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## **Graduate School of Science and Technology Self-evaluation report 2015**

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Faculty of Science and Technology  
Aarhus University 2015



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# 1.0 Introduction

## Evaluation of the Graduate Schools of Aarhus University

According to the Ministerial Order no 960 of 14 August 2014 (concerning the Act on Universities) § 14, 5 the Rector and the head of the Graduate School shall initiate an evaluation of the University's Graduate Schools, and follow up on that evaluation.

Aarhus University has initiated evaluations of its four Graduate Schools. Each evaluation will take the form of an international evaluation based on two elements: a self-evaluating report written by the individual school, and a visit to the school by an international assessment committee.

Aarhus University will write up the final evaluation and a plan of how to implement the recommendations of the evaluations.

The reports will be made public on the graduate schools' websites.

### 1.1/ Mergers at Aarhus University

Since 2007 Aarhus University has gone through a process of mergers with a number of other Danish research institutions. These include The National Environmental Research Institute, Faculty of Agricultural Sciences, The Engineering College, Aarhus School of Business and The Danish School of Education. This has broadened the research coverage of Aarhus University substantially and consequently involved a re-organization of the graduate schools. In 2011 8 graduate schools merged into 4 graduate schools: Graduate School, Arts; Graduate School of Science and Technology, Graduate School of Business and Social Science and Graduate School of Health.

Following the mergers, the graduate schools implemented a new IT system, the PhD-planner, which is the basis for collecting a range of data on PhD students, regarding progress, stays abroad, entrance degree, completion time etc. The IT-system was in place in 2012. Therefore the most comprehensive data on the current PhD students are found in 2012 and 2013 and this self-evaluation report will mainly be based on the data from the PhD planner.

In 2013 a quality survey was conducted among all PhD students at Aarhus University (Quality in the PhD process). Where relevant this present report also refers to the survey and to the Employment Analysis 2013 (in Danish: Beskæftigelsesundersøgelsen 2013).

### 1.2/ The quality framework for doctoral Education at Aarhus University

In 2013 Aarhus University developed a quality framework for doctoral education, focusing on four elements:

#### 1) Output

The doctoral education must result in: A high quality thesis, scientific publications, high employment among doctoral candidates and internationally oriented candidates.

## 2) Entry level requirements

PhD stipends will be granted on the basis of open and fair competition. Applications are evaluated by a group of scientists and selected on the basis of the documented qualifications of applicants and a scientific project proposal.

## 3) Input

During the doctoral studies, PhD researchers must receive supervision, participate in high quality courses, participate in scientific environments both at home and abroad, conduct teaching and/or other dissemination activities.

## 4) Organisation of the PhD education at Aarhus University

Aarhus University will ensure that doctoral education takes place in scientific environments of high international standards. PhD students must complete their thesis on time and the progress of their work is monitored, just as the coursework and teaching activities are documented. Aarhus University will strive to organize PhD courses with international partner universities in order to widen the network of PhD students. Aarhus University will evaluate the graduate schools on a regular basis.

These 4 themes in the quality framework are reflected in the structure of this self-evaluation. The organization is described in chapter 2. In chapter 3 entry level requirements are described and figures on applications and applicants' background are presented. In chapters 4 and 5 the inputs regarding supervision, internationalization, course work as well as the monitoring of study progression are presented. In chapters 6-8 the output is described with regards to the PhD thesis, employment levels, and publication statistics for doctoral researchers. Chapter 9 contains a brief conclusion and a list of issues on which Graduate School of Science and Technology in particular would appreciate suggestions and ideas from the external review panel.

The quality framework is found in table format online here: <http://phd.au.dk/international-evaluations-of-graduate-schools/>

The present report concerns the Graduate School of Science and Technology (GSST). The report has been completed in February 2015 by head of PhD school Professor Jes Madsen in cooperation with team leader Bente Lynge Hansen and advisor Ida Marie Gerdes.

In addition to the report and the appendices at the end of the report, a supplement of documents regarding the PhD education at the Graduate School of Science and Technology is made available to the assessment committee. Further information regarding the PhD education at GSST can be found on the website: [phd.au.dk/st](http://phd.au.dk/st)

## 2.0 The Graduate School of Science and Technology

The Graduate School of Science and Technology (GSST) at Aarhus University was formed on 1 October 2011 in a merger of Aarhus Graduate School of Science (AGSoS) and Graduate School of Agriculture, Food and Environment (SAFE). GSST offers PhD studies within a wide range of research areas in science and technology. PhD students at GSST are enrolled in one of the PhD programmes affiliated to the departments and centres at Science and Technology at Aarhus University with research facilities in various locations within Denmark. The GSST secretariat (see section 2.2.5/) is located in Aarhus and Foulum.

The GSST Rules and Regulations that frame the PhD education at GSST have been laid down in accordance with:

- The Ministerial Order no 1039 on the PhD programmes at the Universities and Certain Higher Artistic Educational Institutions<sup>1</sup> (The PhD Order) of 27 August 2013<sup>1</sup>
- The Danish Act on Universities (The University Act)
- The Ministerial Order no 661 of Law on SU (The SU Law) of 29 June 2009
- The Ministerial Order no 1269 on SU (The Order on Danish students' Grants and Loans Scheme) of 17 December 2012
- The Ministerial Order no 653 on SU PhD scholarships of 31 July 1999
- The collective agreement between the Danish Ministry of Finance and the Danish Confederation of Professional Associations

### 2.1/ Programmes

The PhD education at GSST is organized within one of the following 13 different PhD programmes that are associated with the relevant departments or centres at the Faculty of Science and Technology.<sup>2</sup>

- Agroecology
- Animal Science
- Bioscience
- Chemistry
- Computer Science
- Engineering
- Environmental Science
- Food Science
- Geoscience
- Mathematics
- Molecular Biology and Genetics
- Nanoscience
- Physics and Astronomy

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<sup>1</sup> For English version click [here](#)

<sup>2</sup> See appendix 1 for a list of degree titles

## 2.2/ Organisation

### 2.2.1/ The head of the PhD School

The Vice-Dean for Talent Development at the Faculty of Science and Technology is appointed by the Dean and is also head of the PhD school. The head of PhD school is responsible for the organisation of the PhD studies, the admission of PhD students, regular quality assurance evaluations of the PhD education and for the individual PhD study plans. The head of School makes recommendations to the Dean regarding the appraisal of the PhD studies and supervises the implementation of suggested changes, appoints the PhD supervisors, appoints heads and members of the programme committees after consultation with the head of departments, and reports to the Dean on all matters of significance for the PhD students, such as fellowships and scholarships awarded, paid employment, examinations etc.

