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Decision-maker	**Revised as of**	**Responsible for supervision and questions**
President	05.04.2017	School of Engineering Sciences in Chemistry, Biotechnology and Health

Gener-al study syllabus for the third-cycle subject **Biotechnology**

This regulatory document has been decided by the President (registration number V-2021-0822 3.2.3) pursuant to chapter 6 Sections 26-27 of the Higher Education Ordinance. The regulatory document is valid from 10122021 and was last modified on 05042017 (registration number [V-2017-0035). The regulatory document regulates the main content of the education, requirements for special qualifications and the other regulations that are needed. Responsible for review and questions about the governing document is the School of Engineering Sciences in Chemistry, Biotechnology and Health.

1 Content of the education

1.1 The name of the subject in Swedish and in English translation

Biotechnology

1.2 Subject description

Biotechnology is a third-cycle subject that integrates biology and technology with the aim of utilising organisms, cells or their components to create new knowledge, products and processes. Research within the subject mainly focuses on gene technology, bioinformatics, protein technology, proteomics, nanobiotechnology, systems biology, structural biology, enzyme technology and bioprocess technology. Illustrative examples of research activities that may be included are identification of new biomarkers and mapping of proteins' links to diseases, drug development, enzyme catalysis and the use of microorganisms for production of chemical compounds.

1.3 Specialisation/Specialisations

There are no specialisations within this subject.

1.4 The structure of the education

1.4.1 Activities for fulfilling the degree goals of the education according to the Higher Education Ordinance (HF)

Below are described activities for the doctoral student's fulfilment of the goals for third-cycle education according to the Higher Education Ordinance (HF) and the goals of KTH. The individual study plan specifies the activities for each individual doctoral student.

Learning outcomes: Knowledge and understanding

For the Degree of Doctor the doctoral student shall:

- Demonstrate broad knowledge and systematic understanding of the research field as well as advanced and up-to-date specialised knowledge in a limited area of this field.

The goal can be achieved by the doctoral student continuously practising and developing the ability to: plan and carry out their own research; acquiring both broad and specialised knowledge from scientific literature relevant to the area of research; actively presenting their own research results in the form of scientific publications and at national and international conferences, seminars or workshops; taking exams as part of courses and participating in workshops and scientific seminars relevant to the subject and area of research; completing the compulsory seminar courses for the course part in which the research work of other doctoral students and researchers is critically reviewed, analysed and discussed; and writing and defending a doctoral thesis.

- Demonstrate familiarity with research methodology in general and the methods of the specific field of research in particular.

The goal can be achieved by the doctoral student continuously practising and developing the ability to: identify and motivate relevant research questions and choices of appropriate methods; taking exams as part of courses and participating in workshops and scientific seminars with a methodological focus relevant to the subject and area of research; acquiring knowledge and thoroughly and critically reviewing scientific work in their own area of research; using different methods in practice; and completing courses in scientific theory and research methodology.

For a Degree of Licentiate, the doctoral student shall:

- Demonstrate knowledge and understanding in the field of research including current specialist knowledge in a limited area of this field as well as specialised knowledge of research methodology in general and the methods of the specific field of research in particular.

The goal can be achieved by the doctoral student continuously practising and developing the ability to: plan and carry out their own research; acquiring knowledge from scientific literature relevant to the area of research; actively presenting their own research results in the form of scientific publications and at national and international conferences, seminars or workshops; taking part in courses relevant to the area of research; completing the compulsory seminar courses for the course part in which the research work of other doctoral students and researchers is critically reviewed, analysed and discussed; and writing and defending a licentiate thesis.

Learning outcomes: Competence and skills

For the Degree of Doctor the doctoral student shall:

- Demonstrate the capacity for scholarly analysis and synthesis as well as to review and assess new and complex phenomena, issues and situations autonomously and critically.

The goal can be achieved by the doctoral student continuously practising and developing the ability to: independently interpret, analyse, discuss and compile research results; actively reflecting on possible sources of error and alternative approaches to addressing complex issues; performing interdisciplinary activities and reasoning in an interdisciplinary manner; independently evaluating the reasons why experiments have not produced the expected results and based on these insights proposing new ways of moving the research or issue forward; and testing scientific hypotheses.

