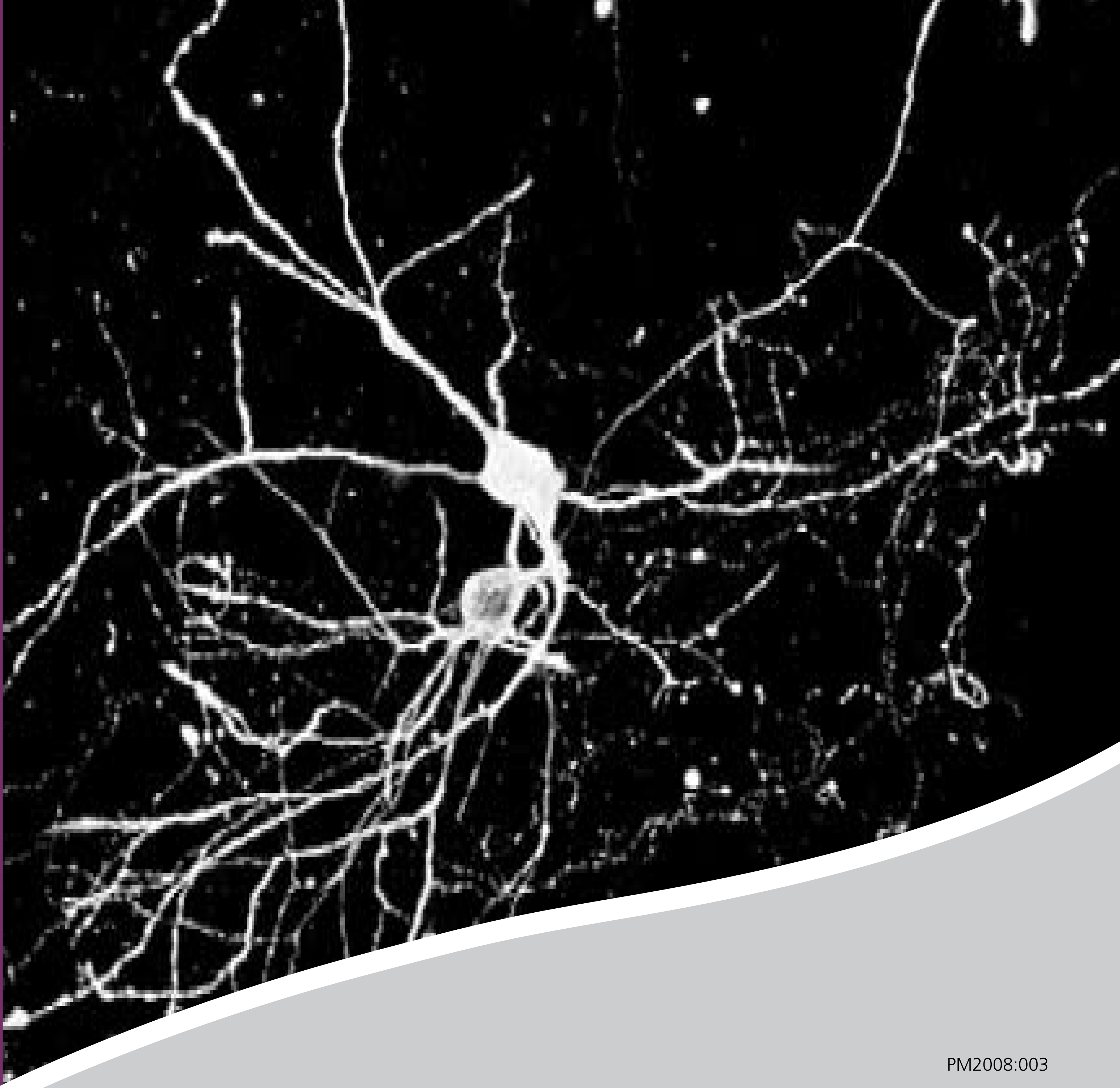

PM2008:003

# The Departments of Neuroscience at the Karolinska Institute and Columbia University

## A limited Comparative Study

Martin A. Wikström

itps SWEDISH INSTITUTE FOR GROWTH POLICY STUDIES

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The illustration on the cover was provided by Dr. Gilad Silberberg, Karolinska Institutet and depicts a striatal cholinergic interneuron filled with a fluorophore.