### 2.2.2/ The PhD committee

The PhD committee at Science and Technology consists of 6 members elected among the permanent academic staff, and 6 members elected among the PhD students. The PhD committee discusses matters related to the PhD studies in general, approves courses, and advises the head of PhD School about the composition of assessment committees and in matters pertaining to supervision and appraisal of the PhD studies.

### 2.2.3/ Programme committees

Each programme has a programme committee composed of members of the permanent academic staff and PhD students. The programme committees discuss matters related to PhD studies at the departmental level and forward their recommendations to the head of PhD School, who holds regular meetings with the heads of the programme committees.

PhD students are excluded from participating in any items on the programme committee agenda that pertain to personal issues, such as the evaluation of incoming applications.

The academic staff members of the programme committees evaluate incoming applications and submit their recommendations to GSST. Their evaluation involves a thorough assessment of each applicant's qualifications, in accordance with the criteria listed in section 3.2/. Academic staff members also participate in connection with qualifying exams and thesis evaluations.

### 2.2.4/ Admissions committee

The GSST admissions committee consists of the head of PhD School and approx. 10 researchers with a broad knowledge of science and technology. Based on input from the programme committees, the admissions committee prepares a list of applicants recommended for admission to GSST. This list is forwarded to the Dean for approval with respect to the amount of funding from the Faculty of Science and Technology.

### 2.2.5/ Administrative secretariat

GSST has administrative support in the GSST secretariat, which is an integrated part of the Aarhus University administration. The GSST Secretariat is responsible for the administration of the PhD education.

### 2.3/ Key figures

Table 1 shows that the number of PhD students in 2012 and 2013 has reached a constant level with approximately 755 enrolled PhD students<sup>3</sup>. GSST anticipates to maintain this level in the coming years. 483 (approx. 64%) of the PhD students are enrolled on the basis of their Master's degree and 273 of the enrolled PhD students are enrolled on the basis of a Bachelor's degree (2013 numbers). This means that 36% of the PhD students start their PhD studies in parallel to their Master's degree programme.

Table 1 Key Figures GSST	2012	2013
Number of PhD students	753	756
Enrolled on the basis of a Bachelor's degree	282	273
Enrolled on the basis of a Master's degree	471	483
Female PhD-students	310	302
Male PhD students	443	454
Non-Danish citizens	301	317
Danish citizens	452	439
Number of conferred PhD degrees	165	181
Age at conferment (median)	30	30

From 2012 -2013 the number of non-Danish PhD students has increased from 301 to 317, hence making up 42% in 2013. This indicates a high level of internationalization at the Graduate School. The increase-ment of enrolled PhD students from 2006 to 2013 has resulted in an increased number of conferred PhD degrees. In 2013 181 PhD degrees were conferred, almost 10 percent more than in 2012.

The number of female PhD students (approx. 40%) varies a lot from programme to programme (see appendix 2 for distribution of gender on the individual PhD programmes). Some programmes have nearly 80% women (e.g. animal science) while others (e.g. computer science and physics and astronomy) have approximately 85% men. While these numbers reflect more general international trends, the skew gender balance may imply that at some point during the education leading to a PhD study talent is lost in some research fields.

### 2.4/ Financing

All PhD students at GSST must have a complete plan for financing the entire PhD study at GSST prior to enrolment. A limited number of students bring their own salary or scholarship. As of August 2014 GSST had 17 PhD students employed in companies enrolled in the Industrial PhD programme, 21 students sponsored via China Scholarship Council and 6 PhD students sponsored by the Brazilian scholarship programme Science without Borders. But in most cases the funding plan is worked out in collaboration between supervisor, department, and GSST. On average, GSST funds around 1/3 and external sources (research councils, companies, private foundations, EU, etc.) around 2/3 of a given stipend. This corresponds to an annual investment of order 100MDKK from GSST and twice that from external sources.

### 2.5/ Conclusion

The organisation of the Graduate School of Science and Technology at Aarhus University secures that both faculty members and PhD students from the scientific environments are involved in matters regarding the PhD education at GSST.

<sup>3</sup> Not including PhD students that have completed their PhD study but not yet defended the thesis.

There are a number of different types of funding with or without contributions from the Faculty of Science and Technology. The total annual investment in scholarships/fellowships is around 300M DKK, out of which 100M DKK is covered by the Faculty and the rest by various external sources.

### 3.0 Criteria for Enrolment and Employment

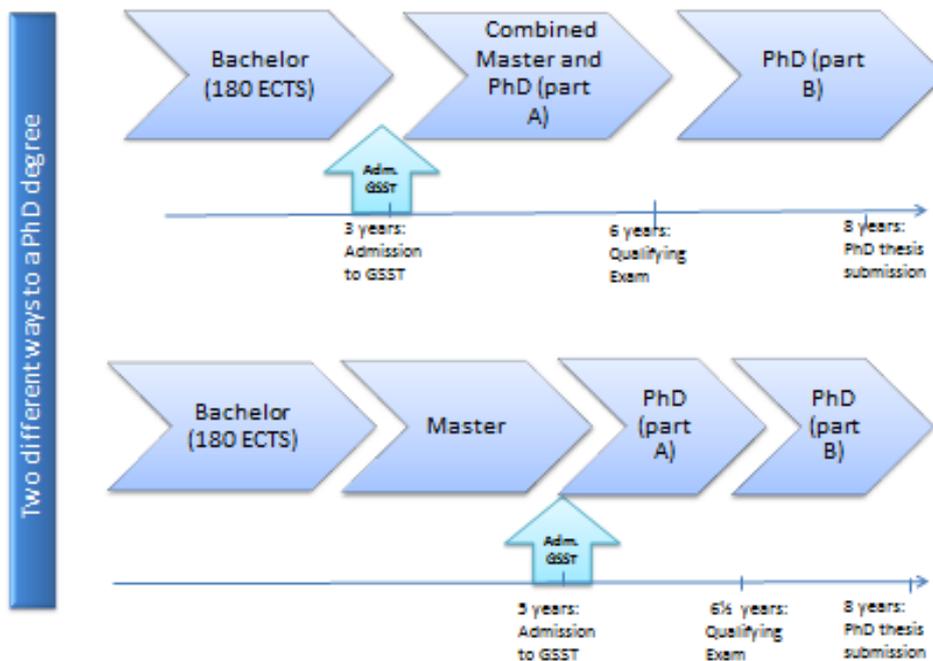
All PhD positions at GSST are open and subject to competition. All positions are advertised online in English both at the website of Aarhus University and at international recruitment websites (e.g. nature-jobs.com) in order to attract talented students from Denmark and abroad. The Faculty of Science and Technology receives approx. 2000 applications from Danish and international applicants per year. Around 200 new PhD students are enrolled every year corresponding to 10 percent successful applications.