- Demonstrate the ability to identify and formulate issues with scholarly precision critically, autonomously and creatively, and to plan and use appropriate methods to undertake research

and other qualified tasks within predetermined time frames and to review and evaluate such work.

The goal can be achieved by the doctoral student continuously practising and developing the ability to: independently plan and carry out relevant studies and experiments with clear goals in a reliable manner and within time frames appropriate to the task; based on existing literature and their own experience of and reflections on their own results formulate new scientific questions, hypotheses and approaches to be answered and tested; and compiling their own results and relating them to other people's published results.

- Demonstrate through a dissertation the ability to make a significant contribution to the formation of knowledge through his or her own research.

The goal is achieved by the doctoral student independently: having planned and performed experimental or theoretical studies with a good and proven scientific basis and using scientific research methodology relevant to the research subject; having analysed and critically reviewed their own results and compiled them in writing in the form of articles published in peer-reviewed international scientific journals, or in the form of manuscripts of sufficient quality for publication in peer-reviewed international scientific journals; having summarised in a doctoral thesis their own research results that are also related to existing knowledge in the field of research; and having meritoriously defended and discussed the results in a public dissertation.

- Demonstrate the ability in both national and international contexts to present and discuss research and research findings authoritatively in speech and writing and in dialogue with the academic community and society in general.

The goal can be achieved by the doctoral student continuously practising and developing the ability to: assume personal responsibility for writing scientific papers; presenting their research results both to experts in the field and to a wider audience; relating their own research results to the current state of knowledge in the research field, and the industry within which the results can be applied; authoritatively and pedagogically presenting their own research results to other researchers and students at academic seminars; and taking exams as part of courses in which presentation and discussion of one’s own research results are compulsory elements.

- Demonstrate the ability to identify the need for further knowledge.

The goal can be achieved by the doctoral student continuously practising and developing the ability to: stay informed and updated on the national and international developments in their own area of research as well as in related fields; critically reflecting on the way their own theoretical and methodological approaches relate to the overall knowledge base and the research front and whether their own knowledge and methodology are sufficient or in need of development; identifying and formulating questions that would be motivated to investigate in order to further develop their own research project from a basic research or applied perspective, and selecting appropriate methods for the purpose; and developing the ability to adapt their own perceptions on the basis of acquisition of new knowledge.

- Demonstrate the capacity to contribute to social development and support the learning of others both through research and education and in some other qualified professional capacity.

The goal can be achieved by the doctoral student continuously practising and developing the ability to: identify questions that may benefit society; communicating their own research results in writing and presenting them to and discussing them with other researchers at academic seminars and in compulsory seminar courses; collaborating with other researchers and interacting with players within and outside academia; in a pedagogical manner teach and supervise students at undergraduate and second-cycle level after having passed a compulsory course in higher education pedagogy; and presenting their own research results to the surrounding society, e.g. in industry journals, at meetings with industry actors, in popular-science journals, or to pupils at primary or secondary level.

For a Degree of Licentiate, the doctoral student shall:

- Demonstrate the ability to identify and formulate issues with scholarly precision critically, autonomously and creatively, and to plan and use appropriate methods to undertake a limited piece of research and other qualified tasks within predetermined time frames in order to contribute to the formation of knowledge as well as to evaluate this work.

The goal can be achieved by the doctoral student continuously practising and developing the ability to: independently plan and carry out limited research tasks with clear goals and within time frames appropriate to the task; based on existing literature and their own experience of, and reflections on, their own results formulate new scientific questions, hypotheses and approaches to be answered and tested; and compiling their own results and relating them to other people's published results.

- Demonstrate the ability in both national and international contexts to present and discuss research and research findings in speech and writing and in dialogue with the academic community and society in general.

The goal can be achieved by the doctoral student continuously practising and developing the ability to: assume responsibility for writing scientific papers; presenting their research results to researchers in the research field; relating their own research results to the current state of knowledge in the research field and the industry within which the results can be applied; pedagogically presenting their own research results to other researchers and students at academic seminars; and passing courses in which presentation and discussion of one’s own research results are compulsory elements.

- Demonstrate the skills required to participate autonomously in research and development work and to work autonomously in some other qualified capacity.

