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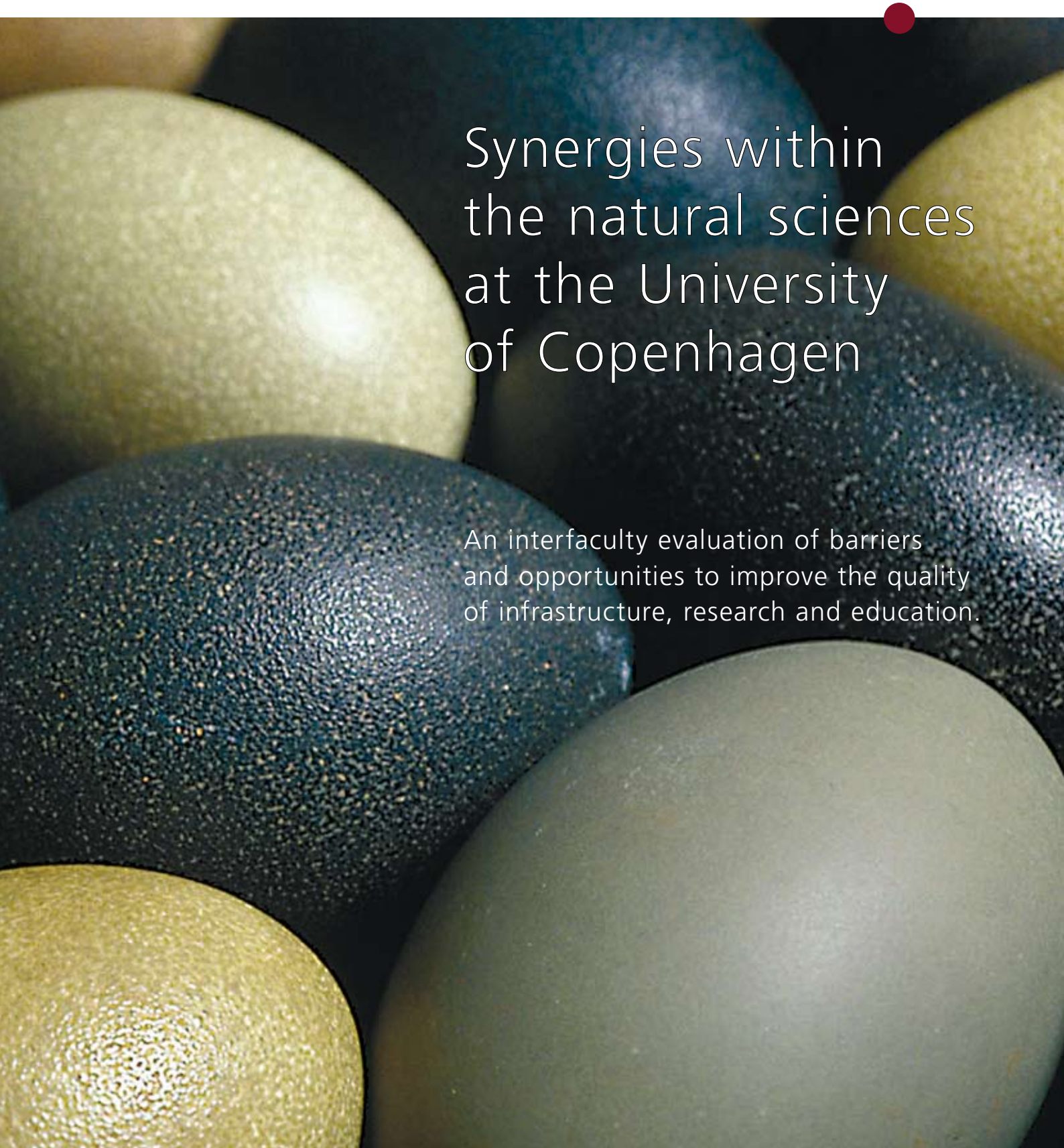

Synergies within the natural sciences at the University of Copenhagen

An interfaculty evaluation of barriers and opportunities to improve the quality of infrastructure, research and education.

FACULTY OF PHARMACEUTICAL SCIENCES
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FACULTY OF LIFE SCIENCES
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FACULTY OF SCIENCE
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Content

Summary

In 2009, the deans of the PHARMA, LIFE and SCIENCE faculties (PhLS) at the University of Copenhagen (KU) appointed a committee to look into synergies in research, infrastructural development and education across the three faculties. This report summarises the observations and recommendations made by the PhLS committee.

Our meetings with 19 departments, heads of department and the Vice Deans for Education and Research provided insight into factors affecting the quality of research and education at the PhLS faculties; they also identified the challenges that need to be overcome to meet future demands in natural sciences at KU. The challenges – and the committee's recommendations as to how they can be overcome – are divided into:

Infrastructure
Academic leadership
Research
Education

Infrastructure (buildings and equipment) that is not properly maintained has a negative impact on the quality and opportunities in research and teaching at KU. Many buildings require significant renovation, and the entire PhLS area needs new, well-equipped laboratory facilities. In particular, we recommend:

- investing in an Interdisciplinary Instrument Tower located in connection with the Niels Bohr Science Park at Nørre Campus, which can house large-scale instrument facilities and serve as a centre for high-level, interdisciplinary education
- setting up a National Centre for the Dating of Materials at the Department of Geography and Geology

- continued support of initiatives within bioimaging – both for the interfaculty Bioimaging Infrastructure project and for KU's prominent position at the new large-scale infrastructures in Lund, Sweden (the Synchroton MAX-IV and the European Spellation Source Scandinavia, ESSS)
- better integration of large infrastructures (such as the Centre for Protein Research) to meet the significant need for a common high-throughput protein production and purification facility at KU
- upgrading and continued maintenance of field stations, making sure that they are efficiently integrated into the natural science curricula
- large-scale expansion of the collections and exhibitions at the Natural History Museum of Denmark to support research and to enable the museum to meet its educational responsibilities
- improving outdated teaching facilities to meet the standards of modern teaching (e.g. E-learning)
- establishing central housing facilities for long and short-term international visitors, preferably in the campus areas
- upgrading the campus environment with better facilities for social activities

Academic leadership needs to be strengthened. Effective leadership plays a major role at all administrative and academic levels. The continuous development of excellent leadership is necessary to fully exploit the potential of research, education and innovation carried out by the large number of highly qualified staff and dedicated students at KU. We recommend that:

- deans formulate and coordinate a long-term vision for the PhLS faculties, specified in common strategies, economical incentives and the coordinated support of selected research areas and environments
- heads of department exercise consistent and role model leadership by defining five-year plans for employments at professorial level and securing a thorough integration of large research centres. This would allow all departments to benefit professionally and economically from large-scale investments
- research group leadership shouldbe strengthened to ensure that all employees understand the importance of practicing good leadership and management at all levels
- tenure-track positions should be introduced to attract and retain particular talents at an early stage in their careers

Research environments are strongly dependent on a well-functioning infrastructure and on proper scientific and strategic leadership if KU is to maintain and further strengthen research at the highest international level. Compared to larger countries, Denmark has limited science resources and capacity, which makes it necessary to prioritise research initiatives. Priorities must, to some extent, build on our research tradition and existing scientific strongholds. However, the research landscape of the future in natural sciences at KU will undoubtedly be determined by: a) research projects and programmes initiated by visionary scientists, capable of establishing competitive interdisciplinary research groups, and b) research programmes that are outlined politically but structured and made operative in academic and industrial environments. Meeting such challenges – and ensuring the best conditions for future research – calls for strong academic leadership.

Some scientists possess or develop the capacity for innovative, cross-frontier research – and they have the courage to initiate integrated programmes. These scientists deserve unrestricted freedom to develop their research and sufficient financial support to establish research groups or centres of optimal size and structure.

The PhLS committee further recommends that:

- research environments at KU should be structured to permit recruitment of researchers from the national and international elite
- coordinated and well-founded research strategies should be defined to support basic science within all major scientific areas at PhLS. These strategies must also stimulate complementary research that is interdisciplinary and focused on societal needs, innovation and development. Maintaining the balance between basic and applied research is key to success
- new strategic KU initiatives should always be accompanied by financial and administrative support, not only to promote the initiatives themselves but also to serve as an incentive for researchers to join
- researchers need competent administrative support for large-scale funding applications
- small- and large-scale reorganisation of research environments (ongoing and future changes) need to be given sufficient time as well as financial and administrative support to mature – at the level of research as well as education

The following areas are of particular concern:

- the Chemistry environment at KU. This field needs substantial upgrading. We recommend the establishment of a well-funded, high profile Centre for Basic Chemistry. This centre would be responsible for coordinating and stimulating the complementary research areas in chemistry at the individual faculties
- the establishment of the Copenhagen Plant Biology Centre and a parallel centre in microbiology (both centres without walls). We recommend direct financial support of these important centre activities
- closer coordination of research in biophysics and structural biology at KU
- Mathematics at KU should be given further incentive to integrate with other disciplines within the natural sciences. Strengthening collaboration between e.g. mathematics and biology will have significant synergetic effects

Education. Many PhLS departments face problems with low student recruitment and high student dropout levels. The teaching at these departments needs to be advanced to comply with modern standards. We recommend that:

- the PhLS faculties should implement a coordinated national and international recruitment strategy
- KU works on improving the general status of natural sciences in society to provide an incentive for young people to choose a career within this field
- all study programmes at PhLS faculties implement Integrated Science modules
- administrative and economic barriers are removed to offer the students free mobility between PhLS faculties. Any mobility initiative will demand clear communication of general rules and significant administrative support for students and staff members
- the PhLS faculties increase their efforts to provide further education within natural sciences for high school teachers so that these teachers can provide up-to-date and motivated teaching for their students
- the PhLS faculties generate and support interfaculty and/or interdisciplinary study programmes

1 October 2009

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1. Introduction

1.1. Background

In 2007, the University of Copenhagen (KU) merged with the Royal Veterinary and Agricultural University and the Danish University of Pharmaceutical Sciences. The two latter institutions are now separate faculties at the University of Copenhagen, respectively known as the Faculty of Life Sciences (LIFE) and the Faculty of Pharmaceutical Sciences (PHARMA). The two new faculties cover disciplines and activities that complement and, to some extent, parallel those offered at other faculties, in particular at the Faculty of Sciences (SCIENCE) and the Faculty of Health Sciences (HEALTH).

Following the university merger, the University Management Team launched a number of initiatives to identify and take advantage of new opportunities in education and research. Efforts were made to disclose possible structural barriers to the development of an optimised education portfolio at KU. These initiatives were organised by the KU Education Strategic Council (KUUR) and the Pro-HaLS committee (Vice Deans for Education from HEALTH and LIFE). In research, an interdisciplinary and interfaculty research initiative, which involved 700 researchers from all eight faculties, resulted in the description of 12 interdisciplinary research platforms. Collaborative work using these platforms was supported by seed money from KU. This initiative augmented collaboration between faculties; it has also provided KU researchers with two grants of DKK 120 million from UNIK (Universitetsforskningens Invisteringskapital/Investment Capital for University Research set up by the Danish Ministry of Science, Technology and Innovation) and facilitated the establishment (and planning) of several basic research centres in PhLS's areas of research.

The PHARMA, LIFE and SCIENCE committee (PhLS) was established to identify new opportunities in education, research and infrastructure generated by the merger, and how to derive maximum benefit from these. The committee was to focus particularly on issues demanding interfaculty collaboration. The deans of PHARMA, LIFE and SCIENCE established the committee, and it consisted of senior representatives from each of the three faculties. Professor Povl Krogsgaard-Larsen (PHARMA) was appointed Chair, and Professor Birger Lindberg Møller (LIFE) and Professor Erik Hviid Larsen (SCIENCE) were members. Each member of the committee was granted an academic secretary: Bente Vestergaard (PHARMA), Christina Lunde (LIFE) and Peter Stæhr (SCIENCE). The committee was supported by administrative staff: Jan Andersen (LIFE) was the committee's main administrative officer, assisted by Ulf Madsen (PHARMA) and Stein Larsen (SCIENCE).

The PhLS committee's mandate stated that only fields and subjects related to PHARMA, LIFE and SCIENCE should be considered. So although e.g. basic pharmacology is primarily a pharmaceutical discipline and could easily have been included in the committee's field of enquiry, this area was not part of the PhLS mandate. However, the PhLS committee wishes to emphasise that certain disciplines within the PhLS area are worthy of consideration in relation to the Faculty of Health Sciences (HEALTH) e.g. veterinary science, pharmacology and sport sciences. Therefore, it is of great importance that border areas and disciplinary overlaps to HEALTH are taken into account when the current recommendations are implemented.

1.2. Objectives

KU is the highest ranked university in Denmark, and the merger offers the opportunity to strengthen KU´s international position. The objective of the PhLS committee is to offer recommendations to secure and further strengthen KU's international profile in research and education. This includes optimising faculty organisation, improving strategic planning and making sure the necessary facilities are in place to carry out basic and applied research. This report also includes recommendations on how to coordinate strategic planning and utilise potential synergies in the PhLS field. The recommendations are brought forward to obtain resources for central academic activities, improve KU's infrastructure, and ensure that innovation continues in PhLS's many fields.

2. Approach

This report is the result of a series of meetings held at PHARMA, LIFE and SCIENCE during 2009. The report does not provide a quantitative assessment of the quality of research and education at the individual departments.