#### 3.1/ Entry requirements

In Denmark, and hence also at the Graduate School of Science and Technology, the total time of university studies leading to a PhD degree is 8 years (480 ECTS).

Admission to the PhD studies at the Graduate School is based on either a two year (120 ECTS) Master's degree on top of a three year (180 ECTS) Bachelor's degree, in which case the student is admitted for a PhD study only (the 5+3 model), or a three year (180 ECTS) Bachelor's degree, in which case the student is admitted to a combined Master's programme/PhD study (the 3+5 model). In both cases, a student may be admitted with transfer of credits based on an individual assessment.

Figure 1 shows the two different paths of study to achieving a PhD degree at GSST:



Admission on the basis of a 3-year Bachelor's degree is in a 5-year study programme. If the student does not have a Master's degree prior to admission, the PhD student is also initially admitted for a Master's degree with an individual programme of study designed as an integral part of the first part of the following 5 years of study.

If the PhD student's admission is based on a Master's degree, he or she is admitted for a 3-year PhD programme of studies (180 ECTS credits).

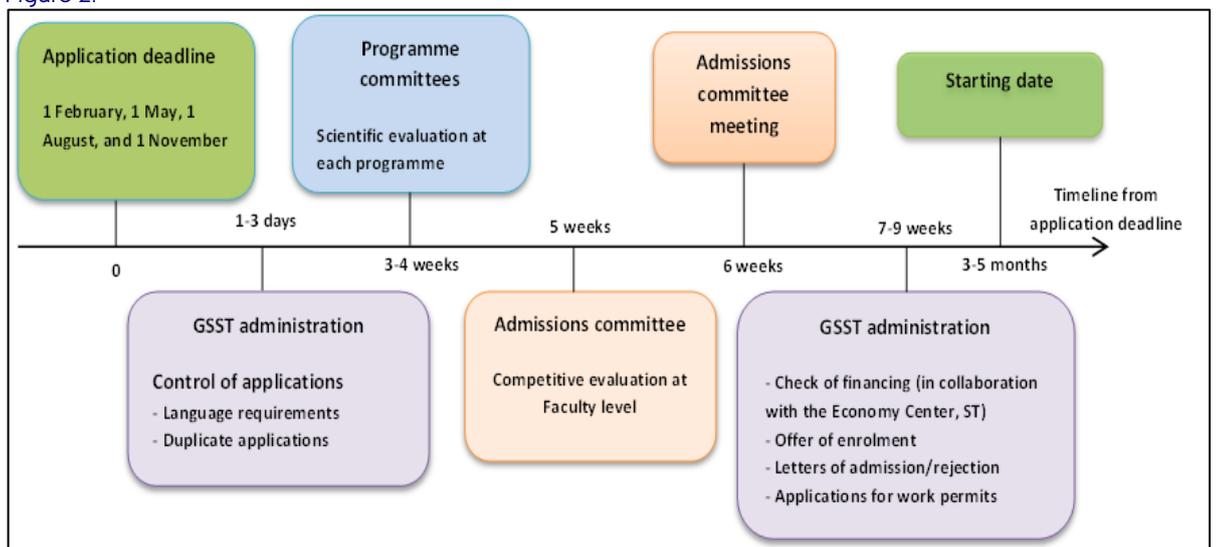
If the PhD student has earned any credits prior to enrolling that exceed the required five/three full years of university study they can be acknowledged and the duration of the PhD study period will be reduced accordingly. The procedure for acknowledgement of credits is part of the admission process. Only documented study activities of academic relevance can be accepted as credits at GSST. For students admitted on the basis of a Bachelor's degree it is also part of the admission procedure that the accepted credits will be part of the credits leading to a Master's degree. All details regarding application details including language requirements can be found in the application guide.

### 3.2/ Academic assessment of the PhD applications

GSST calls for applications four times a year (1 February, 1 May, 1 August and 1 November). Applications may be submitted at any time, but applications are only reviewed following the four annual closing dates for applications. Only applicants who meet all criteria given are taken into consideration.

The main criteria used in evaluating incoming applicants are their documented qualifications (previous course programme, grades, publications, motivation, study periods abroad, duration of study, recommendations, etc.). Other criteria are the scientific quality of the prepared research project for the PhD study and the suitability of the research environment for such a study, including availability of the necessary funding. Additional aspects that can be taken into consideration include previous activities outside the university, plans for mobility during the PhD study period, plans for collaboration with external partners, plans for dissemination activities, etc. When assessing applicants with a Master's degree, more weight is placed on the documented research qualifications than when it comes to applicants at an earlier stage in their career. The programme committees may request further information or invite the applicant to attend an interview. The interview may in some cases be conducted via the internet. Figure 2 shows the workflow of the enrolment process:

Figure 2:



All applications to GSST must be submitted online through the electronic online recruitment system PhD Planner, which is used both for the application process and as an electronic administrative system for enrolled PhD students. The GSST staff controls that only applications that fulfil all formal requirements are forwarded to the respective programme committees for assessment. Based on an assessment of the strengths and weaknesses of the applicants the programme committee must declare the applicant “qualified” or “not qualified” for the PhD study in question. The programme committees send the result of their evaluations to GSST. Based on input from the programme committees, the admissions committee prepares a list of applicants recommended for admission to GSST. The list is forwarded to the Dean for approval with respect to the amount of funding from the Faculty of Science and Technology. When the Dean has approved the list, the head of PhD School admits new PhD students based on the recommendation of the admissions committee. This multiple-step assessment procedure without quotas for the various programmes has proven to be very useful in terms of securing a common high level of student quality across the various disciplines, and therefore also a common understanding of the distribution of available financing from the Faculty for PhD fellow- and -scholarships.

### 3.3/ Number of applicants and enrolments

Table 2 shows application and enrolment numbers from 2013:

Table 2 Applications and enrolment	2013
Applications in total	2.075
Qualified applicants	940
Enrolled	199
Women enrolled	65
Men enrolled	134
Danish citizens	101
Non-Danish citizens	98
Enrolled on the basis of a Bachelor's degree	55

Table 2 shows that nearly 50% of the PhD applicants to GSST in 2013, were assessed qualified and 21% of these applicants were admitted to GSST. This means that approx. 10% of the applicants, who applied in 2013 were admitted to the PhD school. As the table shows 49% of the admitted PhD students in 2013 have non-Danish backgrounds. The distribution of men and women shows that only 33% of the admitted PhD students in 2013 are women. In 2013, more than 80% of the qualified applicants were non-Danish citizens. Many of these applied for predefined project positions with funding for only one applicant, whereas a larger fraction of Danish applicants applied on the basis of projects formulated after discussions with potential supervisors, who also provided the main part of the funding. This partly explains the somewhat higher success rate for Danish applicants. In addition to the 98 international students enrolled, 22 out of 29 students declining an offer of admission were non-Danish citizens.