The goal can be achieved by the doctoral student continuously practising and developing the ability to: communicate their own research results in writing in the form of scientific publications and a licentiate thesis; pedagogically presenting it to, and discussing it with, other researchers within or outside academia; and discussing and critically reviewing their own and others' research results within the framework of compulsory seminar courses.

Learning outcome: Judgement and approach

For *the Degree of Doctor* the doctoral student shall:

- Demonstrate intellectual autonomy and disciplinary rectitude as well as the ability to make assessments of research ethics.

Goal fulfilment includes being examined in a subject course in research ethics. In addition to a compulsory subject course in research ethics, other courses with individual intended learning outcomes in the field of ethics can contribute further progression towards goal achievement. Progression towards the goal is also achieved by the doctoral student continuously practising and developing the ability to: independently formulate and critically review their own and others' research; conscientiously carrying out research tasks in an ethical manner; making research-ethics assessments by reflecting on and dealing with any ethical dilemmas that may arise within their own research field and within research in general; demonstrating intellectual integrity by critically justifying and defending their own positions based on proven experience and a scientific basis. Furthermore, it includes being examined in the compulsory part of the course part that involves a course or course module that includes intended learning outcomes in the field of research ethics.

- Demonstrate specialised insight into the possibilities and limitations of research, its role in society and the responsibility of the individual for how it is used.

The goal can be achieved by the doctoral student continuously practising and developing the ability to: reflect in depth on both expected and unexpected results and managing the results adequately; reflecting on opportunities and limitations within their own research project; and reflecting on the opportunities and limitations of their own research from a broader social-science perspective.

For a Degree of Licentiate, the doctoral student shall:

- Demonstrate the ability to make assessments of ethical aspects of his or her own research.

Goal fulfilment includes being examined in a subject course in in research ethics. In addition to a compulsory subject course in research ethics, other courses with individual intended learning outcomes in the field of ethics can contribute further progression towards goal achievement. Progression towards the goal is also achieved by the doctoral student continuously practising and developing the ability to: independently formulate and critically review their own research results; conscientiously carrying out research tasks in an ethical manner; making research-ethics assessments by reflecting on and dealing with any issues that may arise within their own research and its implementation.

- Demonstrate insight into the possibilities and limitations of research, its role in society and the responsibility of the individual for how it is used.

The goal can be achieved by the doctoral student continuously practising and developing the ability to: reflect on both expected and unexpected results and managing the results adequately; reflecting on opportunities and limitations within their own research project as well as on the opportunities and limitations of their own research from a broader social-science perspective.

- Demonstrate the ability to identify the personal need for further knowledge and take responsibility for his or her ongoing learning.

The goal can be achieved by the doctoral student continuously practising and developing the ability to: stay informed and updated with regard to national and international developments in their research field as well as in related fields; critically reflecting on the way their own theoretical and methodological approaches relate to the overall knowledge base and the research front and whether their own knowledge and methodology are sufficient or in need of development; identifying and formulating questions that would be motivated to investigate in order to further develop their own research project

from a basic-research or applied perspective as well as which methods are suitable for the purpose; and developing the ability to adapt their own perceptions on the basis of acquisition of new knowledge.

KTH's outcome in sustainable development

For both the Degree of *Licentiate and* the Degree of D*octor,* the doctoral student shall:

- Demonstrate the ability to contribute to a sustainable societal development toward a gender equal, inclusive and climate neutral society with knowledge and skills.

Goal fulfilment includes passing a subject course in sustainable development. In addition to a compulsory subject course in sustainable development, other courses with individual learning outcomes in sustainable development can contribute further progression towards goal fulfilment. The goal also includes learning about equality, diversity and equal opportunities and climate-neutral and climate-enhancing societal development, and third-cycle education is responsible for providing information on the learning activities organised to achieve goal fulfilment. As a further progression towards the goal, doctoral students should continuously practise and develop the ability to: account for how their own research, actions and approach take into consideration the concept of sustainability; critically evaluate and reflect on how their own research can be conducted sustainably by considering its direct or indirect economic, social or environmental consequences and its effect on the near or distant environment; and on their own initiative acquire knowledge and reflect on sustainable development from a broader global perspective.

