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President	2017-04-05	CBH

General 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) based on chapter 6 Sections 26-27 of the Higher Education Ordinance. The regulatory document is valid from 10122021 and was last amended 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 Subject name

Biotechnology

1.2 Subject description

Biotechnology is a third-cycle subject that integrates biology and technology in order to utilise organisms, cells or their components to create new knowledge, products and processes. Research in the subject is mainly focused on genetic 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 the identification of new biomarkers as well as the mapping of proteins' links to diseases, drug development, enzyme catalysis and the use of microorganisms for the production of chemical compounds.

1.3 Specialisation/Specialisations

The subject has no specialisations.

1.4 Organisation 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.

Goal: Knowledge and understanding

For *doctoral degree* 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; acquire both broad and specialized knowledge from scientific literature relevant to the field of research; actively present own research results in the form of scientific publications, and at national and international conferences, seminars or workshops; is examined in courses and participates in workshops and scientific seminars relevant to the subject and the research area; complete the compulsory seminar courses for the course part where the research work of other research students and researchers is critically examined, analysed and discussed; and write and defend a doctoral dissertation.

- 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 choose appropriate methods; be examined in courses and participate in workshops and scientific seminars with a methodological focus relevant to the subject and the research area; acquire knowledge and thoroughly and critically review scientific work within one's own research area; practically use different methods; and to complete courses in e.g. scientific theory and research methodology.

For *licentiate degree* 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; acquire knowledge from scientific literature relevant to the field of research; actively present own research results in the form of scientific publications, and at national and international conferences, seminars or workshops; participates in courses relevant to the research area; completes the compulsory seminar courses for the course part where the research work of other research students and researchers is critically examined, analysed and discussed; and writes and defends a licentiate thesis.

Goal: Competence and skills

For *doctoral degree* 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 reflect on possible sources of error and alternative approaches to deal with complex issues; perform interdisciplinary activities and reason interdisciplinary; independently evaluate reasons why experiments have not provided expected results and, based on these insights, suggest new ways of advancing research or the issue; and test 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 adequate time frames for the task; based on existing literature and own experience of, and reflections on, own results formulate new scientific questions, hypotheses, and approaches to be answered and tested; and compile own results and relate these to others' 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 research student: having independently planned, carried out experimental or theoretical studies on a good and proven scientific basis and with scientific research methodology relevant to the research subject; 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 to be assumed to be published in peer-reviewed international scientific journals; summarized in a doctoral dissertation own research results where these were also put in relation to existing knowledge in the research area; and in a meritorious way defended and discussed the results of 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 take personal responsibility for writing scientific papers; present their research results to both experts in the field and to a wider audience; relate own research results to the current state of knowledge in the research area and the industry in which the results can be applied; present own research results in an authoritarian and pedagogical way to other researchers and students at academic seminars; and is examined in courses where presentation and discussion of own research results are included as 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 about the national and international development within their own research area as well as adjacent areas; critically reflect on how one's own theoretical and methodological approaches relate to the overall knowledge base and the research front and whether one's own knowledge and methodology are adequate or need to be developed; identify and formulate issues that would be motivated to investigate in order to further develop one's own research project from a basic research or applied perspective, and which methods are suitable for the purpose; and develop the ability to adapt own perceptions based on the 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 can benefit the surrounding society; communicate own research results in writing and present to, and discuss with, other researchers at academic seminars and compulsory

seminar courses; collaborate with other researchers and collaborate with actors within and outside the academy; in a pedagogical way teach and supervise students at undergraduate and advanced level after having graduated from a compulsory course in higher education pedagogy; and present own research results to the surrounding society, e.g. in industry journals, in meetings with industry actors, in popular science journals, or for students at primary or secondary school level.

For *licentiate degree* 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 perform limited research tasks with clear goals and for the task adequate time frames; based on existing literature and own experience of, and reflections on, own results formulate scientific questions, hypotheses, and approaches to be answered and tested; and compile own results and relate these to others' 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 take personal responsibility for writing scientific papers; present their research results to researchers in the field of research; relate own research results to the current state of knowledge in the research area and the industry in which the results can be applied; present own research results in a pedagogical way to other researchers and students at academic seminars; and is examined in courses where presentation and discussion of own research results are included as 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 present to and discuss with other researchers inside or outside the academy; as well as discussing and critically examining one's own and others' research results within the framework of compulsory seminar courses.

Goal: Judgement and approach

For *doctoral degree* the doctoral student shall:

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

For goal fulfilment, it is required to be examined in a subject course in research ethics. In addition to a compulsory subject course in research ethics, other courses with individual learning objectives in ethics can contribute with further progression towards goal fulfilment. Progression towards the goal is also achieved by the doctoral student continuously practising and developing the ability to independently

formulate and critically examine their own and others' research; perform research tasks in an honest and research ethical manner; make research ethics assessments by reflecting on and dealing with any ethical dilemmas that may arise within one's own research area and within research in general; demonstrate intellectual integrity by critically motivating and defending one's own positions based on proven experience and scientific basis. Furthermore, it is included to be examined on the compulsory element of the course part which comprises a course where learning objectives in the field of research ethics are included.