### 3.4/ Conclusion

In order to recruit the most talented PhD students GSST has an open recruitment procedure in which all PhD positions are announced both nationally and internationally. The criteria are well defined both for applicants for the 3+5 model and applicants for the 5+3 model. All applications are first evaluated by scientific programme committees in order to secure a fair and impartial evaluation and then by the central

admissions committee in order to secure that GSST enrolls the best candidates among all the qualified applicants.

GSST attracts PhD students both nationally and internationally and almost half of the applicants admitted in 2013 were non-Danish citizens (see section 5.0).

## 4.0 Progress Management and Quality Assurance of the Individual PhD study

The aim of the Graduate School is to meet the demand for highly qualified researchers to undertake research, development and teaching assignments in the private and public sectors. In accordance with the Qualifications Framework for Danish Higher Education, the PhD degree is awarded to PhD students who:

- Possess knowledge at the highest international level within the research field
- Have made a significant contribution to the development of new knowledge and understanding within the research field based on scientific studies
- Master the scientific methodologies and tools as well as master other skills related to research and development tasks within the field
- Are able to analyse, evaluate and develop new ideas, including design and develop new techniques and skills within the subject area
- Are able to participate in international discussions within the subject area and disseminate scientific findings and progress to a wide audience
- Are able to plan and carry out research and development tasks in complex and unpredictable contexts
- Are able to independently initiate and participate in national and international collaboration on research and development with scientific integrity
- Are able to independently initiate research and development projects and, through these, generate new knowledge and new skills which develop the research field.

Detailed monitoring of the PhD study is necessary since PhD study time is limited and there are (compared to many other countries) many compulsory elements in the Danish PhD Order besides research work, e.g. work in other research environments, 30 ECTS of course work, as well as dissemination requirements. Students employed in a PhD fellowship are required to work 280 hours per year, typically as teaching assistant or similar tasks (see section 4.5/).

### 4.1/ PhD plan

According to the PhD Order § 9 all PhD students must have individual plans for the PhD study, and the plan must be approved by the institution within the first three months of the PhD study.

The PhD plan provides an outline of the complete PhD study, including a plan for the PhD student's research project but also a description of plans for course work, mobility, dissemination etc. The PhD plan is a mutual agreement between the PhD student and the main supervisor on a work schedule for the entire PhD study. The plan ensures that successful completion will meet the formal requirements of the PhD regulations.

The PhD plan consists of the following elements:

- The PhD project – description, plan and time schedule

- Publication strategy and progress
- PhD courses plan and status
- Dissemination activities e.g. teaching, supervising Bachelors/Master projects
- A plan for visiting other Research environments (mobility). This is typically plans for stay abroad
- Other activities (if relevant)
- Supervision agreement
- Financing plan (uploaded by GSST at the beginning of the PhD study)
- Copyright/intellectual property right agreement (IPR) (if relevant)

The PhD plan can be altered during the PhD study for various reasons and is subject to mandatory half-year evaluations, where any alterations in the PhD plan will be made. The registration and approval of both the initial PhD plan and the half-year evaluations take place in the online PhD planner system. Both are initiated by the PhD student and must subsequently be approved by main supervisor, head of programme and head of PhD School. Regular revisions of the PhD plan are mandatory according to the PhD order and GSST's Rules and regulations, and these revisions are documented in the online PhD Planner system. An updated PhD plan helps to keep track of changes and progress of the PhD study and is a part of the quality assurance of the individual PhD study.

#### **4.2/ Half year evaluations and qualifying examination**

In order to ensure the quality of every individual PhD study at GSST, all PhD plans are evaluated twice a year. One of the main purposes of half-year evaluations of the PhD plan is to ensure alignment of expectations between the PhD student and the supervisor(s) and should be the basis for a structured dialogue between the PhD student and the supervisor(s), where status of the relevant subjects in the plan is discussed.

In spite of significant technical problems with the online PhD planner system in its early implementation phase almost all students and supervisors now use the system as required. According to the 2013-survey *Quality in the PhD process* only 44% of the PhD students (with large variations between the programmes) used the half year evaluations in the PhD planner to take stock of the PhD process. During 2014 the head of PhD School has had meetings with all local PhD programme committees at GSST and has stressed the importance of using the PhD Planner system more actively in order to be able to quality assure the individual PhD plans. Also, as from 2014 the planner system sends automatic alerts and reminders to students to remind them of the half year evaluations. If the student does not react to the automatic reminders, they will receive individual reminder mails from the administration and eventually warnings of a three months trial period cf. GSST rules and regulations section 6.2.

##### **4.2.1/ Positive half year evaluation**

In case of a positive half year evaluation, the PhD student's study continues, possibly based on a revised PhD plan.

#### 4.2.2/ Negative half year evaluation

In case of a negative outcome, the PhD student will be given a period of three months to correct it. The chance to get back on track and be given a three months' trial period can be granted only once during the entire PhD study

#### 4.2.3/ Qualifying examination

As part of ensuring the quality of the PhD education at GSST all PhD students must pass a qualifying examination half way through the PhD study. The qualifying examination concludes Part A of the PhD studies. The PhD student must pass the qualifying examination to continue his or her PhD studies in Part B.

Through a progress report and an oral examination, the PhD student must demonstrate solid progress on the research project, present an ambitious and realistic plan for Part B of the PhD studies and show an ability to communicate scientific work.

At the same time, the qualifying examination also serves the following purposes:

- To ensure that the PhD project and study are on the right track
- To train written and oral presentation of the research project
- To discuss and validate plans for the rest of the study period
- To obtain feedback and suggestions from internal and external researchers
- To obtain a Master's degree if the PhD student was enrolled without such a degree.

The progress report is a max. 30 page document written by the PhD student with a detailed account of the status of the supervised research project and a discussion of the research plans for Part B.

Immediately after admission to Part B, the PhD student discusses the remainder of the PhD study with his or her supervisor(s). Based on this and on the feedback the PhD student will have received during the qualifying examination, the PhD student must update the online PhD plan. This is done in connection with the following half year evaluation. Failing to pass the qualifying examination corresponds to a negative half year evaluation and therefore the PhD student will be offered a three months trial period with a re-examination. The total time of study will not be extended.

### 4.3/ Courses and Quality Assurance of PhD Courses

The PhD plan must include a plan for the required coursework, which must be approved by the main supervisor and the head of programme. The total PhD course requirements are approx. 30 ECTS credits of which normally not more than 10 ECTS are used for transferable skills courses. The scientific PhD courses ensure that the PhD student receives the necessary theoretical and specialised training within his or her field. The PhD student can choose from the selection of advanced courses available within his or her field of research, as well as courses with a wider scope. Courses can be taken at institutions in Denmark or abroad.