1.4.2 Compulsory courses

To promote fulfilment of the degree objectives, compulsory requirements for examination of knowledge and skills include critical review and discussion of one's own and others' scientific work within the framework of higher seminar courses, basic higher-education pedagogy, basic research ethics and sustainable development. Examples of current courses are found in Appendix 2.

The current course offering is continuously being developed and can thus vary over time. The school undertakes to compile and provide current information on courses and other course activities organised at the school, and if necessary to provide information on appropriate courses and course activities outside the school and the university. Doctoral students should also actively seek and propose appropriate learning activities that, in addition to the compulsory courses, aim at further progression towards degree goals and complementation of necessary knowledge, as well as consulting supervisors and the director of third-cycle education/programme director concerning the suitability of the proposed course activities.

1. Seminar courses, at least two consecutive courses in a seminar course series.

   It is mandatory to actively participate in at least two consecutive seminar courses, e.g., courses 1 and 2 in a seminar course series of four courses. You can take several seminar courses in parallel, but the total time you participate in seminar courses should not be less than two years, corresponding to half the period of study for a doctoral student at a 100% study rate.

   The seminar courses referred to here are special courses set up by the school that are part of a series of four consecutive courses, each course being equivalent to 3.0 or 4.0 ECTS credits and lasting about a year.

   The seminar courses are an important tool for supporting progression towards the Higher Education Ordinance's degree objectives, as they provide both broad and specialised knowledge

within one’s own and the broader subject areas, as well as providing skills in presentation and critical review of one’s own research results and those of others. Gatherings for the seminar courses normally take place twice a month during the semester and are led by experienced and actively researching teachers with good knowledge of the research area, the premises for the research, academic authorship, peer review and publishing strategies relevant to the research topic. The motivation for taking these courses for a prolonged period of one’s doctoral studies is to achieve progression regarding one’s own writing of scientific manuscripts, presentation of one’s own results and critical review of other people's scientific manuscripts and published articles.

2. Basic teaching and learning in higher education, minimum 3.0 ECTS credits

   Refers to a third-cycle subject course in pedagogy established at a Swedish university with learning outcomes in the subject higher-education pedagogy stated in the course syllabus that are examined and passed. For doctoral students who are going to teach, a pass grade for a higher education pedagogical basic course is required before teaching begins. Basic higher-education pedagogy is also compulsory for doctoral students who are not to participate in teaching. Examples of courses in basic higher-education pedagogy offered at KTH are found in Appendix 2.

3. Basic research ethics, minimum 2.0 ECTS credits

   Refers to a third-cycle subject course in research ethics established at a Swedish university with learning outcomes in research ethics stated in the course syllabus that are examined and passed. Examples of courses in basic research ethics provided at KTH are found in Appendix 2.

4. Sustainable development, minimum 3.0 ECTS credits

   Refers to a third-cycle subject course in sustainability established at a Swedish university with learning outcomes for knowledge and abilities in sustainable development stated in the course syllabus that is passed. KTH’s sustainability degree objective for third-cycle education also include examinations in knowledge and abilities in the field of equality, diversity and equal treatment, as well as society's climate transition and development towards climate neutrality. To achieve the goal, it is compulsory to participate and be examined in the learning activities organised within the framework of the doctoral programme. Examples of courses in sustainable development provided at KTH are found in Appendix 2.

1.4.3 Recommended courses

Recommended courses include established courses in the third-cycle subject with the relevant research specialisation, courses in research methodology, presentation techniques, scientific writing and communication, and literature studies. Examples of current courses are to be found in Appendix 2.

1.4.4 Conditionally elective courses

Non-established courses may be included in a degree at the third cycle. However, all courses and course activities not established by a Swedish university must be validated by the programme's director of third-cycle education/programme director before they can be included in the individual plan’s course part and the degree.

Within the framework of an individual commitment, ECTS credits can be obtained for completed and documented conference contributions. These refer to oral presentations, posters, and pitch

presentations. For each individual form of presentation, ECTS credits may be awarded on only one occasion, provided it is also included in the course part of the individual study plan.

Online distance courses can be included in the individual plan provided its quality can be substantiated by the doctoral student and supervisor with the required documentation for validation. The scope, level and examination must be substantiated in the manner prescribed by central and local regulations. Any transfer is decided on by the director of third-cycle education/programme director.