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## Summary

In this study, we have made a limited comparison of the research areas and conditions at the Department of Neuroscience at the Karolinska Institute (Stockholm, Sweden) and a neuroscience department of a top level university in the USA – the Department of Neurosciene at Columbia University (New York City). The study was focused on the production of publications, spin-off companies, patents, collaborations, research areas, clinical relevance, extramural funding and personnel structure. The CU-department is better funded compared to the KI department. A fact that may be one underlying reason to that while both departments publish approximately the same number of research articles, the CU department publications are, on the average, published in journals with a higher impact factor. It should however be stressed that both departments publish many articles in journals of very high quality. Patents are relatively scarce at both departments although slightly more common at the CU department. Spin-off companies also appear to be more numerous at the CU department while industrial collaborations are more common at KI. At both universities there are many different neuroscience-related initiatives and the two departments are important key parts thereof. While both departments have approximately the same number of PIs, the total number of employees is higher at the CU department. This may reflect a larger average research group size. Both departments can be classified as being primarily concerned with basic science neuroscience questions although there are also some translational elements. A majority of the principal investigators at both departments state that their research is clearly related to clinical questions.

## Introduction and Acknowledgements

This study aims to compare some aspects of the organization and performance of the Departments of Neuroscience at the Karolinska Institute (KI) in Stockholm, Sweden and the Department of Neuroscience at Columbia University (CU) in New York City, USA. The KI department was formed over 10 years ago when a number of departments active in the neuroscientific area merged. The CU-department is, on the other hand, quite new and started its operation on the 1 July 2007. However, in principle all the constituents of the department were present at Columbia also previously and the department can be seen as a subset of the “old” Center for Neurobiology and Behavior. Because of this, the comparisons made here concerning for instance publications and patents were focused on the principal investigators (PIs) that are part of the new department. The reason for choosing the department for the comparison and not the older center was primarily that the center was a more loose organization in which the PIs belonged to different departments. Furthermore the center was relatively large and therefore not suitable as a comparative object with the KI department. In addition, it was interesting to study the rationale for forming the new department.

Both KI and CU have since long had internationally recognized research in neuroscience and some of the most cited neuroscientists in the world works at the institutions. The objective of the study was to compare the KI-department with one of the best neuroscience-environments in the USA and in line with this it should be noted that the CU-department has had two Nobel prize laureates in Physiology or Medicine during the last seven years. In 2000 the prize was given to Professor Eric Kandel and in 2004 to Professor Richard Axel.

The comparisons made in this study are limited due to the limited time for the project. I would like to thank in particular Professor John Koester (CU), Professor Thomas Jessell (CU), Cecil A. Oberbeck (CU), Professor Staffan Cullheim (KI), Professor Ole Kiehn (KI), Professor Sten Grillner (KI), Christina Ingvarsson (KI) and Therese Sjöblom (KI) for all the help and assistance they have given during the course of the study. Many others have also been helpful for which I am very thankful.

A general description of the methods used can be found at the end of this report. When special methods have been used, this is described in the section concerned.

# 1 Analysis of publications

The analysis is based on publications made by Principal Investigators (PIs) at the two departments during 2006 and should therefore primary be seen as a "snapshot" in time. Fluctuations over time have not been included in the study. It is however feasible to expand the study presented here to cover more aspects in the publication structure. Only publications with at least one PI in the author list are included which may have led to that a small number of articles not were included. For instance, if a graduate student or dependent researcher has published an article with a researcher at another department then that article would not be included in this study. To investigate which publications that were made and to classify them as original or review articles, the ISI Web of Science (Thompson Scientific Inc.) was used. Some controls were made using PubMed (National Library of Medicine).

According to the departments

- the Department of Neuroscience at CU has 36 PIs and
- the Department of Neuroscience at KI has 34 PIs.

## 1.1 Basic analysis and statistics

The number of articles published by the two departments during 2006 was in the same range (CU: 101, KI: 89, table 1). This was true both for original research articles (CU: 93, KI: 78) and for review articles (CU: 8, KI: 11). In original research articles, the order of authors in the publication list is important. Usually, the first author is the individual who has done the largest part of the work while the last author is the research leader (e.g a supervisor or a group leader). Therefore these two positions are the most important and have the highest merit values. It is, however, important to be aware that this situation does not apply in the same way for review articles. The fraction of original research articles in which a department PI was either first or last author was approximately the same at both departments.

Table 1-1 Publication statistics.

| | **CU** | **PI first/last** | **PI first** | **PI last** | **KI** | **PI first/last** | **PI first** | **PI last** |
|---|---|---|---|---|---|---|---|---|
| **All art.** | 101 | 71 | 9 | 65 | 89 | 56 | 13 | 49 |
| **Original res. art.** | 93 | 63 | 6 | 60 | 78 | 47 | 6 | 43 |
| ***% of all Orig. res. art.*** | | *67.7* | *6.5* | *64.5* | | *60.2* | *7.7* | *55.1* |
| **Review art.** | 8 | 8 | 3 | 5 | 11 | 9 | 7 | 6 |

*Note: As a PI may have published alone or together with another PI, the sum of the categories "PI first" and "PI last" may be larger that then category "PI first/last".*

## 1.2 Article distribution in journals

The 93 original articles written by the CU department researchers were published in 36 different journals while the eight review articles were published in seven different journals. For the KI department, the 78 original articles were published in 55 different journals while the 11 review articles were published in 11 different journals. As can be seen in

Table 1-2 the number of articles per PI was approximately the same at both departments for all three article categories.