The scientific PhD courses are planned and carried out by the individual PhD programmes at Science and Technology while the transferable skills courses for PhDs are offered by GSST. The portfolio and contents of the transferable skills courses are all approved by the PhD committee. All courses offered by GSST are evaluated by the participants.

#### 4.3.1/ Scientific courses

The *Quality in the PhD Process*-survey shows that at GSST (in total) 68% of the respondents think that the selection of PhD courses give him or her the possibility of strengthening his or her general research qualifications. Only 47% of the respondents think that the selection of PhD courses gives the PhD student the possibility to strengthen the research qualifications within the framework of the project. The apparent lack

of specialized courses is a focus point for GSST and there is an ongoing dialogue between the departments and GSST concerning the issue of how to offer adequate and relevant PhD courses in addition to further strengthening the use of national and international courses, summerschools etc. A main challenge is the high cost per student ECTS in subfields with a relatively small number of students. It has therefore been decided to allocate funding from GSST to PhD course development at the department level.

#### 4.3.2/ Transferable skills courses

In 2013 GSST offered 24 transferable skills courses, of these 22 were completed (see table 3). The courses took place at different locations in Denmark, mainly in Aarhus. The language of instruction was English with the exemption of the course "Research Dissemination". In comparison 16 transferable skills courses were offered in 2012 of which 14 were completed.

Table 3 Transferable skills courses for PhD-students 2013	ECTS	No. of courses
Academic English - Danish speakers	3	2
Academic English - non-Danish speakers	3	2
Scientific Writing and Communication	3	2
Research dissemination (in Danish)	5	1
Science Teaching 1 - introduction to science teaching	3	3
Science Teaching 2a - instruction	2	2
Science Teaching 2b - lab teaching	2	1
Science Teaching 2c - in an outreach context	2	1
Project Management	5	1
Short introduction to responsible conduct of science and scientific misconduct	0	1
Scientific Practice	1-2	1
Introduction to R	1	2
Basic Statistical Modeling in Life and Environmental Sciences	4	2
The world of research	1-2	1

#### 4.4/ Research environment change

Completing a PhD degree in Science and Technology from Aarhus University typically requires that most of the PhD study takes place at the university. PhD students who are not part of a joint or double degree arrangement are encouraged to go abroad for a period of up till one year (typically 3-6 months). Extended visits to collaborating research groups at other institutions or companies are an important part of the GSST PhD study, and therefore such visits are recommended. 60% of the PhD students enrolled in 2013 have registered<sup>4</sup> one or more research environment changes during their PhD studies. These registrations may cover a wide range of stays abroad from attending international conferences to longer stays at other research institutions for up till one year. Some students, in particular those with family obligations, find it difficult to change research environment for an extended period during their studies.

#### 4.5/ Teaching and dissemination activities

The PhD plan must include a plan concerning the kind and extent of dissemination activities that the PhD student provides during the PhD study period. This may for example include:

<sup>4</sup> in the PhD planner system

- Teaching
- Preparing courses
- Assisting students with lab work or exercises
- Co-supervision of Bachelor students/Master students/group work
- Public lectures
- Writing articles for newspapers
- Creating web pages, book chapters or manuals communicating disciplinary material
- Activities involving high school students
- Presentation of research results to companies

By having a broad range of possibilities for dissemination activities GSST ensures that the PhD students get experience within these kinds of activities. The 2013 survey *Quality in the PhD Process* shows that 83% (GSST total) of the PhD students think that the work he or she does beyond his or her own project (e.g. various department work including teaching) has been useful. However 63% (GSST total) think that the work he or she does beyond his or her own project is of such a magnitude that it affects his or her project. This is not surprising, since students on fellowships according to the Collective Agreement with the trade unions are required to work 280 hours per year for the university, unless they actively decline this (with a corresponding decrease in salary). Thus up to 6 months out of 3 years is allocated to this work. In view of the limited time available for research work, GSST administers these rules flexibly, e.g. by allowing all students one semester free without salary reduction, plus up to one semester free in connection with extended research stays abroad.

#### 4.6/ Supervision

On admission, the head of PhD School appoints the supervisor(s) for each PhD student based on the recommendations of the programme committee. The main supervisor has the overall responsibility for the PhD student's project and PhD studies. At GSST this includes:

- To ensure compliance with all formalities relating to the PhD study as described in the PhD Order, the GSST rules and regulations and any local programme and department rules
- To discuss and review the PhD plan together with the PhD student
- To offer regular and thorough supervision to the PhD student
- To make sure that the PhD student is included in the scientific environment and is integrated in the daily workflows
- To introduce the PhD student to the academic Code of Conduct
- To notify the head of programme as soon as possible if any doubt emerges concerning the PhD student's ability to complete the PhD study
- To introduce the PhD student to active (foreign) research networks
- To advise the PhD student on how the dissemination elements can be included in the course of studies
- To ensure that the PhD student composes a relevant course plan
- To review and comment on the PhD project including the progress report and the PhD thesis
- To review and discuss the half year evaluations in collaboration with the PhD student
- To plan the qualifying examination together with the programme committee
- To write the main supervisor statement and submit it to GSST no later than one week after the PhD student submits the PhD thesis (preferably before)
- To propose external members of the assessment committee in connection with the PhD defence no later than two weeks before the PhD student submits the PhD thesis.

The 2013 survey *Quality in the PhD Process* shows that 79% of the PhD students warmly can recommend his or her main supervisor. 43% of the PhD students experience that his or her supervisor asks him or her

about his or her needs and expectations regarding supervision, 11% sometimes feel that their supervisor sees him or her as a source of labour to advance the supervisor's research.

GSST offers courses for PhD supervisors. The aim is to expand the supervisors' strategies and methods in supervision. In 2013 there were three courses for supervisors of which two were taught in Danish and one in English. A revised concept for supervisor courses has been developed in 2014 resulting in new 2-day courses for supervisors held in the autumn of 2014 at three different locations and all taught in English.

In 2014 the head of the PhD school has held meetings with the PhD committee, the programme chair committee and the local programme committees where one of the focus points has been initiatives that ensure alignment of expectations of the supervisor and the PhD students. This is also discussed during the compulsory introduction day for new PhD students held every three months.

#### **4.7/ Effective study time and drop out rates**

Most of the PhD students at GSST complete their PhD study within the standard time limit. For PhD students following the 3+5 model the average effective study time is 5.1 years, for PhD students following the 4+4 model the average effective study time is 4.1 years and for PhD students following the 5+3 model the average effective study time is 3.2 years (see appendix 3).