In late 2008, the group of deans met to discuss the PhLS committee mandate, single out the relevant departments and organise the meeting schedule. This was followed by a brief information meeting in January 2009 with heads of department, relevant committees and members of the faculty management as well as other key partners. From March to September 2009, the PhLS committee held meetings with 19 departments (see Appendix 1). Prior to all meetings, an invitation letter was forwarded to all heads of department and other meeting partners (see Appendix 2). The letter specified the purpose of the meeting and identified topics to be discussed during the meeting. Detailed minutes were made at each meeting and department representatives were given the opportunity to respond. Based on these minutes and material provided by the departments, the committee secretaries made detailed notes on challenges and possible solutions relevant to each department. On the basis of the meeting notes, two tables were made that summarised the key problems identified at the department meetings (Table 2 and 3). Similarly, the ideas and solutions brought forward at the meetings were summarised in two tables of recommendations (Table 3 and 4). Issues that needed special attention were also identified during the meetings with the departments. These issues were thoroughly discussed by the PhLS committee and by the Vice Deans for Education and Research. The PhLS committee also discussed issues related to education, interdisciplinary approaches and didactics with the Department of Science Education. For a more detailed description of the committee's approach, see Appendix 3.

3. Challenges facing the PhLS faculties

Our meetings raised a number of general issues concerning infrastructure and the organisation and quality of education and research at the PhLS faculties (Tables 1-2). In this chapter, we describe some of the general challenges the three faculties face. Chapter Four presents our recommendations on how to meet these challenges. In Chapter Five, we address specific issues related to particular departments, disciplines or fields that call for special attention.

3.1. Infrastructure and research

3.1.1. Infrastructure

The PhLS departments are situated at separate locations in central Copenhagen. Special laboratories and field stations are placed throughout the country. During the last decade – and particularly after the merger of the three universities – efforts have been made to merge and optimise the use of the faculties' facilities in order to reduce costs and improve the use and quality of existing research and teaching facilities. This is an ongoing process and ambitious plans are still being discussed. With the Government's planned contribution of DKK 2.6 billion to KU for new buildings and renovation, some of the ambitious plans stand a better chance of realisation. Our meetings and visits revealed that the physical facilities at most departments are inadequate and out-of-date, reflecting decades of negletance with respect to investments and improvements.

Poor physical facilities seriously affect the quality of education and research in many departments. However, problems with inadequate, old-fashioned and worn-out teaching and research facilities are most acute at SCIENCE and at the Natural History Museum of Denmark that desperately need larger and up-to-date facilities. At SCIENCE, a large number of square metres are available for teaching, primarily in the form of auditoriums. However, with changes in teaching methodology, there is a need for flexible, smaller-scale teaching facilities.

There is a lack of laboratory facilities for modern natural science teaching at all PhLS faculties. Physical constraints were frequently mentioned as a barrier to the development of research at PHARMA and LIFE. Many study and research programmes rely on access to field laboratories. High maintenance costs have, however, forced many departments either to close their stations or reduce maintenance significantly.

Core facilities with state-of-the-art equipment are in demand at all three faculties. Many disciplines have become fully dependent on large-scale, advanced and costly research equipment (e.g. bioimaging, NMR and mass spectrometry, metabolomics, DNA-sequencing, 3D X-ray facilities, and field stations to enable large-scale environmental studies). The demands for very expensive equipment will increase in the years to come. Moreover, advanced equipment calls for highly trained technicians to ensure correct maintenance and effective guidance for users. Heads of department and deans are responsible for ensuring that large investments are coordinated tso that they benefit the entire PhLS area; they should also make sure the equipment is put to optimal use. Maintenance costs may be recovered by user fees. A rolling strategy plan for KU should be developed to maximise chances for attracting external funding for the most advanced and costly equipment (e.g. where only one instrument is available to all of KU). At international/regional level, the successful integration of KU researches in the use of the new particle accelerator and synchrotron facility at Lund University, Sweden is much appreciated by the committee and the PhLS faculties and KU in general should continue to support this integration.

The merger has also resulted in the introduction of a new financial system. The introduction has been unsatisfactory, causing great frustration among users at LIFE and PHARMA who felt the previous financial systems worked much better. It is also noted that the three faculties use different email systems, and this calls for some degree of standardisation to facilitate and lower the costs of repair services.

Neglecting investments in infrastructure should not be accepted in the future. A lack of proper infrastructure devalues the international reputation of KU and reduces job satisfaction among employees. As a result, recruitment of the best people to positions at KU becomes more difficult. Likewise, an unsatisfactory working environment does not motivate an employee to solve problems arising outside their own area of responsibility. All administrative levels at KU are responsible for securing improvements in infrastructure – except for major building projects that obviously need financial support from the Government. However, optimal performance at all levels may make it easier to secure such financial support. The PhLS committee find it important that all employees are proud to work at KU – and that KU is proud of all its employees.

A) Infrastructure	B) Research
• Teaching facilities do not meet modern teaching requirements within natural sciences. There is an excess of large auditoria and a lack of smaller, flexible rooms necessary for student-to-student and student-to-teacher interaction • There is a lack of modern laboratories, especially at SCIENCE, and PHARMA and LIFE experience physical constraints due to lack of space. • The number of field stations has been reduced, and those that exist are poorly equipped and not sufficiently integrated into the PhLS science curricula • The wide dispersal of sites for teaching and research deprives students and staff of a proper campus environment • There is a lack of housing for short–term students wishing to attend international courses	• There is a lack of core facilities with state-of-the-art equipment • There is a lack of administrative assistance for large EU applications and the subsequent administration of these (mainly at LIFE and PHARMA) • There is a lack of a central KU strategy for large-scale equipment/upgrades • Resource and time-consuming competition for external research funds/resources renders small research groups vulnerable • Strong research centres need to be integrated into research and study programmes in each department • The merging of research groups, administrative restructuring and reductions in public funding have forced most departments to change their organisation and rethink their research strategy. This process is very time-consuming and will only succeed if it is: a) directed by strong academic leadership and b) given sufficient time to become implemented – uninterrupted by new administrative changes • Since the recruitment of new staff relies on external funding, it is difficult for faculties to implement visionary strategic research plans

Table 1. *General issues discussed during our meetings relating to: a) physical conditions that affect the quality of education and research, and b) the quality of research*

3.1.2. Quality of research

The development of our society is strongly dependent on the ability of scientists to generate innovative research that challenges our preconceptions of life and shows the way towards new solutions to contemporary and future problems. The three faculties, SCIENCE, LIFE and PHARMA have produced a series of internationally renowned researchers, who have contributed significantly to furthering our knowledge in a wide range of academic fields. Having visited a significant number of KU's natural science departments, the committee was impressed by the quantitative and qualitative level of research output, and by the diverse range of interdisciplinary research programmes that are being pursued. It is beyond the scope of this evaluation to compare and evaluate the quality of research performed at the many individual departments. Instead, the PhLS committee has focused on common internal barriers that make it difficult to perform cutting-edge research at the three faculties.

3.1.3. Funding and research strategies

Despite the diverse nature of research topics and approaches, a number of similar issues were raised during our meetings with the various departments (Table 1). Many of these issues concerned funding and the recruitment of staff. Although external funding has always been an important supplement to basic research, it has become absolutely essential today. A lot of time and effort is spent writing applications, often with research groups from closely related departments that share similar interests and expertise. Many heads of department expressed a common interest in recruiting qualified assistance to help these groups during the application process – with the application itself and the subsequent administration of large EU projects. SCIENCE seems to have pioneered the implementation of such administrative services, and PHARMA and LIFE could benefit from SCIENCE's experiences.

While competition for external research funds can be intellectually stimulating – and, if successful, boost research significantly – smaller research groups' lack of time and resources make them extremely vulnerable, creating frustration for all researchers involved. It is the head of department's responsibility to be aware of such issues and make sure critical mass is reached. This can be done either by changing the research group's topic, or by aiming the research in a direction that may attract new internal or external collaborators. With this type of proactive, long-term planning, the department can avoid losing expertise within research disciplines that are not at the top of the political or international research agenda. Without such foresight, an inadequate supply of external funding may cause the loss of much needed research competence and weaken the associated

teaching. Numerous cases of negative outcomes due to lack of long-term planning can be listed; the fields of Geology and botany of higher plants are two cases in point. In Botany, proper long-term strategic planning would have ensured that the department kept abreast of new developments in hardware for light microscopy and bioimaging so that proper instrumentation could be acquired. That kind of equipment is now typically found in molecular biology departments where the botanical expertise required for competent interpretation of recorded data is sometimes not present.

Gradual reductions in student recruitment and basic funding for research, along with politically determined mergers and space reductions, have recently forced many departments to make changes to their organisations. Part of this process involves the establishment of new research groups, which need to develop and implement new research strategies. These are time-consuming processes that demand strong academic leadership, as well as time and patience to mature.

Research environments that suffer from long-term reductions in student uptake – and do not substitute reduced teaching activity with a higher output of frontline research to gain strong external funding – experience difficulties in maintaining their academic and technical staff. Close cooperation between heads of department and heads of major research centres is necessary to prevent such an unfortunate situation. That is one of the reasons why it is important to integrate strong research centres into the research and study programmes throughout the PhLS area. Such a process calls for strong academic leadership. However, once such integration is achieved, it is a true win-win situation for all parties involved.

3.1.4. International and national recruitment at all levels

To maintain and further improve the international ranking of the University of Copenhagen, it is necessary to optimise our recruitment and focus strongly on career opportunities in the natural sciences. At all academic levels (students, TAP, VIP), we need to look out for, and nurture, obvious talents who might become key staff members in the future. It is central to the future success of KU that we are able to attract the national and international elite. To do so, we need to overcome several barriers:

- The Danish tax and health care system is complicated and not easy to explain to foreigners. It would be very helpful to have a document describing what needs to be in place in order to live a secure, comfortable life in Denmark
- A warm welcome to foreign employees would include an offer of decent accommodation during

their first month of employment. It is difficult and time-consuming to find adequate (affordable and central) temporary and long-term housing for international staff and their families, visiting researchers and students. At present, temporary housing on campus is essentially non-existent

- English-language communication is not yet fully integrated at KU
- There is no significant support for spouses, neither socially nor in terms of employment support
- KU does not offer tenure-track positions for specially gifted researchers (neither foreign nor Danish), and consequently loses out to international institutions that can provide this
- KU imposes a relatively high teaching load at all career levels. This may influence research recruitment
- The administration of international study programmes in collaboration with foreign universities is complicated by economic systems (STÅ counting) and the administration of parallel student uptake

3.1.5. Academic leadership

Competent academic leadership at all levels (rector, dean, head of department, head of centre, research group leader, and programme director) is a prerequisite for successful development within the PhLS area. An increasing amount of resources for research are channelled via the larger and more flexible centre structures. That is why it is essential that centre and department heads are capable of coordinating and integrating centre activities. Generally, centre activities that are not integrated into departments do not continue beyond the lifetime of the centre. For this reason, they do not have the desired long-term impact on the research environment in which they should have been embedded.

Our interviews clearly show a close relationship between the performance of departments and the professional background of each head of department. Departments led by a head who has a strong, internationally recognised background in science simply perform better. It is far easier to convince employees of the need for long-term strategic research planning and departmental priorities when your own background clearly testifies to your experience and understanding of the nature of scientific research. In cases where the head does not have this type of background, more general parameters will have to be used to exert leadership. For instance, using fixed figures for. the minimum number of employees needed to secure critical mass within a certain research area. However, decisions based on such simple parameters are often flawed. Critical mass within a research area can be established in many different ways. The small biophysics groups at LIFE and PHARMA are good examples of this. They interact very well with biologists and with the main biophysics group at SCIENCE. Thus, they effectively bridge the fields of biophysics and biology. However, the biophysics groups at LIFE and PHARMA are lucky to have in their midst a dedicated individual with good communication skills who is willing to, and capable of collaborating across disciplines and departmental borders. Without such drive and talent, this kind of collaboration would not have worked out. Clearly, such a situation cannot be envisioned just by looking at statistics for the amount of employees needed to gain critical mass. Similarly, the presence of a large group of co-localised chemists is not in itself a measure of critical mass. In short, it is the responsibility of the head of department to oversee that the organisation is appropriate, and to react if it is not.

Interdepartmental collaboration often relies on the dedication of individual staff members. Dedication and commitment is great – but what happens if such key members of staff leave? In order to sustain collaboration across disciplines, department heads need to plan for such events and make the right provisions to mobilise ongoing commitment among staff members when a key member of staff leaves.

As the examples above show, heads of department play a key role in leadership at the University of Copenhagen. In some departments, however, we witnessed heads of department who did not exert the type of leadership needed to properly advance science, education and the reputation of the department. A lack of competent leadership causes a lot of frustration, not only among the department's own members of staff, but also in closely related departments who depend on efficient collaboration within teaching and research. Given the severe long-term consequences of inefficient leadership, the PhLS committee calls for action to be taken in this area. Our detailed recommendations are laid out in Chapter Four.