A course already established at first- or second-cycle level cannot be credited as a course at the third cycle.

1.4.5 Qualification requirements

Degree of Doctor

A Degree of Doctor comprises 240 ECTS credits. At least 120 credits must consist of the doctoral thesis.

Thesis

Quality requirements and possible other requirements for the thesis.

Compilation thesis

The thesis should be based on research results of a quality such that they are or can be expected to be published in scientific journals that apply peer review. The scope should correspond to four scientific articles where the doctoral student is the main author of at least two articles, of which at least one has been accepted for publication in journals that apply peer review. The number of articles may vary, however, depending on the scope, the scientific level and quality, and the doctoral student's contribution to each paper.

According to KTH's regulations for third-cycle education, it is mandatory that a doctoral thesis is, in addition to the main supervisor, reviewed by a formally appointed advance reviewer.

When a doctoral thesis is based solely on work that has not yet been published or accepted for publication in international scientific journals that apply peer review, the dissertation must in addition to the supervisors and the compulsory advance reviewer also be reviewed by two other independent researchers in the research area.

Monograph thesis

A doctoral thesis can also be written as a monograph, which is a relatively comprehensive, coherent scientific paper. Previous publications may be attached to a monograph as appendices. Monographs should be avoided, and decisions to apply this form of thesis are made by the director of third-cycle education. If a monograph is considered applicable, its content must be of a scientific level such that the content in its entirety, or most of it, can be expected to meet the requirements for publication in scientific journals of good international quality that apply peer review.

A monograph shall be reviewed in advance by the main supervisor, a formally appointed advance reviewer, two independent researchers with good knowledge in the research field, and by the director of third-cycle education.

Courses

Doctoral students must have completed courses equivalent to at least ECTS 60 credits, 45 of which must be at third-cycle level, and no more than 10 ECTS credits may be at first-cycle level.

It follows (for a course part of 60 ECTS credits) that a maximum of 15 ECTS credits from second-cycle level can be included in the doctoral degree, provided no credits from first-cycle level are included.

Licentiate degree

A Degree of Licentiate comprises at least 120 credits. The thesis comprises at least 60 ECTS credits.

Thesis

Quality requirements and any other requirements for the licentiate thesis.

Compilation thesis

The thesis should be based on research results of a quality such that they are or can be expected to be published in scientific journals that apply peer review. The scope should correspond to two scientific articles where the doctoral student is the main author of at least one article and at least one having been accepted for publication in a peer-reviewed journal. The number of articles may vary, however, depending on the scope, the scientific level and quality, and the doctoral student's contribution to each paper.

According to KTH's regulations for third-cycle education, a licentiate thesis must, in addition to the main supervisor, be reviewed by a formally appointed advance reviewer.

When a licentiate thesis is based solely on original work that has not yet been published, or accepted for publication, in international scientific journals that apply peer review, the thesis must in addition to supervisors and the mandatory advance reviewer also be reviewed by another independent researcher with good knowledge in the field.

Monograph thesis

A licentiate thesis can also be written as a monograph, which is a relatively comprehensive, coherent scientific paper. Previous publications may be attached to a monograph as appendices. Monographs should be avoided, and decisions to apply this form of thesis are made by the director of third-cycle education. If a monograph is considered applicable, its content must be of a scientific level such that the content in its entirety, or most of it, can be expected to meet the requirements for publication in scientific journals of good international quality that apply peer review.

A monograph paper shall be reviewed in advance by the main supervisor, a formally appointed advance reviewer, another independent researcher with good knowledge in the research field, and by the director of third-cycle education.

Courses

Doctoral students must have completed courses equivalent to at least 30 ECTS credits, 15 of which must be at third-cycle level, and no more than 10 ECTS credits may be at first-cycle level.

It follows that (for a course part of 30 ECTS credits) a maximum of 15 ECTS credits from the second-cycle level can be included in the licentiate degree, provided that no credits from first-cycle level are included.