The drop-out rate has been relatively stable since 2008 (see appendix 6). Approximately 10% of the admitted PhD students end their PhD study without completing it. GSST urges all programmes to improve the matching of expectations between the PhD student and the supervisor as one of the tools to lower the drop-out rate.

## 5.0 Internationalisation of the PhD education

GSST wishes to attract the best talents from all over the world and to offer an international research environment to all PhD students enrolled at GSST.

### 5.1/ Recruitment of international PhD students

Approximately 44% of the enrolled PhD students at GSST are non-Danish citizens and as mentioned in table 2 above, nearly 50% of the PhD students admitted in 2013 are from abroad. Most of the international candidates are enrolled on the basis of a Masters degree.

GSST tries to recruit new international PhD students through existing research networks, among international Bachelor and Master students at Aarhus University, by participating at Career fairs (for instance in China) and by advertising open positions online (see page10).

Table 4 shows the nationalities of the PhD students at GSST (*Data: PhD planner August 2014*):

Table 4 Nationality of PhD students	5+3	3+5	In total
Denmark	211	260	471
China	64	11	75
Germany	26	2	28
Italy	25	2	27
Poland	20	0	20
Iran	19	0	19
India	14	2	16
Nepal	12	0	12
Spain	7	5	12
Brazil	6	2	8
Ethiopia	6	0	6
France	6	0	6
Netherlands	5	1	6
Portugal	6	0	6
Other countries (No. of students ≤ 5)	99	16	115
In total	526	301	827

GSST has PhD students from all over the world, both Western and non-Western countries, representing 68 different nationalities. Nearly 9% of the PhD students at GSST are from China. Other Asian countries are represented as well, such as Iran and India. GSST has 6 or more PhD students from a lot of other European countries such as Germany, Italy, Poland, Spain, France, Netherland and Portugal. The table also shows that most of the international PhD students at GSST are admitted on the basis of a Masters degree and that only few international students are admitted on the basis of a Bachelors degree. In appendix 5 the

distribution of nationalities on the individual programmes shows that even on the programmes with a low number of PhD students many different nationalities are represented and indicates a very international research environment.

## **5.2/ Mobility enhancing efforts at the Graduate School**

One of the ways of ensuring that the academic and scientific level of international PhD students at GSST stays high, GSST has introduced two different internationalisation grants with 6 application deadlines a year: A) Recruitment of foreign research talents for PhD studies at GSST (screening grant); B) A stay at GSST for PhD students enrolled at a foreign university (visiting grants).

Screening grants can be used by the academic staff to invite foreign, potential PhD students (from outside Denmark) to stay at Aarhus University for a period of up to 3 months. The purpose of the stay is to establish the qualifications and the potential of the student as a GSST PhD student. In case of a positive outcome, the intention is to write jointly with the student an application for admission to GSST.

Visiting grants are aimed to strengthen the internationalisation of the PhD education at GSST by providing foreign PhD students with the opportunity of taking a part of their PhD study at GSST. For a period of maximum three months, the PhD student can take part in research collaboration, PhD courses, summer schools, workshops and laboratory work and/or work on his or her PhD thesis. The student must be enrolled for a PhD study at a foreign university.

### **5.2.1/ Joint and double degree**

The four graduate schools at AU are currently collaborating on making common guidelines to facilitate agreements on double and joint degrees.

At the moment GSST has 25 PhD students enrolled in a double or joint degree programme, some agreements based on individual projects, others on more formal collaborations with e.g. Wageningen University, China Agricultural University, University of Edinburgh, and University of York. This type of collaboration is expected to be further developed in the coming years.

## **5.3/ Conclusion**

The PhD education at GSST takes place in a highly international research environment. Significant efforts are made to recruit talented international students as well as to encourage PhD students to go abroad for extended periods during their studies. Challenges remain in recruiting students from top universities in some countries, and the number of PhD students from abroad who are admitted on the basis of a Bachelors degree only is low compared to the number of Danish PhD students admitted on the same basis

## 6.0 PhD Thesis: Procedure and Assessment Criteria

According to the PhD order the PhD thesis must document the author's ability to apply relevant research methods and to conduct research work meeting the international standards for PhD degrees within the field in question.

According to the PhD planner system a total of 348 theses were submitted to the Faculty of Science and Technology in 2012 and 2013. Of these 96.8 % were given a positive evaluation from the assessment committee and were successively recommended to the Academic Council for a doctoral degree. 3.2 % (11 theses) were given a negative evaluation by the assessment committee which resulted in a revision of the thesis. Of the 11 PhD students with a negative evaluation of their thesis, nine have subsequently defended their revised thesis with success. Contrary to the situation in some other countries, it is not common practice in Denmark to send the thesis back to the student for minor revisions, but only if major revision is required

The PhD thesis presents the results of the PhD project and documents the PhD student's ability to communicate theoretical and/or experimental skills. The PhD thesis must document the research conducted by the PhD student alone or in collaboration with co-workers. The PhD thesis may include a number of manuscripts in different stages of completion that are related to the topic of the PhD project.

When the PhD thesis is submitted an expert assessment committee consisting of three experts is appointed, based on a recommendation from the respective PhD programme. The members shall be recognised experts within the relevant scientific area. Two of the members shall be external, and at least one member shall be from outside Denmark. An analysis of the appointed assessment committees in 2013 shows that all of the 219 assessment committees fulfilled these requirements. In 2013 the committee members came from 28 different countries. The third member must in general be a member of the respective GSST programme committee, and he or she acts as chairman of the assessment committee. The PhD student's supervisors shall not be members of the committee - the main supervisor, however, assists the committee.

In order to ensure the impartiality of the assessment committee members, GSST requires that the members must not have prepared, submitted or published any publications with the PhD student. Neither may they have any publications under preparation together. External members of assessment committees may not have prepared, submitted or published any publications with main supervisor or co-supervisor(s) within the past 5 years.

The recommendation must be an impartial and critical evaluation of the thesis in accordance with good scientific practice. The recommendation must include a brief review of the individual sections of the PhD thesis and an overall assessment underlining the most significant results. In case of disagreement amongst the committee members, simple majority prevails.

If the assessment committee has deemed the PhD thesis eligible for defence, GSST informs the PhD student of the decision and sends a copy of the Recommendation. To deem a thesis ineligible the members of the assessment committee must reach either unanimous or majority-voted agreement.. Based on this agreement and comments from student and main supervisor, the head of PhD School decides whether the PhD thesis should be rejected for defence or allowed to be revised and resubmitted within a deadline of at least three months.