Only to a limited extent is leadership experience in industry and non-university institutions an advantage in the university world. Academic leaders must be capable of making decisions in egocentric and competitive academic environments. At the same time, they need to have the personal and intellectual capacity to generate and maintain collective enthusiasm for the development of new scientific ideas. *Thus, the successful academic leader is a competent and visionary scientist endowed with empathy, courage and effective ego-management skills.*

To realise the ambition of long-term success, KU needs to increase its efforts to identify and develop young scientists with leadership potential. This is of paramount importance for KU's future as an advanced and progressive university. However, this process represents a major challenge for the deans and Rector at KU.

3.2. Student recruitment and graduate production

3.2.1. Student recruitment

All departments are aware of how important it is to attract external funding if they are to support their research. A major source of income – and thus the basis for employing permanent academic and technical staff – continues to be the production of graduates. The level of basic funding associated with production of graduates is essentially determined by the number of students recruited, the number of students who pass their exams, and the pace of this process. In Denmark, and in many other countries, student enrolment for most natural sciences has dropped during recent decades. Many PhLS departments and study programmes are very concerned about their reduced number of students and make great efforts to increase recruitment and to ensure high and rapid completion rates (Table 1).

The departments at LIFE, and to some extent departments at PHARMA, have been much faster to recognise the need to take action if they are to avoid a further decline in student intake. They have launched a communication strategy aimed specifically at high school students and their teachers. Among the successful initiatives in this strategy are invitations to lectures, numerous practical courses for high school teachers and students hosted by various PhLS departments, and a High School Teacher Day. The departments at LIFE and PHARMA have also participated actively in events aimed at communicating research activities to the general public. Adverts have also been placed in written and electronic media. If the latter type of communication is to be used by other PhLS departments, the committee recommends that such communication is coordinated at faculty level (by the deans) to avoid unjustified internal competition. However, each department should still be allowed to respond individually to promotion opportunities generated by their collaboration with external partners.

A) Students	B) Education
• Low and/or declining student recruitment in most PhLS departments for more than a decade (particularly at SCIENCE) • High student dropout levels at most PhLS departments (except for those aimed at specific professions) • Reduction in graduate production and income (STÅ) due to decreasing recruitment and high dropout rates. Lower STÅ impacts negatively on study and research programmes • A lack of flexibility for students wishing to change from one study programme to another • Student mobility between faculties impeded by poor communication about – and access to – other courses • An imbalance in the flow of students from classical natural sciences (e.g. physics) to life sciences • An imbalance in the flow of students from the Faculty of Science to the other faculties (the "30 ECTS" rule has only been implemented at SCIENCE) • A lack of ability to attract international students	• Poor coordination between related courses due to feelings of 'course ownership', lack of inter-departmental knowledge among staff in charge of courses, and a rigid course accountant system (the STÅ system) • A lack of coordination between related courses due to planning constraints (such as block vs. semester) • Differences in educational culture has resulted in a lack of integration between, for example, Mathematics at SCIENCE and many life science degree courses. Consequently, too many courses are taught to a low number of students, (especially at master and PhD level) • Strong dependence on external funding for research makes it increasingly difficult to maintain teaching competence in fields low on funding • No professional evaluation of teaching skills (KU employee evaluations prioritise research skills and the ability to attract external funds) • A lack of support for educational development from successful research groups with significant external funding and numerous temporarily employed researchers • A fall in the standard of scientific teaching due to differences in knowledge and skills among new students • Too few students from strictly defined study programmes pursue a further career in academia • Difficult to establish international study programmes

Table 2. *General challenges discussed during our meetings concerning a) student recruitment, dropout and mobility, and b) quality of education*

The reasons for the decline in recruitment in natural sciences at KU are multiple and complex (Figure 1). Interestingly, difficulties in recruitment have been less of an issue for studies that are specifically aimed at a particular profession. Such studies are mostly located at LIFE and PHARMA.

Some study programmes at SCIENCE, especially Chemistry, Geology, Physics and Mathematics, are currently attracting very few students. This low student uptake does not always appear to be balanced by a higher research output, which might have secured strong long-term external funding. This means that the academic staff is extremely vulnerable to the sparse flow of

external funding. The low preference among young people for the above-mentioned disciplines may change in years to come as a result of improved communication and new initiatives from the dean and heads of department. However, it is disturbing to note that only very few of the limited number of graduates completing degrees in chemistry, geology, physics and mathematics take up positions as teachers in Danish high schools. The low numbers of graduates recruited as teachers inevitably affects the quality of teaching in these subjects at Danish high schools. By implication, poor teaching will lower high school students' interest in embarking on university studies within these particular fields or, at worst, natural science in general.

The university museums (the Natural History Museum of Denmark) are very aware of the importance of communicating natural science to the general public, and they play a crucial role in doing so. The planned co-location of the university museums in the Botanical Garden area offers a unique opportunity to redress some of the negative effects of low recruitment through exhibi-tions aimed at high school students, for example.

These efforts are very welcome, but the main responsibility for improving the recruitment situation still lies with the individual departments.

When it comes to creating interdisciplinary research environments that may attract more students, some PhLS departments perform better than others. The Department of Mathematics is rather narrow in its choice of research topics and gives little priority to initiatives that may promote greater interaction with closely related fields such as biology. If the department is not more proactive in its interdepartmental efforts, student interest in mathematics might drop even further, leading them to move into related areas like biology or physics. Lack of student interest arrests research development, lowers the potential for innovation, and makes it even harder to recruit larger numbers of students. If prospective students cannot gauge the usefulness and future prospects of a particular chosen topic, there are lots of other options to choose from at other departments. That is why it is imperative that heads of department pay close attention to creating attractive and dynamic study environments.

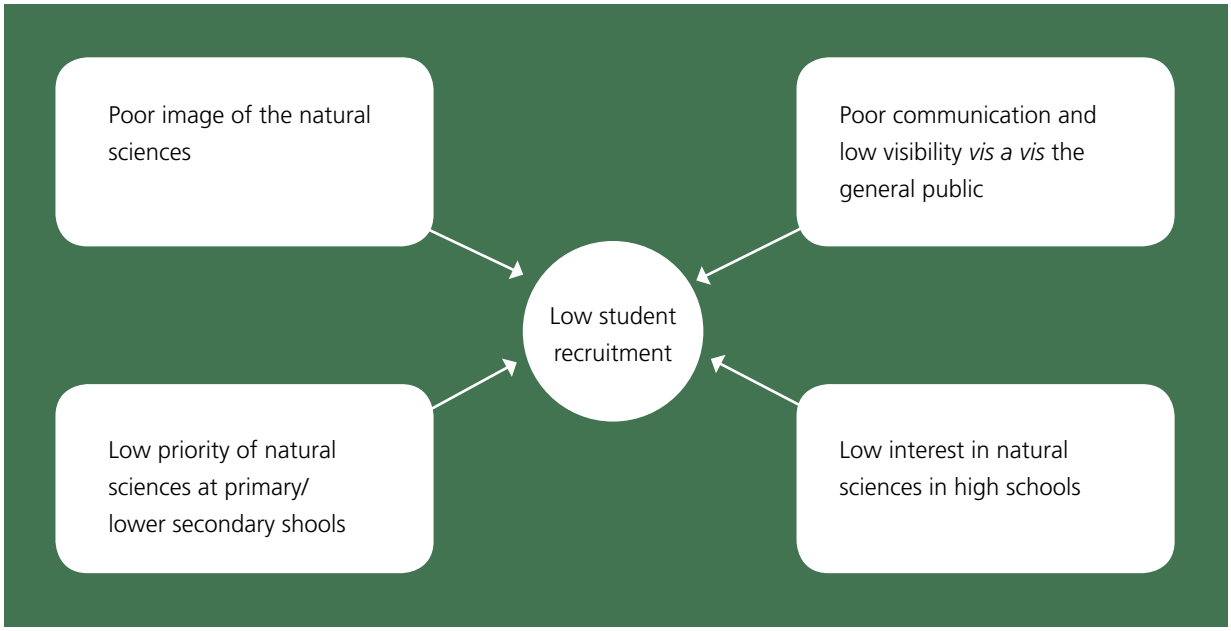


Figure 1. *For more than a decade, recruitment rates have been low and have continued to drop in most of the natural science departments. This has had a significant negative impact on KU's economy*

In view of the unbalanced age profile of high school teachers in physics and mathematics, it is obvious that new measures are necessary if we are to improve the recruitment of students to study programmes – particularly at the Department of Physics and the Department of Mathematics. To solve their recruitment problem, these departments will have to consider study programmes that attract students who wish to pursue a career in the Danish high schools (i.e. 'gymnasieskolelærer').

A two-subject programme covering mathematics and physics combined with courses in didactics might be the solution to improve education in these subjects.

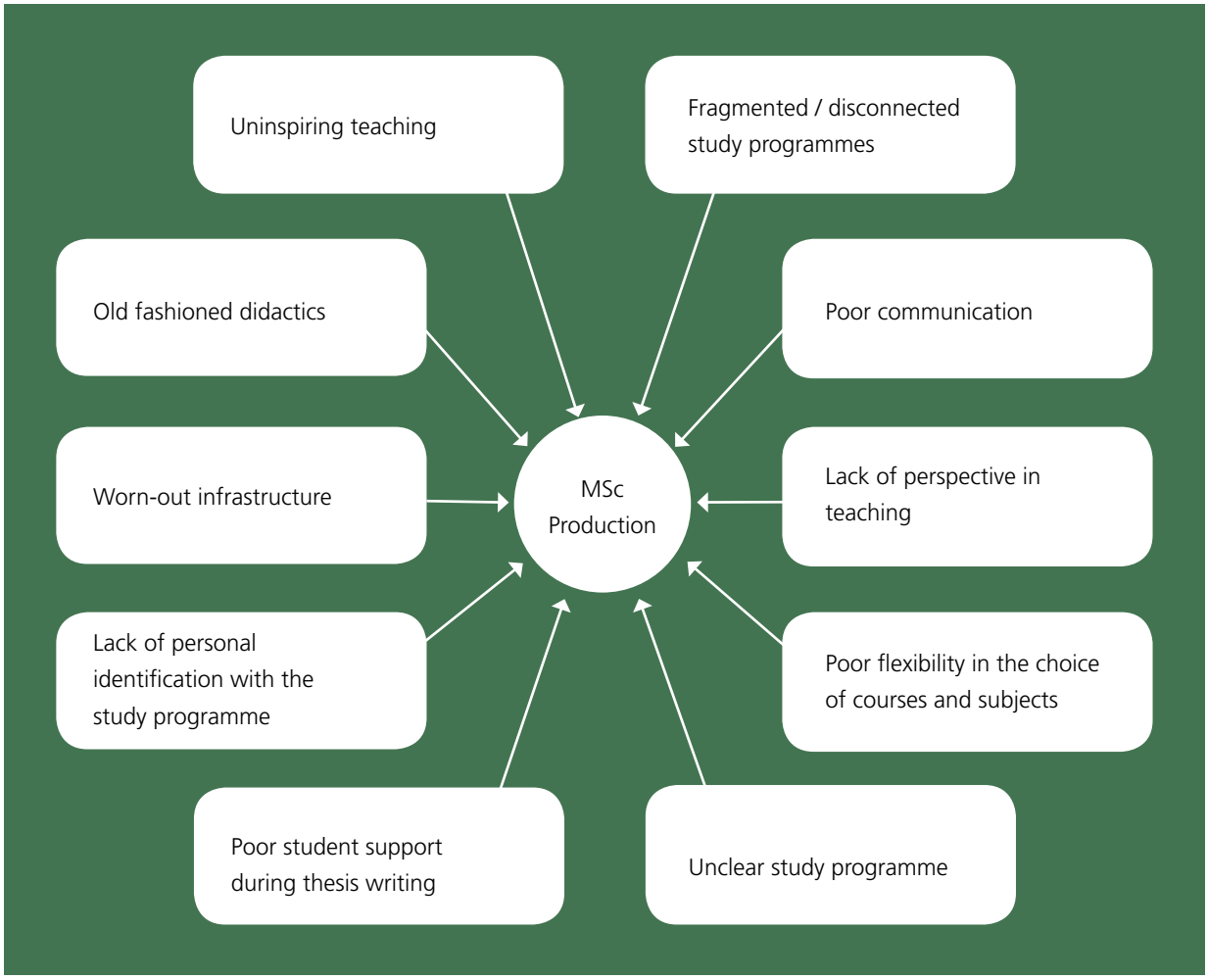


Figure 2. *Student dropout rates are of major concern to many departments, and the causes for dropout are multifaceted.*

3.2.2. Master and PhD student production

The reasons for low student intake and high dropout rates are many and various (Figure 2). Those raised at many of our meetings were:

- lack of transparency and guidance in study programmes
- poor communication to students
- lack of obvious connections between a given subject and closely related subjects – even society
- poor flexibility in the choice of subjects taught
- poor teaching infrastructure
- poor quality of teaching materials

Most departments have taken relevant steps to redress these problems. Historically, PHARMA and the veterinary field at LIFE have experienced the lowest dropout. Their success in reducing student dropout is partly explained by transparent and focused study plans

and substantial investments in up-to-date teaching. In attempts to transfer these measures to other study programmes, it is important to make sure that the students are offered professional guidance so that they understand the basic reasoning behind their study programme and are informed which non-obligatory courses they need to choose to obtain a specific academic profile. Students also need to understand the consequences of not taking a recommended course. Specific overviews may be used to illustrate the courses necessary to achieve specific academic profiles.