1.4.6 Other elements in the education to promote and ensure goal fulfilment

Follow-up of individual study plan. It is mandatory that supervisors and doctoral students jointly follow up the individual study plan regularly, and at least once a year. The individual study plan must be designed to ensure that the Higher Education Ordinance's and KTH's degree goals can be met within the set time. The general study syllabus should be used as support in the work of designing and following up the individual study plan. Progression towards goal fulfilment must be evaluated by supervisors and doctoral students at the compulsory follow-up of the individual study plan. The doctoral student reflects on, exemplifies, and justifies how completed and ongoing study activities have promoted progression since the most recent follow-up. Justification of progression must be made in writing in the intended section of the electronic individual study plan, and preferably by the doctoral student. All elements of the education, thesis work, courses, workshops, conferences, outreach activities etc. must be taken into account.

Non-compulsory courses and learning activities are chosen by agreement between the doctoral student and supervisor. During the annual follow-up, planned courses and learning activities are included in the individual study plan for the forthcoming year.

Half-time seminar. The seminar is compulsory and is held after half of the study time. Third-cycle studies with a doctoral degree as the target degree include 48 months of full-time study (100% activity) if 0% departmental duties are included, and 60 months of study (80% activity) if 20% departmental duties are included. Third-cycle studies with a licentiate degree as the target degree include 24 months of full-time studies (100% activity) if 0% departmental duties are included, and 30 months of study (80% activity) if 20% departmental duties are included. The estimated time for the half-time seminar for the doctoral degree as the target degree is 24-30 months. The estimated time for the half-time seminar for the degree of licentiate as the target degree is 12-15 months. The lower- and upper-time limits are with regard to studies involving 0% and 20% departmental duties, respectively. Please note that 20% is the maximum allowed percentage of departmental duties.

Scientific exchange and communication. Active participation in scientific exchange by presenting one's own research results at international conferences, major national conferences, workshops, summer schools or gatherings arranged by companies. Active participation refers here to a scientific lecture, an oral research presentation in "pitch format" or a poster presentation for a scientific audience.

Mid-year seminars. It is recommended that doctoral students with the doctoral degree as the target degree also present their research results and achieved goals at so-called interim mid-year seminars. A mid-year seminar refers to a seminar given halfway between the start and the half-time seminar, and halfway between the half-time seminar and the completion of the doctoral education. The form of the mid-year seminar is determined by the doctoral student and supervisor in consultation but should include control of progression towards the degree goals, be open to at least the own department and concluded by a short written report based on a template describing the progression of achieved goals and sent to the third-cycle education coordinator for archiving.

2 Admission to third-cycle education (eligibility etc.)

Admission to third-cycle education is regulated in Chapter 7, Section 40 of the Higher Education Ordinance, and in the KTH admission regulation. KTH's regulations on special prerequisites and other abilities needed to assimilate the education in the relevant subject at the third cycle are set out below.

2.1 Special prerequisites

To be admitted to third-cycle education in the subject Biotechnology, the applicant must have approved courses of at least 60 ECTS credits at least at the advanced level in the subject Biotechnology or other subjects that are judged to be directly relevant to the current specialisation. These requirements are also considered to be met by those who have acquired substantially equivalent knowledge by other means.

To be admitted to third-cycle education in the subject Biotechnology , the applicant must have knowledge of English equivalent to English 6.

2.2 Assessment criteria for evaluating the ability to assimilate the education

The following applies as assessment criteria in the examination of the ability to assimilate the education:

Selection for third-cycle education is based on assessed ability to assimilate such education. The assessment of the ability takes place mainly on the basis of qualifying education. Particular consideration is given to the following:

1. Knowledge and skills relevant to the dissertation and the subject. These can be shown through attached documents and a possible interview.
2. Assessed ability to work independently
    a. ability to formulate and tackle scientific problems
    b. ability to communicate well in speech and writing
    c. maturity, judgement, and ability for independent critical analysis

    The assessment may be based, for example, on degree projects and discussion of these at a possible interview.
3. Other experiences relevant to third-cycle education, e.g., professional experience.

3 Other regulations needed

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3.1 Transitional regulations

Doctoral students who have been admitted to a previous study syllabus have the right to transfer to the most recently established and valid general study syllabus. A request to change to a later study syllabus is made in writing to the director of third-cycle education. A change of general study syllabus, however, presupposes that the requirements of the new study syllabus can be met within the set time.