### **6.1/ Defence**

The chair of the assessment committee presides at the PhD defence procedure. The public PhD defence procedure starts with the PhD student's presentation of the results of the PhD project. The members of the assessment committee then discuss the presentation and the thesis with the PhD student. Immediately following the defence, the assessment committee submits its Final recommendation based on the public defence and on the previous evaluation of the thesis of whether the PhD student should be awarded the PhD degree. The recommendation shall be reasoned, and in the event of disagreement, the majority shall prevail.

### **6.2/ Conclusion**

By having recognised experts both from Denmark and from abroad in the assessment committees GSST strives to appoint assessment committees that can assess whether the theses fulfil the requirements and meet the international standards for PhD degrees within the field in question. By having strict rules of impartiality GSST ensures the objectivity of the assessment committee members. The high percentage of theses given a positive evaluation from the assessment committee hence indicates a high quality of the submitted theses.

## 7.0 Employability of the PhD candidates

All PhD students at GSST must be ensured a PhD education that prepares them for a career either in the public or private sector. As the number of graduated PhD students has increased significantly over the last five years it is clear that only a small fraction will or can follow a career within academia. Therefore it is important for GSST that it is possible for the PhD students to prepare for careers inside as well as outside academia.

The Employment Analysis accounts for the general rate of employment and shows that the employability of PhDs from GSST is generally very high, and higher than for candidates with a Master's degree. 98 percent of the PhD students graduated in 2008/2009 were in employment in 2013 according to the Employment Analysis. Only 85 percent of the PhDs graduated in 2012/2013 were employed at the specific time of the analysis (2013), though a larger fraction had been employed and/or were moving between positions.

The analysis also shows that PhDs from Aarhus University in general find employment soon after graduation as 98 percent have found a job within six months after graduation. The main occupational sector is the public sector. 49% of the employed PhD candidates from Science and Technology who graduated in 2008/09 were employed in the public sector while 43% were employed in the private sector. For the PhD candidates from Science and Technology in employment, who graduated in 2012/13, 72% were employed in the public sector while 24 were employed in the private sector. 90 percent reply that they are employed within research and development (both private and public sector).

Almost one out of four of the respondents from ST are employed outside Denmark according to the analysis<sup>5</sup>, indicating that PhDs from GSST are attractive at the international job market. A common career path is going from PhD to postdoc employment (often abroad) before taking up a job in the private sector.

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<sup>5</sup> It is noted in the employment analysis that this number most likely is understated as there have been difficulties in obtaining addresses for some of the PhDs abroad.

## 8.0 Bibliometrics

The theses are made public prior to the defence and are available for reading at the Graduate School of Science and Technology. All defences are public as required according to the PhD order § 19. The defences are announced at the GSST website as well as in relevant newspapers.

The PhD thesis must among other things document the author's ability to conduct research work meeting the international standards for PhD degrees within the field in question. This implies that the thesis should include published or at least publishable material, and while no strict quantitative requirement is imposed, a typical PhD thesis at GSST does include several published or submitted manuscripts.

Data on the publication activities of GSST PhD students has been extracted for the system used by Aarhus University to register publication and research activities (PURE). The data is not accurate due to different factors: The data is partly based on individual registrations in PURE. Also, the publications of a PhD-student are often prepared during the PhD study period but published after graduation making the data in PURE inaccurate.

Table 5 illustrates the number of published and accepted articles and other publications made in the period 2009-2013 by the 199 PhD students who graduated in 2013.

Table 5	Publications
Contribution to journals	726
Contribution to book/thesis/report	389
Conference contribution	431
Working papers	15
Other contributions	17
Total	1578

The data shows that the PhD students both contribute to writing articles for journals and to a large extent also make contributions to conferences.

The average number of publications is almost 8 (including the PhD thesis) but with large variations across the disciplines.

## 9.0 Conclusion and Questions

As implied above and as demonstrated also through the survey Quality in the PhD process in 2013, the PhD education within the framework of GSST is generally quite successful. However several issues have been identified where there is room for improvement.

GSST would appreciate advice from the panel on all matters concerning the PhD education. In particular we would appreciate input on the following:

1. How to secure that more Danish top talented students are recruited to a PhD study at GSST?
2. How to recruit more talented students from top universities currently underrepresented at GSST?
3. How to improve recruitment of bright international students immediately after they obtain their Bachelor's degree?
4. How to expand the portfolio of project-relevant PhD-courses in a cost-effective manner in fields with a limited number of students?
5. How to ensure the possibility for PhD students with eg. family obligations to go on extended re-search visits abroad?
6. How to improve the gender balance in fields where there is currently an imbalance?
7. How to better engage international students in teaching activities, given that most introductory courses are taught in Danish?
8. How to increase the number of Industrial PhD projects?
9. How to further reduce the drop-out rate?
10. How to further improve the employability and competences of the PhD candidates following a career outside academia?
11. How to further improve the supervision of PhD students?

# 10.0 Appendices

## 10.1/ Appendix 1: Degree titles

GSST confers degrees in:

<b>Agroecology:</b> <ul style="list-style-type: none"><li>• Agroecology</li><li>• Plant Science</li><li>• Soil Science</li></ul>	<b>Animal Science:</b> <ul style="list-style-type: none"><li>• Animal Science</li></ul>	<b>Bioscience:</b> <ul style="list-style-type: none"><li>• Bioscience</li></ul>	<b>Chemistry:</b> <ul style="list-style-type: none"><li>• Chemistry</li></ul>
<b>Computer Science:</b> <ul style="list-style-type: none"><li>• Computer Science</li><li>• Bioinformatics</li></ul>	<b>Geoscience:</b> <ul style="list-style-type: none"><li>• Geoscience</li></ul>	<b>Engineering:</b> <ul style="list-style-type: none"><li>• Engineering</li></ul>	<b>Environmental Science:</b> <ul style="list-style-type: none"><li>• Environmental science</li></ul>
<b>Food Science:</b> <ul style="list-style-type: none"><li>• Food Science</li><li>• Horticulture</li></ul>	<b>Mathematics:</b> <ul style="list-style-type: none"><li>• Mathematics</li><li>• Science Studies</li></ul>	<b>Molecular Biology and Genetics:</b> <ul style="list-style-type: none"><li>• Molecular Biology</li><li>• Genetics</li><li>• Molecular Medicine</li></ul>	<b>Nanoscience:</b> <ul style="list-style-type: none"><li>• Nanoscience</li></ul>
<b>Physics and Astronomy:</b> <ul style="list-style-type: none"><li>• Physics</li><li>• Astronomy</li><li>• Science Education</li></ul>			