Strictly defined study programmes such as those that apply to students who need accreditation to practice also explain the low dropout rates at PHARMA and in the veterinary field at LIFE. While strictly defined study programmes appear to reduce dropout levels, they also have serious drawbacks. Such programmes put greater onus on teaching capacities, consequently reducing the resources available for research. If the cost of teaching reduces the output of research groups, the department cannot sustain a productive research environment that will attract prospective PhD students. As a result, the development of the entire field will suffer – both with regard to research and teaching. Moreover, the reduced freedom of choice at undergraduate level does not encourage students to think for themselves; this may affect their innovative skills and their ability to make independent choices later in their career. Likewise, students experiencing this type of strictly programmed, modular teaching may have less incentive to extend their education with a PhD programme. In some cases, the lack of applications for PhD studies at PHARMA and the veterinary studies at LIFE have been explained by the great demand for PHARMA and veterinary graduates in private sector industries – and by the university's inability to compete with salaries offered in this sector. However, this argument would apply to almost all disciplines in the natural sciences. PhD students are attracted by inspiring research environments, by the possibility to carry out research within a topic they are particularly interested in, and by the prospect of having qualified supervisors that are able to guide them through academically challenging studies. The ability to recruit a sufficient number of excellent PhD students should be included as a success criterion in the assessment of each PhLS department's performance.

Most PhLS departments are keen to recruit international students and establish international collaboration in education. Unfortunately, efforts to set up international study programmes are typically held back by factors such as strict rules on the equivalent uptake of students by exchanging institutions, inflexible rules on study duration and admission fees for students outside the European countries, and different examination standards. While attempts are made to ease the establishment of international study programmes through the EU Erasmus Mundus programme, similar initiatives need to be taken for students outside the EU.

As previously stated, the recruitment of excellent PhD students is central to the future success of any department – both as a teaching resource and to gain a high-impact research output. However, a PhD student salary cannot compete with the salaries offered in the private sector. What KU can offer, however, are strong, dynamic research environments. Therefore, the ability to recruit first-class PhD students is an important parameter for success. Heads of department as well as research group leaders are obliged to make sure that their staff is committed to developing and maintaining high international standards in the training of young scientists.

3.2.3. Interfaculty student mobility

The renowned and diverse education and research in natural sciences at KU provides a strong foundation for meeting different demands. However, our meetings also revealed that a number of improvements are necessary if the PhLS faculties are to optimise their collaboration and ensure high-quality education for future generations of students. While a number of problems relate to structural and economic barriers (some of which may be solved by the realisation of the Free Inner Market), others deal with cultural differences between departments. External factors also obstruct interfaculty mobility, and such issues call for serious political consideration (Table 1). A rigid course accountant system (STÅ) has, until recently, hindered obvious interdisciplinary collaboration. Likewise, differences in study programme structure have impeded the flow of students between faculties. According to the deans of education, common solutions to many of these problems have already been found. The PhLS committee stresses the need to secure and facilitate the fast implementation of the new set of rules at faculty and departmental levels.

The expansion of the university and the relatively close proximity of most teaching facilities offer a unique opportunity to raise the general level of education and teaching in KU's natural science departments. If students are given a good overview of available courses and coherent study plans that include the right mixture of obligatory, recommended and optional courses, they are

likely to choose challenging courses offered by dedicated and skilled teachers. Fortunately, many departments have made a lot of successful efforts to create such courses. However, it is very important that all faculties have transparent course syllabi that enable students to choose the best courses available, to move between faculties and to choose interdisciplinary combinations. Granting students true mobility will increase the overall quality of a KU education. Student preferences will also act as a good indicator for which courses to maintain and which to close down or run biannually.

Throughout our visits, it has been evident that many structural barriers remain, obstructing an easy flow of students across departments and between faculties. Barriers are typically caused by course economy, differences in programme structure and the lack of coherent study rules, common course databases/websites and joint application dates. In general, the strong dependence on student production (STÅ) creates a protectionist atmosphere throughout KU, which complicates or even obstructs processes that would otherwise benefit the university. The mobility of both students and teachers suffers as a result. Fortunately, a number of interfaculty initiatives (ProHALS and KUUR) have been taken to address the problems that the so-called Free Inner Market may give rise to. A number of decisions have already been taken that will open up the Free Inner Market at KU. However, had these decisions been made immediately after the merger, much frustration among university staff could have been avoided. It is of great importance that the deans and the University Management Team communicate the rules of the inner market clearly to the heads of department and make sure the rules are interpreted in the same way by all faculties and departments. This will ensure that all parties involved have the incentive to proceed. Local ownership and involvement in the Free Inner Market is of key importance to the successful implementation of this project. This includes making sure that courses are aligned with local department demands and, at the same time, open towards students from outside the respective department.

The 60 ECTS maximum rule should be cancelled. This government imposed rule prevents the most bright and innovative students from taking the supplementary courses they find interesting. This is highly demotivating. The desire to implement elite education could be met in a non-bureaucratic manner by abandonning the 60 ECTS rule.

3.2.4. Quality of education

The natural science courses offered by the PhLS faculties cover an impressively wide range of basic and applied fields. In fact, the diversity of disciplines has become the hallmark of natural science at KU, attracting students and employees from all over Denmark and abroad. Despite economic constraints and the increased awareness of costs and benefits associated with graduate production (STÅ), it is clear that tremendous efforts are being made at all PhLS departments to ensure a high quality of education. Study plans are being revised and aligned continuously to meet current and future needs.

There are at least four major recipient groups that significantly influence the type of education offered by the PhLS faculties (Figure 3):

- **Politicians/society in general** want better educated graduates who graduate fast and generate value for society; for example, high school teachers, scientists setting standards for health security and foods, and graduates who can offer visionary solutions to complex societal problems

- **The private sector** depends on well educated graduates with solid basic science backgrounds. They are also looking for interdisciplinary skills and the ability to use acquired knowledge to solve practical problems, such as product development, analysis, quality control and new, practical solutions to complex industrial problems.

- **Research environments** need graduates who can continue to develop basic and interdisciplinary research that involve large networks and complex infrastructures. They are looking for graduates with innovative ideas, specialised as well as general scientific knowledge, and the ability to combine knowledge from different disciplines. The German term 'bildung' ('dannelse') is an apt description of the intellectual quality that research environments are looking for when selecting graduates for research.

- **Students** are very aware of the profile and future prospects of particular education programmes. They often define themselves in relation to the profile of the academic field they have chosen. Students see university studies as a right, an obligation and a privilege. They are very selective, and most of them have no qualms about leaving a chosen study programme if they are not satisfied.

3.2.5. Education oriented towards society

While SCIENCE predominantly educates students with classical basic research approaches, PHARMA, and to some extent LIFE, are more focused on educating students who wish to pursue professional careers in the private sector. As a result, these faculties offer courses with different goals, purposes and internal values. However, all natural science programmes have gone through the same development: they have evolved from being primarily focused on educating the elite for a career in research, to offering mass education to a much larger segment of the upcoming generation. Today, students do not enter university only to pursue an academic career; most of them wish to apply their academic qualifications to solve problems in society.

One of the major challenges facing the university today is to balance the need for specialised and interdisciplinary qualifications. Students need to cultivate an interdisciplinary mindset. At the same, they must have sufficient specialised knowledge within a given field.

Figure 3. *Education in natural sciences has to meet the demands of different recipient groups.*

3.2.6. PhD studies – recruitment, environment and courses

PhLS faculties need to offer research environments that can attract excellent graduates who want to pursue a career in the natural sciences. It is necessary that research groups have sufficient critical mass to integrate prospective researches into a well-functioning research environment. Accepted PhD projects must be ambitious but always supported by guidance from competent supervisors. The PhD courses offered need to be relevant, and participation should be organised in a flexible manner to avoid unnecessary bottleneck situations during the experimental phases of PhD research.

The PhLS faculties should coordinate a common course database, also at PhD level, and the three faculties should aim at offering complementary courses. Experimentally oriented courses are very popular and important at this level, and should be particularly welcomed. The PhD-course portfolio is also a positive base for international recruitment.

4. Recommendations for the PhLS area

4.1. Vision for the natural sciences at the University of Copenhagen

The quest to understand the fundamentals of life and the universe is the bedrock and internal strength of the natural sciences. The PhLS committee's vision is to make this pursuit more visible in society, to impart the fascination with natural phenomena to students, and make sure that resources are found to allow academic staff to immerse themselves in their academic activities. If we coordinate efforts, utilise synergies, optimise infrastructure and research environments, and support innovative initiatives, the standard for natural science research and education at KU will improve significantly (Table 3 and 4).

A) Infrastructure	B) Research
• Upgrade teaching facilities to ensure adequate conditions for modern teaching • Improve laboratory facilities (especially at SCIENCE) • Prioritise the maintenance of equipment and field stations • Work towards creating campus environments in future construction plans • Improve housing for visiting students and researchers	• Establish core facilities with state-of-the-art equipment • Provide qualified assistance for large EU applications and the subsequent administration of such grants • Focused university strategies for large-scale equipment/upgrades • Improve the basic funding to reduce time-consuming competition for external research funds • Better integration of research centres with departmental research and study programmes • Allow sufficient time and resources for the integration of major administrative changes – such changes need time to take effect • Focus on strong academic leadership • The implementation of a tenure-track system, allowing for the employment of externally financed staff. This will ensure continuity in vital research areas during temporary periods of low student recruitment

Table 3. *General recommendations on: a) physical conditions affecting education and research quality, and b) conditions concerning research quality*

Initiatives should be taken to:

- cultivate academic abilities, promote focused study and generate a broad understanding of the PhLS area at a very early stage in a student's career. To be affiliated to the natural science departments at KU must carry the stamp of academic quality for students as well as members of staff

- promote interdisciplinary thinking at all levels – from students to professors – and facilitate collaboration within education, research and innovation. This will further consolidate KU's international ranking

- strengthen academic leadership at all levels to ensure strategic thinking and proactive management. Academic leadership across all faculties at KU will release resources to further develop the PhLS area as a coordinated and well-functioning academic field

- strengthen the societal position of natural sciences in general and the PhLS area in particular. We need to transmit the fascination of science to the general public and communicate the remarkable findings generated within the natural sciences. Reaching out to society and engaging in dialogues with the general public will have a positive impact on student uptake, societal acknowledgement and political goodwill

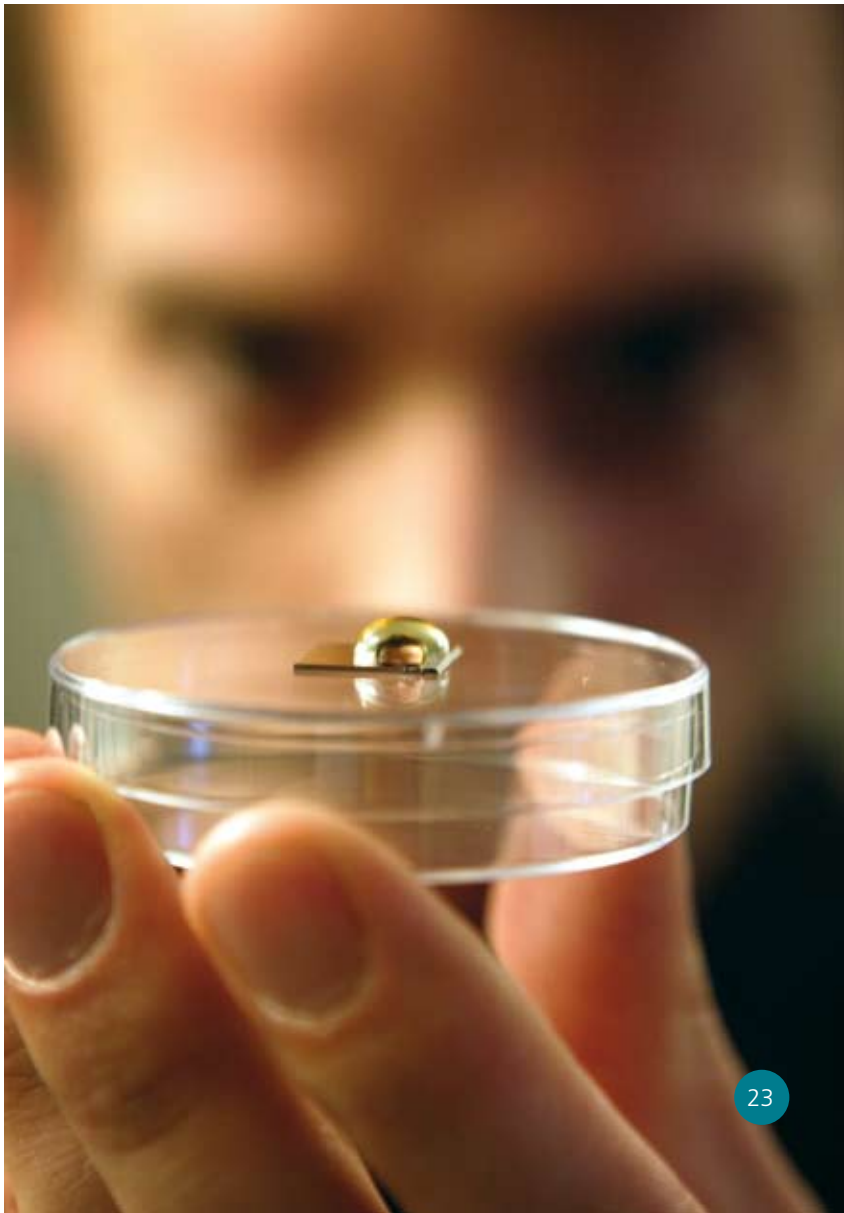
- continue to strengthen the international profile within research and education to attract more international students. A common strategy for the international 'branding' of KU's PhLS area will increase student recruitment and attract a sufficient number of qualified students to all PhLS study programmes

- attract more high-profile scientists from abroad. We need to establish a first-class working environment at KU that will draw researchers from the national and international elite to the natural sciences at KU

4.2. Infrastructure

4.2.1. The Interdisciplinary Instrument Tower

The need for significant investments in larger and more advanced equipment and services at KU was a concern raised by the majority of PhLS departments. A case in point is the need for a high-throughput protein production and purification facility. To derive the full benefit from such investments, it is essential that such expensive and unique equipment is accessible to the relevant scientists. To allow easy access, the equipment should be placed in a shared instrument core facility where users can work for longer or shorter periods of time. The physical outline of this core facility should be carefully considered and integrated into the future building plans for Nørre Campus. This core facility should not just represent a machine park; it should also contain laboratories to support ongoing research. A sufficient amount of technical personnel need to be employed to ensure the efficient usage, proper maintenance and upgrading of the equipment.



