organised in three research groups. They include organic chemistry (synthesis and studies of organic molecules and materials), applied theoretical chemistry (calculations and studies of complex chemical molecules at equilibrium and non-equilibrium conditions) as well as studies in environmental and analytical chemistry.</p> <p>This basic research may be applied to problems in medical technology, energy conversion, nano-technology and marine and chemistry, and such applications are also part of the activity. The methods and techniques used in the programme are relevant for applications in the industry and the society at large. The research groups, which include world renowned investigators, have extended international collaborations.</p> <p>The purpose of the PhD programme is to contribute to national needs for competence in research, this being in the industrial sector, in public and private research institutions as well as in the public sector, as teacher in the higher education system, musea or governmental research institutions.</p>
Research fields
<p>The work on the PhD thesis will lead to competence in the research front in one of the following fields</p> <ul style="list-style-type: none">• Organic chemistry• Applied theoretical chemistry• Environmental and analytical chemistry <p>The Department homepage gives further information on the research fields, see http://www.ntnu.edu/chemistry</p>
Overall learning aim of the PhD programme
<p>The PhD programme has as aim to train the candidate in the generation and publication of new knowledge, and to strengthen the candidate's general competence in the chosen research field.</p>
Outcome of the learning programme
<p>By completing the requirements of the PhD degree in chemistry the candidate shall have the following knowledge, skills and general competence:</p> <p>Knowledge</p> <p>Upon the completing of the PhD degree in chemistry, it is expected that the candidate</p> <ul style="list-style-type: none">* is in the research front of the specialty field of chemistry, and can evaluate limitations of current knowledge in the field* masters the relevant theory, problem formulations and methodologies at a broad and advanced level to allow for future flexibility in the field

- * can evaluate suitability and application of various methods and processes in chemistry for research and development purposes
- * can contribute to development of new knowledge, new theories or methods, and interpretations or methods of documentation in chemistry

Knowledge will be achieved through:

- * *The passing of courses amounting to 30 credit points*
- * *Continuous reading of the field's scientific literature*
- * *The thesis work, where the candidate independently has written an introduction to the work, that gives the background for the research, sets it in an international perspective and gives the rationale for the methods used*

Skills

At the time of the thesis defence, it is expected that the candidate:

- * can formulate problems necessary to plan and carry out research at advanced levels in chemistry and to create new knowledge, new theories and methods
- * can perform research on a high international level
- * can handle complex scientific questions and challenge established knowledge within the specialty field of chemistry
- * can combine insights from different fields

Skills will be achieved through:

- * *supervision and own research*
- * *work with the publication(s) of the thesis and the international publication process, handling of reviews etc.*
- * *presentation of results in internal, national and international meetings/conferences*

General competence

At the time of the thesis defence, it is expected that the candidate can:

- * perform original research at a high international level
- * carry out responsible research and innovation with scientific integrity in accordance to international and national legal and ethical statutes and guidelines
- * assess risks of own activity for health, environment and safety of self and others
- * direct complex inter-/multidisciplinary project work and assignments
- * disseminate research and development-results through well reputed national and international channels, in oral and written ways
- * participate in discussions within the field in international fora
- * evaluate and initiate actions of innovative character and acquire new knowledge
- * transfer and use knowledge in a way that meets the need of the society
- * establish and work with peers in networks

General competence is achieved through:

- * *supervision and own research*
- * *work on publications and thesis*
- * *the trial lecture; documenting the ability to learn a new topic in an allotted, short time and present the results.*

Admission requirements

In order to be admitted to the PhD programme the candidate must document a strong background in the chemistry and in other relevant disciplines. A strong background should, according to the PhD regulations, be understood as a Bachelor degree (or an equivalent thereof) with average grade C or better, plus a Master degree (or an equivalent thereof) with grade B or better.

Financial requirements

Financing of the PhD study must be available before the student is accepted to the PhD programme.