Programme - gender distribution	No. of PhDstudents	Percentage
<b>Agroecology</b>	<b>70</b>	
Female	29	41%
Male	41	59%
<b>Animal Science</b>	<b>41</b>	
Female	32	78%
Male	9	22%
<b>Bioscience</b>	<b>96</b>	
Female	48	50%
Male	48	50%
<b>Chemistry</b>	<b>57</b>	
Female	21	37%
Male	36	63%
<b>Computer Science</b>	<b>65</b>	
Female	10	15%
Male	55	85%
<b>Engineering</b>	<b>64</b>	
Female	15	23%
Male	49	77%
<b>Environmental Science</b>	<b>11</b>	
Female	8	73%
Male	3	27%
<b>Food Science</b>	<b>26</b>	
Female	10	38%
Male	16	62%
<b>Geoscience</b>	<b>25</b>	
Female	11	44%
Male	14	56%
<b>Mathematics</b>	<b>34</b>	
Female	7	21%
Male	27	79%
<b>Molecular Biology and Genetics</b>	<b>112</b>	
Female	55	49%
Male	57	51%
<b>Nanoscience</b>	<b>156</b>	
Female	64	41%
Male	92	59%
<b>Physics and Astronomy</b>	<b>71</b>	
Female	11	15%
Male	60	85%
<b>All active PhD students in 2014</b>	<b>828</b>	

## 10.3/ Appendix 3: Effective study time:

Effective study time, ST, 2013 (in years per PhD study programme)	
<b>Agroecology</b>	
5+3	3,0
<b>Animal Science</b>	
5+3	3,3
<b>Bioscience</b>	
3+5	5,1
4+4	4,0
5+3	3,2
<b>Chemistry</b>	
3+5	5,1
4+4	4,1
5+3	3,0
<b>Computer Science</b>	
3+5	5,1
4+4	4,1
5+3	3,2
<b>Engineering</b>	
4+4	4,1
5+3	3,3
<b>Food Science</b>	
5+3	3,3
<b>Geoscience</b>	
4+4	4,2
5+3	3,0
<b>Mathematics</b>	
4+4	4,0
5+3	3,2
<b>Molecular Biology and Genetics</b>	
4+4	4,2
5+3	3,3
<b>Physics and Astronomy</b>	
4+4	4,0
5+3	3,1
<b>iNANO</b>	
3+5	5,1
4+4	3,9
5+3	3,2
<b>ST average effective study time<sup>6</sup></b>	
3+5	5,1
4+4	4,1
5+3	3,2

<sup>6</sup> Covering the effective study time, from enrolment to the PhD student hands in the thesis (not including leaves).

10.4/ Appendix 4: Distribution of PhD students by programme (Danish/non-Danish)

Programme	No. of PhD students	PhD students with Danish citizenship	Percentage Danish citizens	No. of different nationalities
Agroecology	70	20	29%	22
Animal Science	41	29	71%	10
Bioscience	95	43	45%	28
Chemistry	57	49	86%	8
Computer Science	65	37	57%	16
Engineering	64	39	61%	14
Environmental Science	11	5	45%	6
Food Science	26	12	46%	11
Geoscience	25	17	68%	8
Mathematics	34	26	76%	5
Molecular Biology and Genetics	112	47	42%	27
Nanoscience	156	96	62%	22
Physics and Astronomy	71	51	72%	16
<b>Grand Total</b>	<b>827</b>	<b>471</b>	<b>57%</b>	

10.5/ Appendix 5: Overall distribution of PhD students (Danish/non-Danish)

Programme	No of PhDstudents	Overall distribution	PhD students with Danish citizenship	Distribution of Danish citizens
<b>Agroecology</b>	<b>70</b>		20	
3 year programme	63	90%	16	80%
5 year programme	7	10%	4	20%
<b>Animal Science</b>	<b>41</b>		29	
3 year programme	39	95%	27	93%
5 year programme	2	5%	2	7%
<b>Bioscience</b>	<b>95</b>		43	
3 year programme	70	74%	23	53%
5 year programme	25	26%	20	47%
<b>Chemistry</b>	<b>57</b>		49	
3 year programme	18	32%	12	24%
5 year programme	39	68%	37	76%
<b>Computer Science</b>	<b>65</b>		37	
3 year programme	34	52%	13	35%
5 year programme	31	48%	24	65%
<b>Engineering</b>	<b>64</b>		39	
3 year programme	54	84%	32	82%
5 year programme	10	16%	7	18%
<b>Environmental Science</b>	<b>11</b>		5	
3 year programme	11	100%	5	100%
<b>Food Science</b>	<b>26</b>		12	
3 year programme	25	96%	11	92%
5 year programme	1	4%	2	17%
<b>Geoscience</b>	<b>25</b>		17	
3 year programme	12	48%	5	29%
5 year programme	13	52%	12	71%
<b>Mathematics</b>	<b>34</b>		26	
3 year programme	9	26%	1	4%
5 year programme	25	74%	25	96%
<b>Molecular Biology and Genetics</b>	<b>112</b>		47	
3 year programme	79	71%	22	47%
5 year programme	33	29%	25	53%
<b>Nanoscience</b>	<b>156</b>		96	
3 year programme	82	53%	31	32%
5 year programme	74	47%	65	68%
<b>Physics and Astronomy</b>	<b>71</b>		51	
3 year programme	30	42%	13	25%
5 year programme	41	58%	38	75%
<b>Grand Total</b>	<b>827</b>			

## 10.6/ Appendix 6: PhD completion and drop-out rates

Completion and drop-out rates calculated for students admitted in the PhD programs at Aarhus University in the calendar year

Status as of 31 December 2013 (Aarhus University key figures)

COMPLETION AND DROP-OUT	2005	2006	2007	2008	2009	2010	2011	2012	2013
Science and Technology									
Number of admitted PhD students in the year	83	99	154	210	196	227	234	202	203
Hereof completed by 31.12-2013	70	91	145	180	154	47	5	0	0
Hereof active by 31.12-2013	0	0	1	5	21	119	210	191	195
Hereof not completed by 31.12-2013	13	8	7	21	16	19	6	8	2

### Definitions:

<b>Admitted</b>	Number of PhD students admitted in one year. The number for 2013 differs from the number given in Table 2. The small difference is due to differences in definitions of PhD students admitted in one calendar year with starting date in the following calendar year.
<b>Completed</b>	Number of PhD students who at the date of status successfully has completed the PhD defence.
<b>Active</b>	Number of PhD students who at the date of status are registered as active. Both PhD students who are active within the period of enrolment and PhD students who are active after the period of enrolment.
<b>Not completed (drop-out)</b>	Number of PhD students who at the date of status are registered neither "active" nor "completed". This refers to students whose PhD program is registered "ended" on the date of status on the initiative of either the PhD student or the PhD school without awarding of the PhD degree.