The availability of state-of-the-art equipment in such a central facility will strengthen the entire scientific community at KU and attract new international collaborators. The fact that such equipment is located in the same place will also facilitate interaction and cross-fertilisation between different scientific fields. As part of the instrument core facility, groups of researchers should have the opportunity to form temporary, interdisciplinary teams working on specific topics. Therefore, the core facility should be able to accommodate large centre structures.

To facilitate better use of smaller and less expensive equipment (often located in specific departments), the core facility should be supplemented with an *in silico* instrument facility. This virtual instrument facility should provide an overview of the available equipment at all natural science faculties and enable potential users to quickly identify contact persons who may provide details on the equipment and its accessibility. The usage of equipment through the virtual instrument facility could be user financed, and the fee should cover expected cost of reinvestment in new equipment. This will create the incentive to allow access to instruments. In fact, the letting of equipment via fees may pave the way for new interdisciplinary research collaboration.

The establishment of an instrument core facility serves another important purpose when it comes to teaching. This facility may be where the Integrated Science module is taught (see section 4.4.1.). It is important that the core facility is actively used for teaching. The combination of state-of-the-art equipment and an active research environment will provide an advanced level of contextual learning for the students. It will also allow students access to the kind of equipment they are likely to use in their professional careers. The core instrument facility will also act as a physical framework for highly specialised courses e.g. PhD summer schools and inter-faculty courses offered by the Integrated Science module (see 4.4.1.).

4.2.2. The National Centre for the Dating of Materials

The PhLS committee recommends the establishment of a National Centre for the Dating of Materials under the auspices of Geocenter Denmark, and managed by Department of Geography and Geology. Such a centre would be internationally unique in bringing together a series of dating techniques that allow the dating of geological and archaeological samples from the entire history of the earth and mankind. The centre would also be able to attract elite geo-scientific researchers and, by implication, offer Geology much-needed support to increase its student uptake. The centre would become an

important player in the education of master students in earth system science.

4.2.3. Bioimaging

At KU, a well-coordinated interfaculty initiative attempts to achieve significant upgrading of different types of bioimaging equipment. This is important to further strengthen research within a wide range of interdisciplinary fields. The PhLS committee stresses the importance of an upgrading for the field of biology and closely related disciplines. KU and the PhLS faculties should continue to support this initiative and ensure that the planned investments are in fact made and the equipment maintained. During the next few years, the establishment of large-scale international infrastructures in Lund (the synchrotron facility MAX-IV and the European Spellation Source Scandinavia) will have a major impact on the field of bioimaging. The PhLS faculties at KU need to play a key role in this development. To take full advantage of the geographical closeness of such equipment, KU needs to engage actively – politically as well as financially – also in the early development of these facilities.

The outcome of investments in technology platforms like metabolomics, bioimaging and in the synchrotron facility are substantial. They ensure the continued development of related research fields and allow for first-class education of students and young researchers within a wide range of disciplines. There is no doubt that this type of equipment infrastructure is necessary to conduct cutting-edge research in the future. Thus, it is the responsibility of KU and its researchers to ensure that opportunities within these areas are not lost.

4.2.4. Coordinated infrastructure applications

To ensure the optimal development of infrastructure, it is necessary to strengthen the coordination of major applications, firstly at PhLS level, then at university level and finally at national and international levels. The deans are responsible for such large-scale applications.

4.2.5. Improved teaching facilities

To comply with modern teaching methods, the existing teaching facilities at the PhLS faculties need to be improved. Didactic methods today demand flexible spaces that allow for teaching in smaller or larger groups, and the integration of E-learning. This means that many of KU's large auditoria are effectively redundant and need to be converted into smaller, more flexible spaces.

It is an absolute necessity to improve the laboratory facilities for wet-lab courses. To ensure optimal usage, this should be coordinated at faculty level (the Interdisciplinary Instrument Tower will also play a role here). Finally, the PhLS faculties need to improve the maintenance of field stations and ensure that they are sufficiently integrated into faculty study programmes.

4.3. Academic leadership

Academic leadership means that the head of department has:

- the ability to formulate ambitious scientific goals
- the capacity to come up with visionary ideas and create enthusiasm for them among staff members at research centres/groups
- an awareness of the dynamics of scientific structures with regard to immediate goals, technologies and participating scientists
- the ability to stimulate collaborative efforts to reach defined research goals while still allowing the individual scientists personal freedom to perform and develop on his/her own
- the courage to make the right decisions in egocentric and competitive scientific environments

4.3.1. Intensified management education

KU has acknowledged the importance of strong academic leadership. The faculties have already invested significantly in management courses for employees and management. This area needs more attention, particularly at a departmental management level. Very strong skills in academic management (distinct from general management skills) are indispensable for heads of department, and must be prioritised when recruiting people for these positions in the future.

4.3.2. The dean's obligations

In cases where external funding is not available, new interdepartmental research initiatives should receive seed money to document the university leadership's commitment to the project, and to provide the researchers involved with the financial incentive to overcome the barriers associated with the start-up of a new research project. LIFE has initiated several interdepartmental research initiatives with faculty support ranging from DKK 3 to 11 million per initiative.

All departments at PhLS are within biking distance. This is unique to the University of Copenhagen and offers a competitive advantage when it comes to interdisciplinary research activities. However, it is important to

emphasise that while new interdepartmental research initiatives should certainly be encouraged, such collaboration takes time that will inevitably be taken away from other obligations. To optimise the chances of success, the PhLS deans should coordinate interdepartmental activities to make sure the long-term profile of the PhLS area is coherent. The committee recommends that the deans provide the means to implement the long-term strategy of research at the three faculties. Research and Innovation Boards may provide guidance and inspiration for the deans. Faculty deans are also responsible for launching interdisciplinary research initiatives that bridge research traditionally carried out by different disciplines. Interdisciplinary research initiatives may, of course, include faculties outside of the PhLS, as illustrated by the two UNIK research projects.

It should be noted that there are potential conflicts between society-defined research strategies and internal long-term strategies defined by the university itself. The strong reliance on external funding may, at times, make it difficult to retain important teaching and research competences. Hence, it is important to maintain the economic means for long-term planning at university level to ensure the survival of central research environments at all times.

4.3.3. The head of department's obligations

Strategic research planning is becoming increasingly more important. Heads of department need to know the research groups in their department well enough to appreciate their international status and provide relevant guidance on how to develop their research further. The fact that the head of department has personal experience of the potential barriers research groups may face, and the ability to encourage individual groups to positively exploit new opportunities, are key to the research group's success. For this reason, the PhLS committee recommends that heads of department have an academic background and a strong research profile.

When it comes to professorial recruitment, the PhLS committee recommends that all heads of department devise a rolling five-year plan. This will encourage long-term planning and increase the chances of obtaining co-financing from external sources. External donors are more likely to respond positively to applications when they can see the clear research profile and the long-term purpose of their investment. Close collaboration with heads of centres hosted by the department is important to ensure that the research profile of the given centre matches or complements the profile of the department. If this is not properly coordinated, the benefits of centres that might appear highly successful, will be limited – simply because they are not embedded in the university system. Without close integration, centres will be of limited long-term value to the departments.

Deans should be given the mandate to compose and implement five-year plans for professorial recruitments because such long-term planning will help the PhLS faculties coordinate research activities and priorities.

4.3.4. Research group leadership

It is important that all employees at a department contribute to the advancement of science and teaching. Scientists become frustrated when they cannot secure external funding for their research. In such situations, heads of department, heads of centres and section leaders need to step in to advise the scientist. The scientist may need to modify the focus of his/her research project to identify new collaborators, or he/she may need to define new research areas with greater potential for success (which may even fill gaps in the department's research profile). If none of these initiatives are successful, the research field might then be closed down, and the researcher assigned a heavier teaching load. Research group leaders should understand these issues and clearly convey the message to the researchers in their own group.

4.3.5. Tenure-track positions

Increasing dependence on externally funded research staff raises the issue of whether it would be useful to implement US-inspired tenure-track positions. A tenure-track system may hopefully provide a higher level of security for young, upcoming researchers, and encourage them to participate more strongly in teaching programmes.

4.4. Education

4.4.1. Integrated Science module

The integration of relevant disciplines is far more demanding, and, for all parties involved, more rewarding than an inexpedient combination of disciplines.

A number of departments, in particular at SCIENCE and LIFE, raised issues regarding student mobility and the development of sufficient knowledge about closely related subjects. To tackle complex scientific and societal issues of the future, it is a prerequisite for graduates in the natural sciences to be able to navigate within related scientific fields and master integrated approaches to scientific problems. To develop interdisciplinary thinking and a broader understanding of the many disciplines within PhLS early in students' careers, the PhLS committee recommends the introduction of an Integrated Science module. To have the required effect, Integrated Science should be implemented throughout the PhLS faculties' natural science disciplines. The Integrated Science module consist of two complementing, interdisciplinary elements (Figure 4):

1. An introductory course during the first year of study
2. A practical course in the beginning of master degree studies based on innovative, interdisciplinary topics.

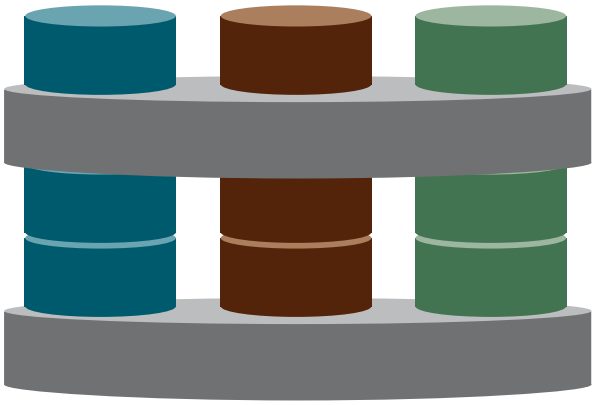


Figure 4. *The Integrated Science module creates two platforms for the interdisciplinary interaction of students: in the first and the fourth year of study.*

The introductory courses consist of a number of interdisciplinary subjects, which represent some of the major challenges and scientific questions that face natural sciences today. A number of courses with this type of focus already exist, such as "The Origin of all Things" and "Climate Change," but more courses need to be developed specifically for the Integrated Science module (for example, courses on sustainable development, foods, the universe, interdisciplinary chemistry, intelligent therapeutic drugs, welfare, and life and death). Several departments across the PhLS faculties should collaborate to develop the specific Integrated Science courses. The PhLS committee suggests that the Integrated Science module offers six specific 7.5 ECTS courses, from which the individual student chooses two. Some of these courses may be based on the introductory courses already on offer, which fulfil the same purpose; but they need to be adapted to the requirements of the Integrated Science module.

The courses should be taught by lecturers with excellent pedagogical skills, who can bring scientific questions into perspective, and em-phasise the need for the kind of basic knowledge that students start to acquire in the first year of their study.

In some cases, it may be necessary to produce new teaching materials, for example a focused compendium or textbook for each subject.

The introductory course should stimulate students' ability to see their own specific field in a broader perspective, and encourage them to think across conventional scientific boundaries. Such teaching will develop students' innovative skills and allow them to apply these to solving the scientific challenges that develop in the interfaces between classical scientific disciplines. We also expect an Integrated Science module to help the individual student identify his/her main scientific interests and choose relevant courses from other study programmes. All too often, we see that a considerable number of students become disappointed soon after they begin their university studies, and they decide to drop out of one study programme and embark on another. Appropriately planned, introductory courses might well stimulate the students to make more informed decisions about the new subject to study without loosing valuable study time.

The second interdisciplinary course (7.5 ECTS) is of a more practical/experimental nature, and we suggest placing it at the beginning of the master programme. During this course, students from different disciplines will work with a teacher in small groups to solve a specific scientific problem. This will encourage students to

collaborate across disciplines at a point in their career when their academic profile is more defined and they possess more advanced scientific skills. Preferably, the students should be exposed to different laboratory environments during this course, such as an appropriate core instrument facility (see section 4.2.1.).