Table 1-2 Articles per PI.

| | CU | KI |
|---|---|---|
| **All art./PI** | 2.80 | 2.62 |
| **Original res. art./PI** | 2.58 | 2.29 |
| **Review art./PI** | 0.22 | 0.32 |

## 1.3 Impact factor analysis

### 1.3.1 Method description

Two articles in journals that had no impact factor listed in the Web of Science were excluded from the analysis. With one exception the impact factor listed in the Web of Science for 2006 was used for the analysis. The exception was Acta Physiologica for which the 2005 impact factor for Acta Physiologica Scandinavica was used.

For each category (All articles, Original research articles and Review articles), the impact factor for each specific journal was multiplied by the number of articles published in that journal. This resulted in accumulated impact factors for each journal that subsequently were summed together for each department (total accumulated impact factors). The summed impact factors were then divided by the number of publications (in each category) in journals with impact factor to yield an average impact factor per publication type (1). This analysis did not take into account the placement of authors in the author list.

**Average impact factor per article** = $[\Sigma(N_{art\_in\_journal} * IF_j)]/N_{art\_total(cat)}$ (1)

In addition, the total accumulated impact factor in each category was divided with the number of PIs to yield a PI comparative index (2).

**Comparative index** = $[\Sigma(N_{art\_in\_journal} * IF_j)]/N_{pi}$ (2)

$N_{art\_in\_journal}$ = Number of articles published in a specific journal.

$IF_j$= Impact factor for a specific journal.

$N_{pi}$ = Number of PIs at department.

$N_{art\_total(cat)}$ = Total number of articles in category.

### 1.3.2 Results

The results from the impact factor analysis can be seen in Table 1-3. On the average, original research articles from the CU department were published in journals with a higher impact factor than those arising from the department at KI. Furthermore, the PI comparative index for original research articles which in principle measures the accumulated impact factor per PI is also higher at CU than at KI. However, for review articles both the average impact factor per article as well as the PI comparative index were approximately the same for both departments.

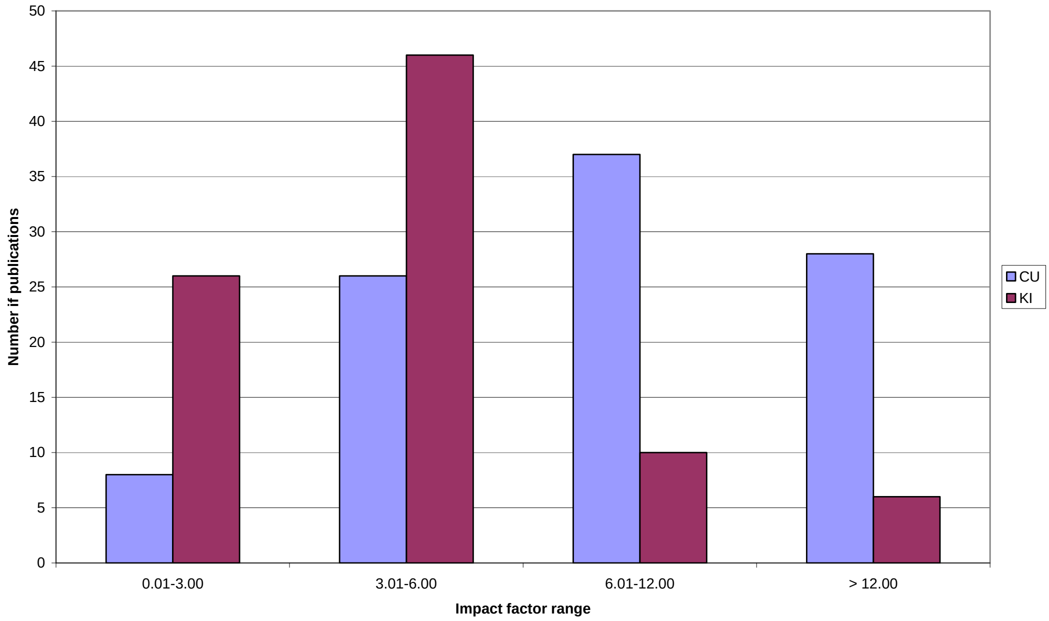
Table 1-3 Impact factor analysis.