- 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 thoroughly reflect on both expected and unexpected results and manage the results in an adequate way; reflect on opportunities and limitations within one's own research project; reflect on the possibilities and limitations of one's own research in a broader social science perspective.

For *licentiate degree* the doctoral student shall:

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

For goal fulfilment, it is included to be examined in a subject course in research ethics. In addition to a compulsory subject course in research ethics, other courses with individual learning objectives in ethics can contribute with further progression towards goal fulfilment. Progression towards the goal is also achieved by the doctoral student continuously practising and developing the ability to: independently formulate and critically examine their own research results; perform research tasks in an honest and research ethical manner; make research ethics assessments by reflecting on and dealing with issues that may arise within one's 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 to manage the results in an adequate way; reflect on opportunities and limitations within one's own research project, as well as on one's own research opportunities and limitations in 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 about the national and international development within their own research area as well as adjacent areas; critically reflect on how one's own theoretical and methodological approaches relate to the overall knowledge base and the research front and whether one's own knowledge and methodology are adequate or need to be developed; identify and formulate issues that would be motivated to investigate in order to further develop one's own research project from a basic research or applied perspective, and which methods are suitable for the purpose; and develop the ability to adapt own perceptions based on the acquisition of new knowledge.

KTH sustainability goal

For both *licentiate and doctoral degree* 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.

For goal fulfilment, it is required to be examined in a subject course in sustainable development. In addition to a compulsory subject course in sustainable development, other courses with individual learning objectives in sustainable development can contribute with further progression towards goal fulfilment. The goal also includes education about gender equality, diversity and equal conditions and climate-neutral and climate-improving societal development, and the doctoral education is responsible for informing about which learning activities are organized in order to achieve goal fulfilment. As a further progression towards the goal, the research student should continuously train and develop the ability to account for how his or her own research, actions and approach take into account the concept of sustainability; critically evaluate and reflect on how own research can be conducted in a sustainable way by taking into account its direct or indirect economic, social or environmental consequences and impact on the near or distant environment; and on their own initiative acquire knowledge and reflect on sustainable development in a broader global perspective.

1.4.2 Compulsory courses

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

The relevant range of courses is continuously developed and can therefore vary over time. The school undertakes to compile and provide current information about courses and other course activities that are arranged at its own school, and if necessary, assist with information about suitable courses and course activities outside the school and the university. Doctoral students should also actively search for and suggest suitable learning activities that, in addition to the compulsory courses, aim at further progression towards examination goals and supplementation of necessary knowledge, as well as consult with supervisors and postgraduate / program manager on 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 study several seminar courses in parallel, but the total time you participate in seminar courses should not be less than two years, which corresponds to half the study time for a doctoral student with a 100% study rate.

   The seminar courses referred to here are special courses set up by the school which are part of a series of four consecutive courses and where each course gives 3.0 or 4.0 ECTS credits and extends over approximately one 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 specialized knowledge in one’s own and the broader subject area, as well as provide skills in presentation and critical examination of one's own and others' research results. Seminar courses usually take place twice a month during term time and are led by experienced and actively researching teachers with good knowledge of the research area, research premises, academic authorship, peer review and publishing strategies relevant to the research topic. Motivation for reading these courses for a longer

period of the doctoral program is to achieve progression regarding own writing of scientific manuscripts, presentation of own results and critical examination of others' scientific manuscripts and published articles.

2. Basic higher education pedagogy, minimum 3.0 ECTS credits

   Refers to a third-cycle course in pedagogy established at a Swedish higher education institution with specified learning objectives in the subject higher education pedagogy that are examined, and the grade passed is obtained. For doctoral students who are to teach, a pass grade is required for a higher education pedagogical basic course before teaching begins. Basic higher education pedagogy is also compulsory for doctoral students who are teaching. Examples of courses in basic higher education pedagogy given at KTH are given in Appendix 2.

3. Basic research ethics, minimum 2.0 ECTS credits

   Refers to a third-cycle course in research ethics established at a Swedish higher education institution with specified learning objectives in the subject of research ethics that are examined, and the grade pass is obtained. Examples of courses in basic research ethics given at KTH can be found in Appendix 2.

4. Sustainable development, minimum 3.0 ECTS credits

   Refers to a third-cycle course in sustainable development established at a Swedish higher education institution with specified learning objectives for examination of knowledge and abilities in sustainable development where the grade pass is obtained. KTH's sustainability goals for degrees at the third cycle also require that knowledge and abilities are examined in equality, diversity and equal treatment, as well as society's adaptation to climate change and development towards climate neutrality. To achieve the goal, it is mandatory to participate and be examined in the learning activities that are arranged within the framework of the doctoral program. Examples of courses in sustainable development given at KTH can be found in Appendix 2.

1.4.3 Recommended courses

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

1.4.4 Conditionally elective courses

Non-established courses can be included in a degree at the third cycle. However, all courses and course activities that are not established by a Swedish university must be validated by the program’s program director / director of third-cycle education before these can be included in the individual study plan's course part and 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 can be awarded on only one occasion, provided that it is also included in the course section of the individual study plan.