4.4.2. Recruitment and reduced dropout of students

Being able to recruit a sufficient number of students is a major concern for many PhLS departments. For some departments, low recruitment has been an issue for some time; for others, a continued decline in student intake suggests that this may become a problem in the near future. The reasons for this might differ from department to department. But there is one central problem that afflicts all PhLS departments: natural science is not communicated well enough to the general public or, more importantly, to the next generation of students. The committee is convinced that the main reason the recruitment of students to natural sciences has declined relates to a lack of proper "bildung" within natural sciences. The fact that Danish high schools have difficulty attracting natural science teachers capable of inspiring the next generation of natural science students has significantly weakened the "food chain". To break this vicious circle of lower focus, lower recruitment, etc., we recommend that the role of the Natural History Museum be strengthened so it becomes the key communication centre for the natural sciences. The museum should also act as the prime driver in the continuing education of high school teachers in natural science and ensure that future generations of university students receive inspiring and up-to-date instruction in science.

It is recommended that the PhLS faculties coordinate their recruitment strategies aimed at national and international students and staff. A strong, integrated external profile that highlights selected topics within natural sciences is of particular importance. One obvious way of communicating and strengthening the image of natural science education at KU would be to establish a central PhLS website that provides links to departmental homepages where current research projects are presented. Another would be to promote the Free Inner Market at KU – the fact that students at PhLS departments have access to a wealth of education programmes that all offer close interaction with students and staff from closely related departments.

It is recommended that certain study programmes open up for "two-subject" students. This has already been implemented at Mathematics (mat-øk) and other areas. Geology, in particular, could benefit from this model.

4.4.3. Interfaculty student mobility

The committee emphasises the importance of the work done by the Pro-HALS and KUUR committees, which has resulted in a series of decisions and recommendations (read more at: www.kuur.ku.dk). These decisions should be implemented as fast as possible to counteract the fatigue and lack of patience with structural difficulties, which, quite understandably, have increased among students and staff at KU.

4.4.4. International recruitment of students

Several subjects in the master studies curricula at PHARMA, LIFE and SCIENCE are now being taught in English. We strongly recommend that English-language teaching be implemented in all disciplines to facilitate the uptake of students from aboard. In addition to increasing the student mass and income (via the STÅ counting system), an increase in the recruitment of foreign students will serve to improve and enrich the international profile of our study programmes. Familiarity with English-language teaching will also encourage Danish students to travel abroad to pursue, for example, PhD studies or seek employment in international organisations or industries. If managed successfully, this will help to improve the employment rate within an academic area that has produced a surplus of candidates for a number of years.

The PhLS committee further recommends a common international marketing strategy for the PhLS faculties at KU.

A) Students	B) Education
Better student recruitment: • Improve communication of natural science to the general public • Continued education for high school teachers and primary/lower secondary school teachers • Ensure better transfer of knowledge from the university to younger people • Improve conditions for the recruitment of international students **Reduce dropout of students:** • Improve flexibility in combination and choice of studies • Better alignment of studies • Implementation of the Free Inner Market and ensure better advertisement of courses • Improve infrastructure • Implement modern didactics in teaching • Implement an Integrated Science module to inspire students	**Improved course mobility:** • Implementation of ProHals and KUUR initiatives to remove the rigid STÅ counting system • Implement the Free Inner Market • Implement block structure at all studies • Implement the "30 ECTS" rule for all study programmes **Integration of studies:** • Ensure stronger integration between Mathematics and closely related life science educations • Better coordination and integration of related courses at master and PhD level to increase student uptake and prevent specialised courses being cancelled due to too few participants • Support ongoing initiatives to establish new interdisciplinary and international studies • Implement an integrated study plan to provide a broader perspective **Employment:** • More focus on teaching competences • Implement a tenure-track system to ensure continuity, raise expectations from teaching competences and reduce vulnerability in fields with reduced student recruitment

Table 4. *General recommendations on a) conditions concerning recruitment, dropout and mobility of students, and b) conditions concerning quality of education*

5. Special focus areas

5.1. Introduction

Some disciplines and research areas within KU's PhLS faculties are clearly ready to take advantage of synergies between departments. In other areas, interdepartmental initiatives are already in progress. However, some areas experience slow progress on this front, demanding quite significant initiatives from the deans involved, as outlined in Chapter Four. From a research and educational point of view, it is imperative that top management at KU takes action to reap the benefits of these synergies. We are convinced that this would also have a positive impact on closely related areas in the PhLS field.

During our visits to the PhLS departments, we identified a number of barriers as well as unexploited possibilities. The most significant of these are discussed in this section. However, before engaging in issues that need to be improved, the PhLS committee wishes to emphasise that research activity and associated study programmes were generally found to be of a high international standard, with some departments ranking among the best institutions in the world. Likewise, it was encouraging to experience the strong links that exist between industry and the Departments of Medicinal Chemistry, Forest & Landscape, Food Science, and Plant Biology and Biotechnology. Concurrent with their industry collaboration, these departments still manage to maintain a strong international reputation in their basic research areas. In the following, we will not comment on each individual PhLS department but focus on those that need special attention.

5.2. Chemistry

Chemistry is acknowledged to be a field of central importance – both in its own right and as a field that invites interdisciplinary collaboration with several strong and important areas of research, for example, environment, biochemistry, biology, drug sciences and nanoscience. It is essential to stimulate and coordinate the chemistry environments at KU. To do so, staff and student recruitment, as well as career development, need to be stimulated.

5.2.1. Research

Chemistry departments at KU need to be strengthened and integrated by coordinating, supporting and increasing the talent and expertise present in these departments. One way would be to ensure that Chemistry

departments are competitive enough to attract funding for centres of excellence as well as basic research centres. In particular, joint efforts to support the development of a strong research centre in basic chemistry are much needed. We also need interfaculty collaboration to offer critical mass to more specialised chemistry research at PHARMA and LIFE, addressing aspects relevant to advance research within drug development and biological sciences. The Nanoscience Centre and a few other activities demonstrate that establishing, or participating in such centres of excellence is certainly possible within the field of chemistry as long as the right ideas and scientific leadership are present.

The PhLS committee recommends the establishment of a Centre for Basic Chemistry. The centre should receive a five-year, university-funded grant of DKK 100 million. Two internationally renowned chemists are recruited to establish and direct two research initiatives that will develop into two centres of excellence. Within the five-year period, it is predicted that these centres will gain the reputation necessary to warrant further funding from KU and to attract substantial external funding. In choosing the topics for the two research centres, we recommend that serious consideration is given to the research areas, Atmosphere Chemistry and Chemical Synthesis of Bio-active Compounds.

If properly described and advertised, it should be possible to attract two scientists from the international elite for the director positions. The two directors choose which of the current employees at SCIENCE, PHARMA and LIFE's chemistry departments they find qualified to receive funding from the centre's grant. One of the two directors will also function as head of the graduate school. The two directors evaluate applications for PhD scholarships and decide which will be funded. In short, the two directors will have the responsibility for overseeing the development of chemistry's research profile at KU in a coherent and complementary fashion.

The joint funding available through the Centre for Basic Chemistry will be essential to coordinate the research within the field of Chemistry at KU; it will also stimulate collaborative efforts to raise the overall status of research in chemistry. Research in the interphase between the fields of chemistry and, for example, biology and physics should not be neglected, and the two proposed major research subjects, Atmosphere Chemistry and Chemical Synthesis of Bio-active Compounds would offer numerous opportunities in this respect.

5.2.2. Education

The coordination of teaching efforts in the area of Chemistry is almost non-existent at KU – despite the fact that chemistry is taught at all three PhLS faculties. The students entering the field of Chemistry at KU form a very heterogeneous group when it comes to intellectual skills and pre-knowledge. Due to national regulations, no upgrading pre-bachelor courses are offered at KU (only at DTU). Consequently, differences in qualifications among the students are maintained on subsequent courses and throughout entire study programmes. This becomes very challenging for teachers who need to adjust their teaching to the varying qualifications of their students. The difficulties that ensue may cause students to drop out of their course or transfer to competing study programmes at other universities.

Basic courses should be coordinated between faculties to optimise the use of laboratory facilities and staff expertise. It is important to keep up subject-specific focus by, for example, maintaining focus on drugs in the basic teaching of organic chemistry and synthesis at PHARMA. However, it is possible to develop a model where general aspects of organic chemistry are taught by central staff, while group work brings the subjects into perspective with examples relevant to the particular study programme.

The courses offered should be differentiated so they target and support students with low as well as high pre-qualifications. To secure recruitment for the University of Copenhagen and chemistry teachers for Danish high schools, special attention should be given to particularly gifted students by offering highly demanding and stimulating subjects. This is only possible through interfaculty coordination, which ensures a sufficiently large number of students for these activities. Teachers from closely related disciplines like biochemistry, biology and nanoscience should be involved. A Centre for Basic Chemistry (see below) should host a Graduate School of Pure Chemistry, which is granted a significant number of PhD scholarships initially sponsored by KU. Chemistry environments at PhLS that fund 66 per cent of a PhD scholarship, may apply for the remaining third from the graduate school. The graduate school directors evaluate and award PhD scholarships.

5.2.3. Infrastructure

At present, the general coordination of infrastructural development within the chemistry area is weak. External funding is concentrated on few centres and groups but otherwise low. Facilities for teaching are in a totally non-acceptable state, particularly at SCIENCE.