The course part

A set of courses is included in the programme corresponding to one semester full time studies (30 credit hours). The main purpose of the course programme is to give the candidate a broader basis for the work on the thesis (in terms of scientific methods and ethics) plus the necessary theoretical fundament for the thesis work. The course **MN-8000** "Doing Science: Methods, Ethics and Dissemination" (7,5 credits) is a mandatory part of the PhD programme.

PhD courses offered at Department of chemistry are listed below. Candidates from department of chemistry are required to study at least one of these topics.

Description of the PhD programme in Chemical Engineering

General programme description

The PhD programme in chemical engineering provides organized research training in the various research areas covered by the Department of Chemical Engineering. The objective is to train independent researchers at an international level in close collaboration with national and international research partners. 15 PhD candidates graduate on average from the Department annually.

The programme includes a wide range of research fields within important national and international subject areas. The focus could be on design of new chemical processes, scale up of processes from lab scale to industrial scale, or on further development and optimization of existing processes. In other cases, it could be more relevant to develop methods, be it experimental, mathematical or numerical, to be used as tools for characterizing, studying and understanding the underlying physical and chemical phenomena which control the various process units.

The research activities are carried out in close collaboration with national and international industry and academic partners. This gives PhD projects on topics of high scientific interest and often with a high degree of relevancy for real challenges in industry. The PhD programme is intended to comply with current and future needs for competence and skills in chemical engineering in research, development and dissemination at the university, and at other public and private institutions, enterprises and organizations.

The programme qualifies for research and development and other activities which require a high degree of scientific insight. The candidate performs an independent research project which leads to a scientific thesis at a high professional level. The candidate should learn critical thinking, dissemination of scientific knowledge and to work in a research team.

The department has excellent laboratory facilities and an extensive international network. The PhD projects often include one extended or several shorter stays outside NTNU or abroad, in particular, this applies to all candidates with a background from NTNU. The possibilities for funding via national and international funding schemes and industry are good.

Areas of research

The PhD programme in chemical engineering covers a wide specter of subject areas and candidate is normally expected to specialize within one of these.

The four main areas of research are:

Catalysis

Colloid- and Polymer Chemistry

Process Systems Engineering
Environmental Engineering and Reactor Technology

A more detailed description of ongoing research activities can be found at the department home page:

<http://www.ntnu.edu/chemeng/research>

General learning outcome for the programme

The PhD programme should give training in generation and publishing of new knowledge and understanding, and increase the candidates' general competence within their field of specialty.

The PhD study should in close collaboration with national and international research partners and relevant industry, educate PhD candidates at a high international level within the research areas covered by the department, and moreover contribute to strengthen the candidates' general competence and skills within state-of-the-art chemical engineering.

Learning outcome

A candidate with a PhD in chemical engineering should have the following total learning outcome in terms of knowledge, skills and general competence.

Knowledge

After completed a PhD in chemical engineering the candidate is expected to:

- Be in the forefront of his/her area of specialties and be able to evaluate the limitations in existing knowledge and methods within the relevant research area
- Master the theoretical basis, problems and methods within his/her research area
- Be able to contribute to new knowledge, methods, interpretations and procedures for documentation and dissemination within the research area
- Be familiar with the risks and legal aspects related to experimental activity

Knowledge is achieved through:

- The compulsory course work
- Reading and keeping updated on relevant literature within the field
- Laboratory courses and practical training
- The introductory part and summing up of the research work of the thesis, where the candidate independently describes the background, and discusses and argue for the choice of approach

and research methods, relating the actual work to state-of-the-art in the field and places the work into an international perspective

Skills

After completed a PhD in chemical engineering the candidate is expected to:

- Being able to formulate problems and make adequate plans for research and development
- Can perform and critically evaluate own and others experimental and/or theoretical research work with respect to methods, accuracy, sources of error, good conduct of HSE
- Can carry out research at a high international level
- Can handle complex scientific problems and challenge established knowledge and common practice within the area of research