Online distance courses can be included in the individual study plan provided that the quality can be proven

by the doctoral student and supervisor supported by the documentation required for validation. Scope, level and examination must be substantiated in the manner prescribed by central and local regulations. Any crediting is decided by the director for third-cycle education or program director.

A course that has already been established at the first or second cycle cannot be credited as a course at the third cycle.

1.4.5 Requirements for the degree

Doctoral degree

The doctoral degree comprises 240 ECTS credits. The thesis comprises at least 120 ECTS credits.

Thesis

Quality requirements and any other requirements for the thesis.

Compilation thesis

The dissertation should be based on research results that are of such a quality 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, at least one of which is accepted for publication in journals that apply peer review. However, the number of articles may vary depending on the scope, scientific height, and dignity, as well as the research student's contribution to each work.

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.

In cases where a doctoral thesis is only based 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 dissertation can also be written as a monograph, which is a relatively comprehensive coherent scientific paper. Previous publications can be attached to a monograph as appendices. Monograph theses should be avoided, and decisions to apply this form of thesis are made by person appointed director of third-cycle education. In cases where a monograph is considered applicable, its content must be of such a scientific level that the content in its entirety, or its majority, can be considered to meet the requirements for publication in scientific journals of good international quality that apply peer review.

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

Courses

The doctoral student must complete courses of at least 60 ECTS credits, of which at least 45 ECTS credits must be at the third cycle and a maximum of 10 ECTS credits may be at the first cycle.

From this follows that a maximum of 15 ECTS credits from the second cycle can be included in the doctoral degree, provided that no ECTS credits are included from the first cycle.

Licentiate degree

The licentiate degree comprises 120 ECTS credits. The thesis comprises at least 60 ECTS credits.

Thesis

Quality requirements and any other requirements for the thesis.

Compilation thesis

The thesis should be based on research results that are of such a quality 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 is accepted for publication in a peer-reviewed journal. However, the number of articles may vary depending on the scope, scientific height and dignity, as well as the research student's contribution to each work.

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.

In cases where a licentiate thesis is only based 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 can be attached to a monograph as appendices. Monograph theses should be avoided, and decisions to apply this form of dissertation are made by the person appointed director of third-cycle education. In cases where a monograph is considered applicable, its content must be of such a scientific level that the content in its entirety, or its majority, can be considered to meet the requirements for publication in scientific journals of good international quality that apply peer review.

A monograph thesis must be pre-examined by the main supervisor, a formally appointed advance reviewer, another independent researcher with good knowledge in the research area, and by the person appointed director of third-cycle education.

Courses

The doctoral student must complete courses of at least 30 ECTS credits, of which at least 15 ECTS credits must be at the third cycle and a maximum of 10 ECTS credits may be at the first cycle.

From this follows that a maximum of 15 ECTS credits from the second cycle can be included in the licentiate degree, provided that no ECTS credits are included from the first cycle.

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

Follow-up of individual study plan. It is mandatory for supervisors and doctoral students to jointly follow up the individual study plan regularly and at least once a year. The individual study plan must be designed so that it ensures that the Higher Education Ordinance's degree objectives and KTH's objectives 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 postgraduate students in the compulsory follow-up of the individual study plan. The research 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 research student. All elements in the education, dissertation, courses, workshops, conferences, external activities, etc. shall be taken into account.

Selection of courses and learning activities that are not compulsory takes place according to an agreement between doctoral students and supervisors. During the annual follow-up, planned courses and learning activities are included in the individual study plan for the coming 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 target degree include 48 months of full-time studies (100% activity) if 0% departmental service is included, and 60 months of study (80% activity) with 20% departmental service included. Third-cycle studies with a licentiate degree as a target degree include 24 months of full-time studies (100% activity) if 0% departmental service is included, and 30 months of study (80% activity) if 20% departmental service is included. Estimated time for a half-time seminar for a doctoral degree is 24-30 months. Estimated time for a half-time seminar for the licentiate degree is 12-15 months. The lower- and upper-time limits refer to studies with 0% and 20% departmental service, respectively. Please note that 20% is the maximum allowed percentage of departmental service.

Scientific exchange and communication. Active participation in scientific exchange by presenting own research results at international conferences, major national conferences, workshops, summer schools or gatherings arranged by companies. Active participation here refers 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 aiming for a doctoral degree also present their research results and achieved goals at interim mid-year seminars. Mid-year seminars refer 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 studies. 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 examination goals, be open to at least the own department and end with a short written report according to a template describing the progression of achieved goals to the research education administrator 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 eligibility and other abilities needed to assimilate the education in the relevant subject at the third cycle are set out below.

2.1 Special eligibility

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 takes place according to the assessed ability to assimilate the same. The assessment of the ability takes place mainly on the basis of qualifying education. The following are considered in particular:

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 for written and oral communication

    c. maturity, judgement, and ability for independent critical analysis

    The assessment can, for example, be based on the degree project and a discussion about this in an 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 change to the most recently established and valid general study syllabus. Requests to change to a later study syllabus are made in writing to the director of third-cycle education. A change of general study syllabus, however, presupposes that the requirements in the new study syllabus can be achieved on time.