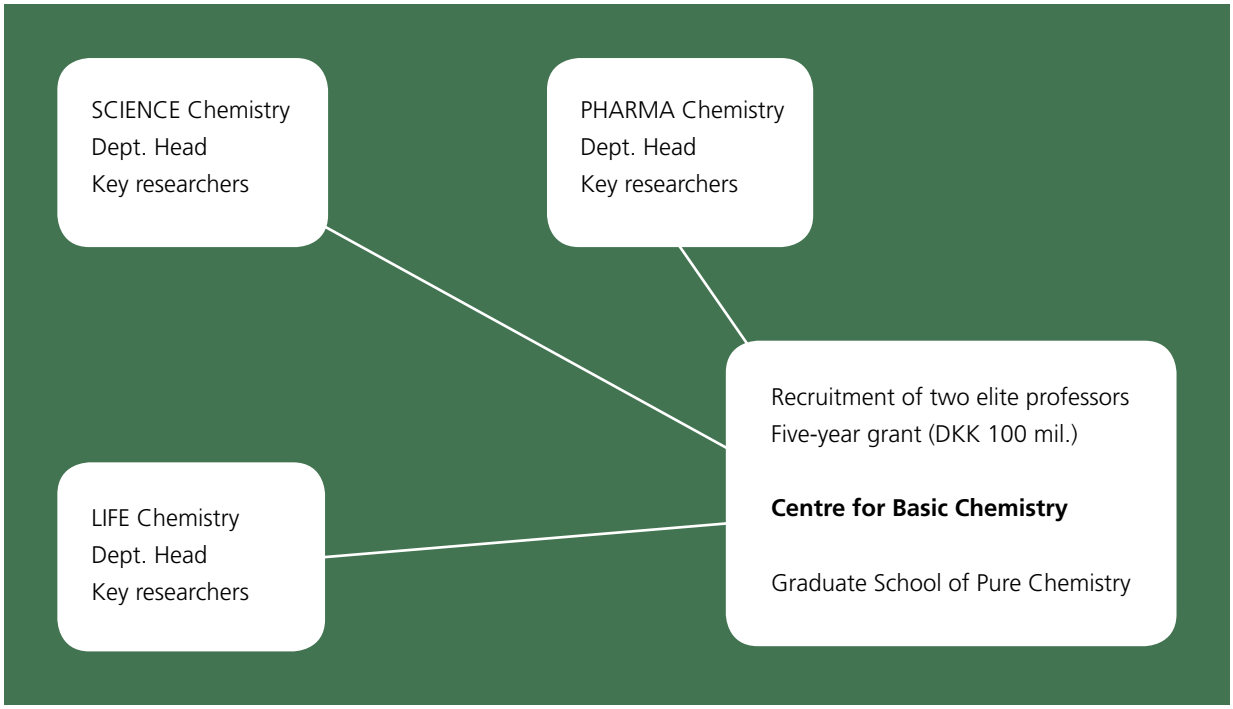


Figure 5. *Concept for the Centre for Basic Chemistry.*

5.3. Biology

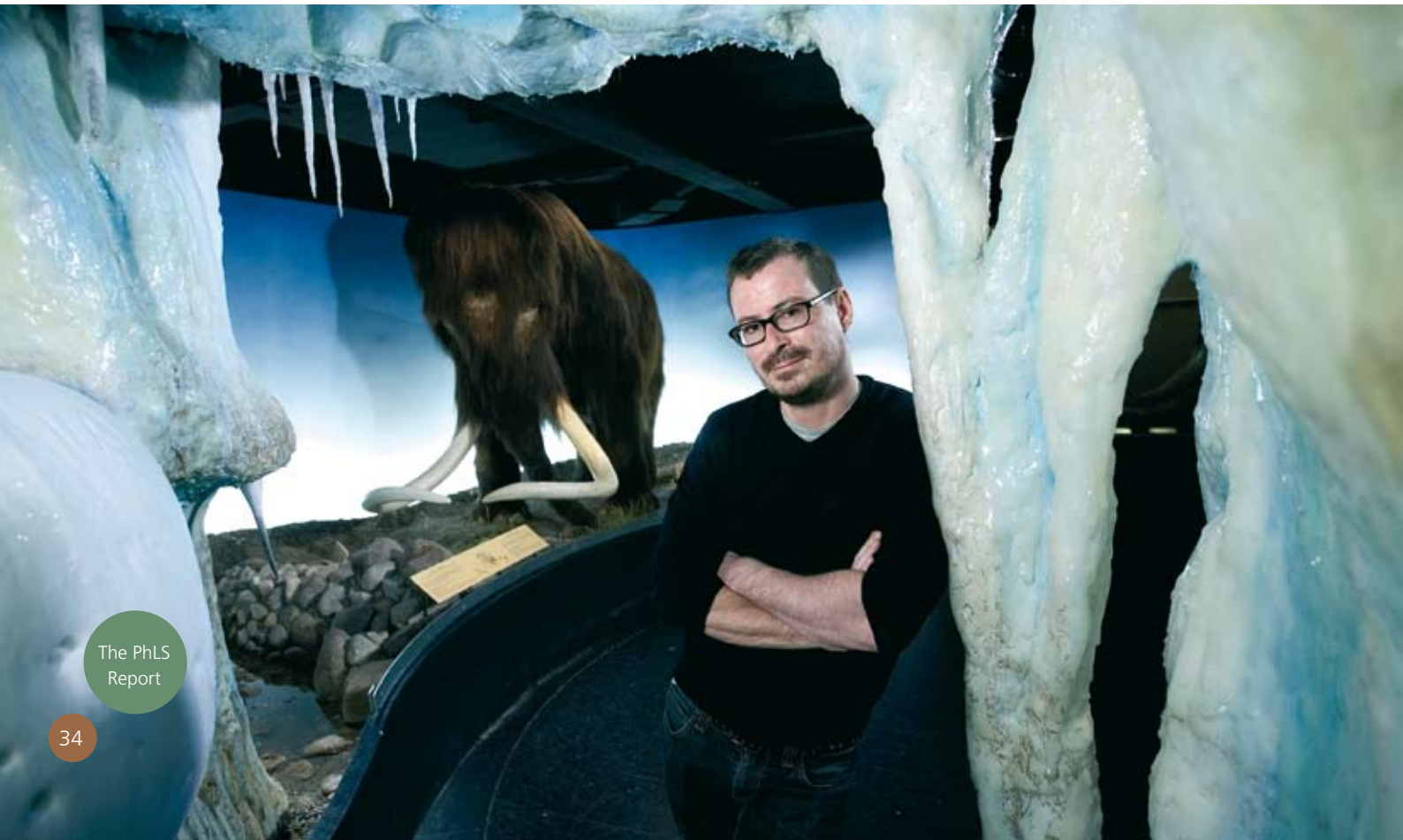
Biological research and education is practiced in a multitude of environments at PHARMA, LIFE and SCIENCE. Several of these engage in close interfaculty collaboration, are strongly integrated with closely related disciplines, and/or generate significant external funding. At the same time, they also attract large numbers of students at all levels. The recent administrative merger of four biological departments at SCIENCE has facilitated a much-needed coordinated biological science policy that aims to strengthen research priorities and avoid overlapping teaching activities. This merger further facilitates the development of 'integrative biology' (including disciplines from genomics to ecology and evolution), which deals with the complex interrelationships between different levels of organisations and between living organisms and the physical and biological environment in which they live. It is mandatory to maintain a diversity of biological disciplines whether they are concerned with higher levels of organisation or deal with levels of molecular biology. A few particular environments show a lack of coordination and therefore invite attention.

5.3.1. Research

A Copenhagen Plant Biology Centre without walls is an interfaculty initiative in plant biology that is currently in the pipeline. It is an excellent example of how to organise complementary research across three faculties, and the initiative also documents excellent departmental leadership. Plants (including moss and algae) are central to research areas such as climate change, plant productivity, biotic and abiotic stress responses, food supply and quality, biodiversity and energy supply. The centre encompasses all plant research areas from molecular biology to ecosystems. The objective of the centre is to further stimulate and emphasise the excellent scientific research at several departments at KU, and to coordinate larger research initiatives to secure aligned improvements to the infrastructure and technology platforms. New joint projects and more focused research are emerging from this interfaculty initiative, and it is expected that plant biologists will be able to attract significantly more national and international funding. The centre also aims to facilitate interaction between KU and the industry.

The initiative to establish the centre was taken by the Department of Biology, the Department of Plant Biology and Biotechnology, and the Department of Soil Science and Ecology; it comprises a bottom-up process with contributions from all plant biologists at KU.

KU is expected to support the Copenhagen Plant Biology Centre with resources for the necessary development of up-to-date research facilities, such as advanced equipment for bioimaging, metabolomics and improved growth facilities (i.e. greenhouses and climate chambers).



A similarly advanced initiative has been launched to coordinate research and education into microbiology by the PhLS faculties. To create win-win situations, this may eventually result in reallocation of research groups between faculties.

Other topics:
The PhLS committee recommends the coordination of activities in the fields of biophysics and biostructural research. Biophysics would benefit from continued coordinated efforts between the Biology departments at SCIENCE and LIFE and the Niels Bohr Institute, as well as the biophysics activities at PHARMA. Biostructural research is driven from SCIENCE and PHARMA, and important research draws on biostructure research at LIFE. The PhLS faculties will derive great benefit from strengthening and coordinating these activities. Again, it needs to be emphasised that seed money is needed to ensure the success of new structures and centres.

5.3.2. Education

The Department of Biology at SCIENCE and the Department of Plant Biology and Biotechnology at LIFE have taken serious measures to optimise their study programmes, and they have already had some success in improving the throughput of students. The next step would be to present coordinated study programmes for, for example, students aiming to become high school teachers ('gymnasielærer').

Generally, students in biology have fairly weak skills in physics and mathematics. This situation has to be rectified if future biology candidates from KU are to contribute to innovative research across boundaries between traditional disciplines. It is clear that more attention has to be given to this problem in the design of future study programmes, but this calls for close collaboration between the departments of Biology, Physics and Mathematics. Interdisciplinary studies may increase biology students' skills in physics and mathematics. Students who choose this option could take fewer biology courses at master level to allow time for specially designed courses in mathematics and/or physics. We suggest that a team of collaborating teachers at the departments involved develop transparent study plans for such a programme. If the study plans are well-designed, it is to be expected that such an interdisciplinary programme may attract students from abroad.

Every year, several hundred students fail to be accepted to the veterinary study programme. This issue calls for more attention. The faculty of LIFE needs to consider how to plan alternative study programmes for these students, which would qualify them for professions in closely related areas that do not require the international accreditations of a practicing veterinarian.

5.3.3. Infrastructure

The present association of structural biology and chemistry may not be the optimal solution. However, if the Chemistry area at KU improves, this may serve as an important bridgehead to the field of biology. Although bioinformatics has already been embedded in clusters of complementary, well-established research centres and teaching environments, this field would benefit from further coordination and integration. Likewise, the field of biophysics is weak at KU because high profile research and education is driven from small, yet productive units.

In Biology, there is a critical need for improved access to field stations and for high-throughput screening and production facilities for molecular biology. High-impact publications within these fields currently rely on such facilities, which are currently completely inaccessible to the Biology environments at KU. The Copenhagen Plant Biology Centre should be supported with resources from KU so that they can invest in up-to-date research facilities for, for example, bioimaging, metabolomics and improved growth facilities (i.e. greenhouses and climate chambers). At present, the facilities and research at Centre for Protein Research (CPR) are not properly integrated. Although CPR is still under construction, it is important that plans for integration are clearly outlined from the very beginning. In particular, the protein-science communities' need for a high-throughput protein production and purification facility should be coordinated with the integration of CPR at KU. The fact that centres are embedded in associated activities at KU is the key to their success. It is important to achieve long-term, positive effects for a broader environment, to ensure synergetic impact on the closely related research fields, and to justify large investments.

5.4. Geology

The Department of Geology and the Department of Geography at SCIENCE have merged into a single administrative unit. The Department of Geography and Geology is housed in the same building complex as the Geological Survey of Denmark and Greenland (GEUS). This research environment is of significant importance to the Danish governmental sector and to the private industry. The geo-scientific research at SCIENCE spans a wide spectrum – from basin studies and studies in water resources, to strategic planning and management of the environment and terrestrial ecosystems. Where relevant, the department coordinates research activities with the Department of Forestry and Landscape at LIFE.

Geological research has a long and strong tradition in Denmark and plays a critical role in Danish society. Graduates of the Department of Geology are employed by the state as well as industry. Geologists from KU participate in the Nordic Centre for Earth Evolution financed by the Danish National Research Foundation.

The PhLS committee recommends further coordination of geological research activities. This will improve the future economy of a department that is facing serious and growing problems due to a devastatingly low student recruitment rate.

5.4.1. Education

Geology at KU is experiencing what could be called a contradictory crisis, which is partly explained by the field's serious recruitment problems. Undoubtedly, this is because geology is no longer taught as a subject in Danish high schools. The department will have to take serious measures to rectify this unhappy situation. As things are today, it is difficult to study geology in a two-subject combination; we should consider allowing students to do this. Another possibility worth considering is to internationalise studies to attract students from abroad. Perhaps more immediate effects might be seen if geologists at the Natural History Museum and at the Department of Geography and Geology devise an offensive pedagogical information strategy aimed at Danish high school students.

5.4.2. Infrastructure

So far, efforts to establish a National Centre for the Dating of Materials have been unsuccessful. Such a centre would significantly boost both education and research in the field, and would be another way of improving the situation for Geology at KU.

5.5. Mathematics

This field is central, both in its own right and for all other natural science disciplines. Mathematics is used both as a tool and as a language, communicating results between sciences. The interdisciplinary use of mathematics has the potential to provide new avenues to analyse and understand complex chemical and biological systems at molecular as well as global environmental levels.

5.5.1. Research

It would be highly beneficial to KU if research into mathematics was better integrated and combined with a number of closely related disciplines that, in turn, would stimulate new fields of research. This potential is not adequately exploited today. One way to improve this situation would be to generate research projects through close collaboration between mathematicians, biologists and physicists. Such collaboration would improve teaching as well as research.

5.5.2. Education

Mathematics is taught as a subject at all faculties. Historically, it has been taught by mathematicians at all faculties. However, it has been acknowledged that subject anchorage is paramount for learning.
It must be stressed that not all natural science disciplines need to have a significant mathematical component. It should also be kept in mind that many students have a non-mathematical approach to their natural science discipline. On the other hand, a number of natural science disciplines would be strengthened by an integrated mathematical course component. In such cases, it is of critical importance that the mathematical content of relevant courses is provided by competent mathematicians who have a profound understanding of the key elements of the particular natural science course. It is neither sufficient nor satisfactory for students to be presented with a mathematical lesson and then left with the challenge of transforming the mathematical terms into the scientific terms particular to their field of study.

5.6. Computer Sciences

5.6.1. Research

The integration of computer sciences with central basic research areas within PhLS is very important. Computer sciences should play an active role in, for example, bioimaging, metabolomics, biophysics, modelling, bioinformatics, statistics and database mining. The department is associated with the E-science Centre. However, this centre is not affiliated to any PhLS departments. This might constitute a future problem when it comes to securing facilities, expertise and commitment from partners. Moreover, the centre is experiencing a lack of financial support and seed money – a general problem shared by many centres currently initiated at SCIENCE. In order to succeed, research centres need structural and financial support as well as administrative specifications.

5.6.2. Education

Computer programming for the simulation and exploration of scientific models used in biology, geology, chemistry, etc. is taught at universities abroad. The PhLS committee recommends that the Department of Computer Science develops such teaching. The planning of new courses should be carried out in collaboration with colleagues in other PhLS departments. Because computer modelling is a tool for other natural sciences, it should accommodate user needs. Rather than a full bachelor study programme, it would be appropriate to develop a few customised courses that could be offered to master students from different study programmes

5.7. Museums

The Natural History Museum of Denmark was established on 1 January 2004 by merging four separate institutions: the Botanical Garden, the Botanical Museum and Library, the Geological Museum and the Zoological Museum. The museum is now integrated as a department of the University of Copenhagen.

The Natural History Museum comprises research institutions of international calibre. The idea to locate all the museums around the Botanical Garden makes great sense. Staff are excited by this merger, but the committee has learnt that funds for the required renovations and new buildings to create the desired infrastructure for the exhibitions have not yet been obtained. The museum's performance is of great importance if we are to increase the understanding of natural sciences among the general public. The museum also provides a direct platform from which to address high school teachers and offer them inspiring new entries to natural sciences that they can use in their teaching. Long-term, this could result in an increase in the number of students recruited by the natural science faculties at KU. In this way, the key target group of the museum complements the basic academic education offered by the PhLS faculties to university stu-

dents. The challenge facing the museums, therefore, is to maintain continued basic research activities while at the same time offering a window to society. The transfer of the Centre for Ancient Genetics to the Natural History Museum certainly strengthens this goal.