Skills are achieved through:

- Supervision and own research activities
- Preparation and submission of peer-review journal papers, and experience related to the revision and re-submission of reviewed papers
- The thesis
- Presentation of own research and results at national and international conferences

General competence

After completing a PhD in chemical engineering the candidate is expected to:

- Be able to identify ethical problems and execute own research with professional integrity and independence
- Be able to risk-assess own research activities and adequately take care of health, security environmental issues
- Be able to organize and lead complex interdisciplinary projects
- Be able to be an active partner and handle relevant scientific problems where the candidate works as a part of a research team
- Be able to present own research and results through relevant national and international fora
- Be able to participate in debates within the field of specialty in national and international fora
- Be able to assess the needs for and to initiate innovation
- Be able to establish a professional network

General competence is achieved through:

- Supervision and own research
- The process of preparing publications and preparing the thesis
- The trial lecture, by acquiring knowledge about a new topic in a short time, time planning, seek/select/evaluate/process and prepare an oral presentation

- Gradually become part of a professional network during the PhD period

Requirements for admission to the programme, cf. Faculty regulations

Applicants for the PhD programme in chemical engineering must have a relevant master's degree or equivalent education, with a strong academic record.

Applicants are required to have a weighted average grade of B or higher (in accordance with NTNU's grading system) in the two last years of their master's degree (equivalent to 120 ECTS).

Funding

Before you can apply for admission to the PhD programme, the funding of the study period, including running costs, must be confirmed.

Course work, cf. Faculty regulations

An important part of the PhD education is the required course work, or academic training. It corresponds to at least one semester of full time study (30 credits). The main objective is to provide the candidate with a general and broad theoretical background in chemical engineering as well as giving the candidate the necessary competence and skills required for their actual PhD project.

For applicants with another background than Master in Chemical Engineering it is recommended to include in the course plan some master courses at the department. The faculty offers compulsory training in methods, ethics, HSE and innovation.

Requirements for the thesis

The thesis shall be an independent scientific work at an international level.

The thesis may be in the form of a monograph or consist of a collection of scientific papers (see § 10.1.)

PhD programme in Materials Science and Engineering

General program description

The PhD program in materials science and engineering provides organized research training in the various research areas covered by the Department of Materials Science and Engineering (DMSE), with the objective to train independent researchers at an international level in close collaboration with national and international research partners.

Research activities in the Department cover, amongst others, ferroic materials and phenomena, materials for energy technology (e.g. photovoltaics, fuel cells, batteries, catalysis), corrosion and coatings, nanomaterials and nanodevices, and physical metallurgy and metallurgical and electro-chemical process engineering with focus on light metals and solar-grade silicon. At present the Department has 44 professors and associate professors, and about 105 research fellows. On average about 15-20 PhD candidates graduate from DMSE annually.

The research activities are carried out in close collaboration with national and international industry and academic partners from DMSE's extensive network. Such collaborations results in PhD projects on topics of state-of-the-art scientific interest and often with a high degree of relevancy for real challenges in industry. Projects often include one extended or several shorter stays outside NTNU. The department has excellent laboratory facilities. The possibilities for funding via national and international funding schemes and industry are good.

The PhD program is intended to comply with current and future needs for competence and skills in material science and engineering in research, development and dissemination at the university, and at other public and private institutions, enterprises and organizations.

The PhD program in Material Science and Engineering qualifies for research and development and other activities which require a high degree of scientific insight. The candidate performs an independent research project which leads to a scientific thesis at a high professional level. The candidate should learn critical thinking, dissemination of scientific knowledge and findings, in addition to team work.