5.8. Forest & Landscape and ministerial services

5.8.1. Considerations/ministries

As a result of the incorporation of many sector research institutions into Danish universities, many departments have taken on the role of advisors to government ministries. Forest & Landscape at LIFE is the result of a previous merger between a private research institution and a university department. This is a well-functioning department with clear research objectives and an organisation that is ready to handle a substantial number of requests – often at very short notice – from ministries. The experience that Forest & Landscape has gained with respect to fulfilling the combined role of a university department carrying out basic research and education as well as acting an advisor and consultant to government institutions (while maintaining research independence), is essential to communicate to other departments which are already, or may receive similar obligations. It was encouraging to see how well such difficult issues can be managed. To be noted, however, are the difficulties encountered for such departments when university funds become very small compared to external research funding and payments obtained for ministerial services (both of which may fluctuate dramatically). This situation needs serious consideration.

6. Conclusion

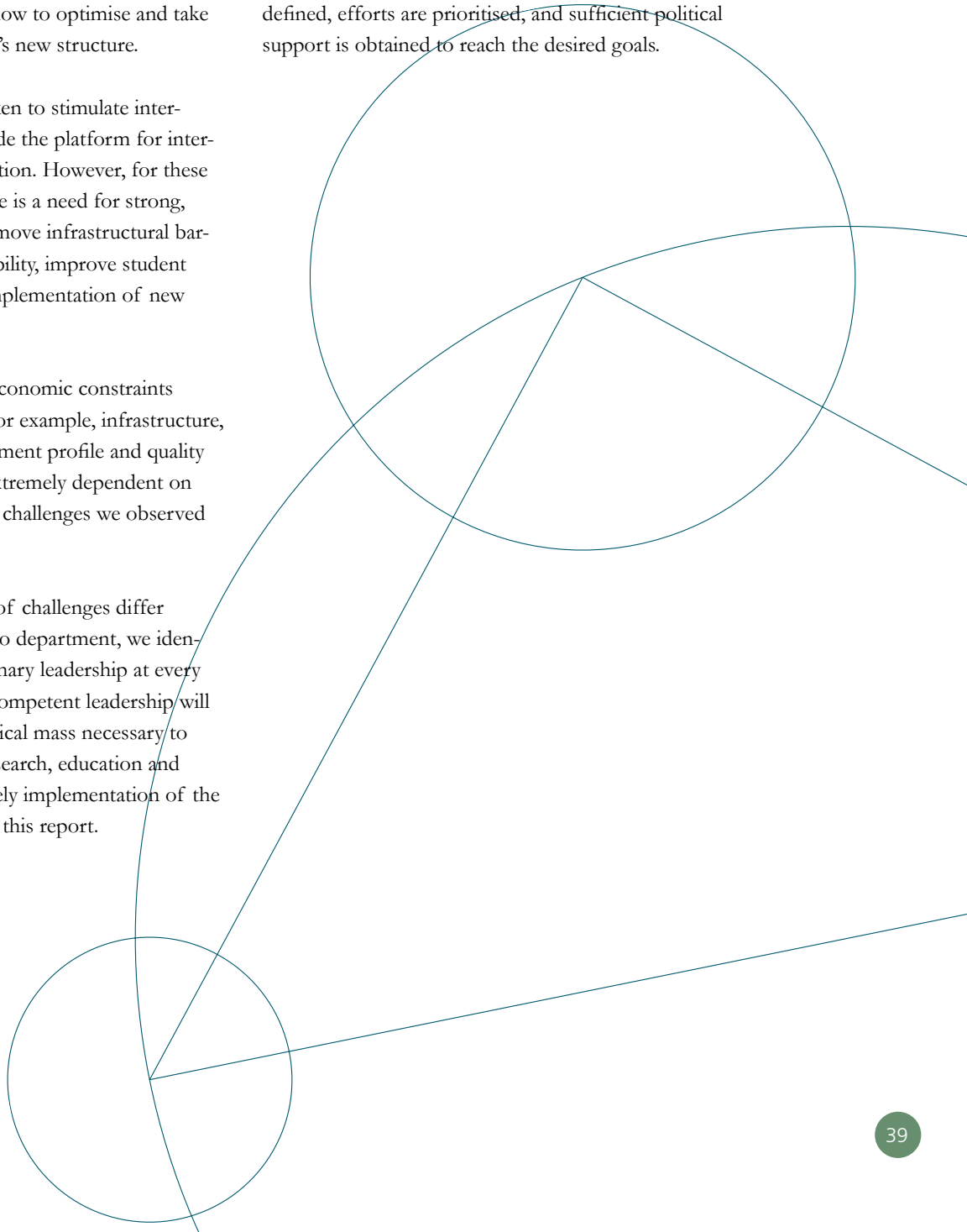
Research and education in natural sciences are of paramount importance to the further development of our society. The natural sciences at KU have had a huge impact on the general awareness of natural sciences, and they are internationally renowned for their high quality of research and teaching. With the introduction of new members to the KU university family in 2007, we have a unique opportunity to further strengthen this position and use our acclaim to attract first-class students and scientists from all over the world. This report presents specific recommendations on how to optimise and take full advantage of the university's new structure.

Several initiatives have been taken to stimulate inter-faculty collaboration and provide the platform for inter-disciplinary research and education. However, for these initiatives to be successful, there is a need for strong, coordinated efforts that can remove infrastructural barriers, ensure better student mobility, improve student recruitment and support the implementation of new initiatives.

Many departments claim that economic constraints obstruct their development – for example, infrastructure, the quality of research, employment profile and quality of education – making them extremely dependent on external funding. However, the challenges we observed are not only economic.

While the type and magnitude of challenges differ significantly from department to department, we identified a common need for visionary leadership at every academic level. Only through competent leadership will KU be able to establish the critical mass necessary to fully exploit its potential for research, education and innovation, and ensure the timely implementation of the recommendations presented in this report.

This report draws attention to issues that need prompt attention. The most important of these concern research collaboration, mobility between faculties, inadequate teaching facilities and improved recruitment of students. We encourage the deans and heads of department to address these issues as soon as possible. The establishment of core facilities, research centres, Integrated Science courses, and tenure-track positions must be discussed thoroughly. Ultimately, KU's top management needs to formulate a strategy in which specific goals are defined, efforts are prioritised, and sufficient political support is obtained to reach the desired goals.



Appendices

A1. List of meetings

DATE	Meetings
21 January, 2009	Information meeting
30 March, 2009	Department of Medicinal Chemistry
30 March, 2009	Department of Basic Sciences and Environment
31 March, 2009	Department of Chemistry
31 March, 2009	Department of Pharmaceutics and Analytical Chemistry
2 June, 2009	Niels Bohr Institute
2 June, 2009	Natural History Museum of Denmark
3 June, 2009	Department of Agriculture and Ecology
8 June, 2009	Department of Plant Biology and Biotechnology
8 June, 2009	Department of Mathematical Sciences
8 June, 2009	Department of Computer Science
8 June, 2009	Forest & Landscape
11 June, 2009	Department of Biology
12 June, 2009	Department of Geography and Geology
12 June, 2009	Department of Science Education
5 August, 2009	Department of Food Science
5 August, 2009	Vice Deans for Education
31 August, 2009	Department of Basic Animal and Veterinary Sciences Department of Small Animal Clinical Sciences Department of Large Animal Sciences Department of Disease Biology
2 September, 2009	Vice Deans for Research
2 September, 2009	Study leaders
14 September, 2009	Department of Biology Department of Plant Biology and Biotechnology

Beside these meetings, the PhLS committee held meetings with the faculty deans on a regular basis. Two newsletters have been sent to all employees.

A2. Letter of invitation

KØBENHAVNS UNIVERSITET

Til Institutlederen
Københavns Universitet

København, 2009

Invitation til møde med PHARMA/LIFE/SCIENCE (PhLS) udredningsudvalget

Dette brev udsendes som et led i PhLS-udrednings udvalgets arbejde med henblik på at give inspiration til et konstruktivt møde mellem institutlederen og udvalget. Såfremt der er ønske om dette, kan relevante repræsentanter for instituttets ledelse og studienævn være til stede ved mødet.

Udvalget vil besøge et større antal institutter på de berørte fakulteter i den kommende tid.

Møderne er et element i en længere proces, og udfaldet af møderne vil indgå i udarbejdelsen af en rapport, hvor udvalget vil fremkomme med en række anbefalinger til dekanerne for PhLS med henblik på et optimeret samarbejde omkring de synergier, som KU-fusionen muliggør for de nævnte fakulteter. Udvalget er vidende om, at der inden for fakulteterne er igangsat en række initiativer for allerede på kort sigt at udmønte disse synergier, og udvalget vil naturligvis så vidt muligt forsøge at understøtte og fremme disse initiativer.

Udvalgets hovedopgave er imidlertidig at afklare mulighederne for mere vidtrækkende og langsigtede tværfakultære initiativer med det formål at videreudvikle såvel forskning som undervisning samt innovationsgrundlaget på de tre fakulteter og naturvidenskab generelt på KU. Et vigtigt element i denne proces vil være frigørelse af og optimal udnyttelse af KU-ressourcer, så medarbejderne får øget mulighed for at arbejde med deres kernekompetencer. Det skal understreges, at udredningen på ingen måde sigter mod nedskæringer eller besparelser.

Kort sagt – hvordan kan fusionen medvirke til at KU får styrket naturvidenskabelig undervisning, innovation og forskning yderligere?

I løbet af mødet ønsker vi bl.a. at berøre følgende emner:

1. *Vedrørende allerede iværksatte initiativer*

a. Hvilke tværfakultære initiativer er instituttet allerede involveret i inden for innovation, undervisning, infrastruktur og forskning?
b. Hvilke er strandet – og hvorfor?
c. Hvilke ønskes opstartet?

2. *Vedrørende vidtrækkende nye interfakultære initiativer*

a. Hvis alting var økonomisk og praktisk muligt – hvordan styrkes de naturvidenskabelige fag på PhLS så, og hvilken rolle spiller dette institut i den proces?
b. Delemner af særlig interesse, der bør indgå i samtalen, er: bachelor-, kandidat- og forskeruddannelse, nybyggeri, infrastruktur og apparaturdeling, administrative forbedringer etc.
c. Hvordan kan det samlede optag på de tre naturvidenskabelige fakulteter øges? Nye kurser alene er ikke løsningen.
d. Indspil af udvalgets undervisningsmæssige visioner
   Mødet vil forløbe som en dialog, og udvalgets faglige sekretærer vil udarbejde et referat, som efter samråd med institutlederen efterfølgende vil indgå i udvalgets videre arbejde.

Inden mødet kan følgende med fordel overvejes:

- Er det et problem, at (nogle af) de studerende ikke har et tilstrækkeligt højt niveau inden for naturvidenskabelige fag?
- Er spredningen i de studerendes niveau for stor?
- Er det et problem, at de studerende ikke er samfundsmæssigt bredt perspektiverende?
- Er det et problem, at institutterne dublerer frem for at komplementere med kursusudbud?
- Hvordan kan vi forbedre undervisningsfaciliteter (laboratorier, auditorier, grupperum etc.) på KU?
- Hvordan sikrer man mere tid til forskning uden at gå på kompromis med undervisningskvaliteten?
- Afholdes der for mange kurser med for få deltagende studerende?
- Hvordan kan man gøre det udfordrende og prestigefyldt at undervise på basisfag?
- Hvilke tilgrænsende fagområder er instituttets undervisning med til at tilgodese?

Med venlig hilsen på vegne af PhLS-udredningsudvalget

Povl Krogsgaard-Larsen Birger Lindberg Møller Erik Hviid Larsen

A3. Detailed methods

Internal meetings in the PhLS committee: Initially, a number of meetings were held with the group of deans to organise the meeting schedule. Between meetings with departments and other central partners, the group of secretaries and the PhLS committee conducted several meetings. During these meetings, it was ensured that input from meeting partners were secured and referenced. Subjects of interest were identified throughout the process (those of common interest to the entire PhLS area and those that were more department-specific).

Identification of relevant meeting partners: All relevant departments within the PhLS group as defined by the group of deans, were listed. Excluded from this list were a smaller number of departments with obvious primary synergetic interests with HEALTH. These are expected to be included in a later process within KU. Further identified partners were the Vice Deans for Education and Research, the heads of studies and the didactic units of KU at the Department of Science Education. A list of meetings held can be found in Appendix A1.

Meetings with partners: Prior to all meetings, a letter of invitation was forwarded to all meeting partners. The letter specified the purpose of the meeting, identified key subjects to be discussed during the meeting, and encouraged meeting partners to invite relevant people from the respective departments/groups to the meeting. All meetings were primarily held on location (i.e. at relevant departments where possible), and they lasted approximately two hours. In several cases, the partners involved had prepared written material and oral presentations, the former of which are stored and referenced by the PhLS committee secretaries. All meetings were conducted as open and free dialogues and minutes were taken and catalogued as internal material.

Minutes from meetings: The PhLS secretaries forwarded minutes to the meeting partners based on notes from the meeting. Meeting partners commented on the minutes, which were subsequently forwarded to the PhLS committee. These minutes have been an important resource for the formulation of the current report.

Sparring with the Department of Science Education: Since central aspects of the PhLS committee's work concerned educational issues, the expertise of the Department of Science Education were drawn upon via discussions of visions and recommendations.

Meetings with the group of deans: Throughout the process, the PhLS committee has reported both in writing and in person to the group of deans via a series of meetings.

Report: The present report summarises and concludes the committee work in a short format. The report is intended as public material.

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