Areas of Research

The PhD work gives high level competence within one of the following research areas:

- Metal production and recycling
- Materials development and properties
- Materials for energy technology

A more detailed description of ongoing research activities at the department can be found at the Department of Materials Science and Engineering
<http://www.ntnu.edu/ima/research>

General learning outcome for the program

The PhD program should give training in the generation and publishing of new knowledge and understanding, and increase the candidates' general competence within their field of speciality.

The PhD study in material science and engineering should in close collaboration with national and international research partners and relevant industry, educate PhD candidates at a high international level within the research areas covered by the department, and moreover contribute to strengthen the candidates' general competence and skills within state-of-the-art materials science and engineering.

Learning outcome

A candidate with a PhD in materials science and engineering should have the following total learning outcome in terms of knowledge, skills and general competence

Knowledge

After completed a PhD in material science and engineering the candidate is expected to:

- Be in the forefront of his/her area of specialities and be able to evaluate the limitations in existing knowledge and methods within the relevant research area in materials science and engineering
- Be able to contribute to new knowledge, methods, interpretations and procedures for documentation and dissemination within materials science and engineering
- Be familiar with the risks and legal aspects related to experimental activity
- Mastering the theoretical basis, problems and methods for synthesis and processing of structural, functional and/or nano-materials
- Mastering the theoretical basis and mathematical models describing the relationships between material structure (e.g. electronic, atomic, nano-/micro-structure ..) and properties of metals and alloys, ceramics, functional materials and/or nano-materials
- Mastering the theoretical basis for relevant experimental and computational methods to characterize and analyse structure and properties of structural, functional and/or nano-materials

Skills

After completed a PhD in material science and engineering the candidate is expected to:

- Be able to formulate problems and make adequate plans for research and development, on the basis of the current state of knowledge about a certain topic
- Be able to perform and critically evaluate own and other's experimental and/or theoretical research work with respect to methods, accuracy, sources of error, good conduct of HSE
- Be able to carry out research at a high international level within her/his area of research in materials science and engineering
- Be able to handle complex scientific problems and to challenge established knowledge and common praxis within her/his area of research in materials science and engineering
- Be able to analyse and document own research and results in reports and scientific papers for publication in peer reviewed international scientific journals

- Be able to prepare and present own research and results for presentation at national and international conferences
- Be able to risk assess own research activities and adequately take care of health, security environmental issues
- Be able to present own research and results through relevant national and international fora

General competence

After completed a PhD in material science and engineering the candidate is expected to:

- Be able to identify ethical problems and execute own research with professional integrity and independence
- Be able to organise and lead complex interdisciplinary projects
- Be able to be an active partner and handle relevant scientific problems where the candidate works as a part of a research team
- Be able to participate in debates within the field of speciality in national and international fora
- Be able to assess the needs for and to initiate innovation
- Be able to establish a professional network

Requirements for admission to the program

Applicants for the PhD program in Materials Science and Engineering must have a relevant master's degree or equivalent education, with a strong academic record.

Applicants are required to have a weighted average grade of B or higher (in accordance with NTNU's grading system) in the two last years of their master's degree (equivalent to 120 ECTS).

Funding

Before you can apply for admission to the PhD programme, the funding of the study period, including running costs, must be confirmed.

Course work

An important part of the PhD education is the required course work, or academic training. It corresponds to at least one semester of full time study (30 credits). The main objective is to provide the candidate with a general and broad theoretical background in material science and engineering as well as to give the candidate the necessary competence and skills required for their actual PhD project.

The plan for academic training should be adapted to the research area of the candidates' PhD project and worked out together with main supervisor. The course work should consist of a minimum of 30 credits, of which at least 20 credits are to be taken as established PhD level courses. The new course on research ethics and research methodology is compulsory. Normally a minimum of two PhD/MSc courses (15 credits) should be chosen from the courses offered by DMSE.

MN8000 "Doing Science: Methods, Ethics and Dissemination" constitutes a compulsory part of the training component.

The NV- faculty offers introductory training in ethics, HSE and innovation through a compulsory one day introduction seminar.