| | CU | KI |
|---|---|---|
| *Average impact factor/article* | | |
| **All art.** | 9.84 | 5.21 |
| **Original res. art.** | 9.97 | 4.88 |
| **Review art.** | 8.33 | 7.55 |
| *PI Comparative index* | | |
| **All art.** | 27.05 | 13.63 |
| **Original res. art.** | 25.20 | 11.19 |
| **Review art.** | 1.85 | 2.44 |

*Note: See section 2.3.1 for explanations.*

It is difficult to measure the quality of a journal by impact factor alone. Journals of the same quality, but in different scientific areas, may have different impact factors depending on for instance how many researchers that are active in the scientific areas and the age of the journals. Journals with a very high impact factor are often (but not always) less specialized than those with lower impact factor. Some examples of such journals are Science and Nature. Many high-quality but specialized journals have an impact factor between 3 and 6. Furthermore, the impact factor for a journal may vary from year to year. To enable a better overview of the publications arising from the two departments, Figure 1-1 shows the total number of articles published in journals in different impact factor ranges.

Figure 1-1 Number of published articles in journals in different impact factor ranges.




## 1.4 Summary and Discussion

According to the analysis, the two departments produce approximately the same number of original research and review articles in peer-reviewed journals per PI. The average impact factor for original research articles (based on the impact factors of the journals), but not for review articles, was however clearly higher for articles written by CU researchers. For review articles the average impact factor was similar at the two departments. The comparative index (cumulative impact factor) per PI was highest for CU.

However, while the CU department has more publications in high-ranking journals such as Science, Nature, Nature Neuroscience, Cell and Neuron they also have a larger total scientific staff (PIs, associate researchers, postdocs, graduate students etc., see chapter 6). The data therefore suggest that, on the average, the number of articles per scientist may be higher at the KI department although the research is presented in journals with a, relatively seen, lower impact factor. Also, the results do not imply that the research made at the KI department in general is published in journals of low quality. As mentioned before, many specialized journals of high quality have impact factors between 3 and 6.

The differences in publication structure may also reflect that the two departments live with different economic realities. As can be seen in chapter 7, the CU department has a significantly stronger funding situation compared to the KI department.

Finally, it is important to remember that the comparison only was made for publications during a specific year (2006) and that the publication structure and rate may vary significantly over time.

# 2 Patents, Industrial collaborations and Companies

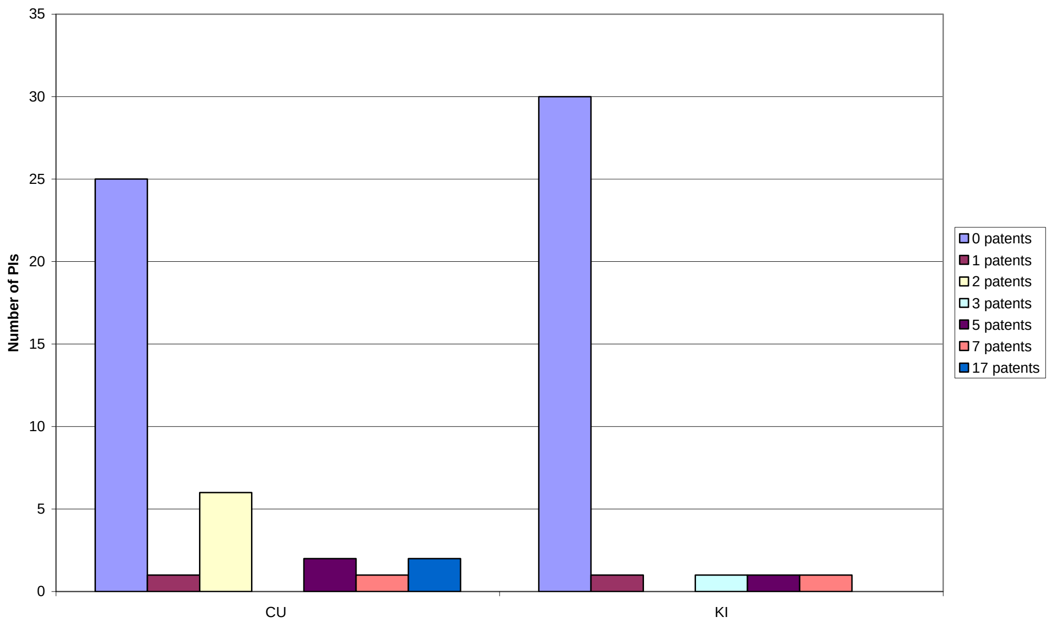
## 2.1 Methods

Surveys were sent out at both departments to investigate if PIs have registered patents, have industrial collaborations and/or are involved in companies relating to their scientific work. The response rate for the survey was approximately 53 per cent (18 of 34) at KI and 53 per cent (19 of 36) at CU.

## 2.2 Results

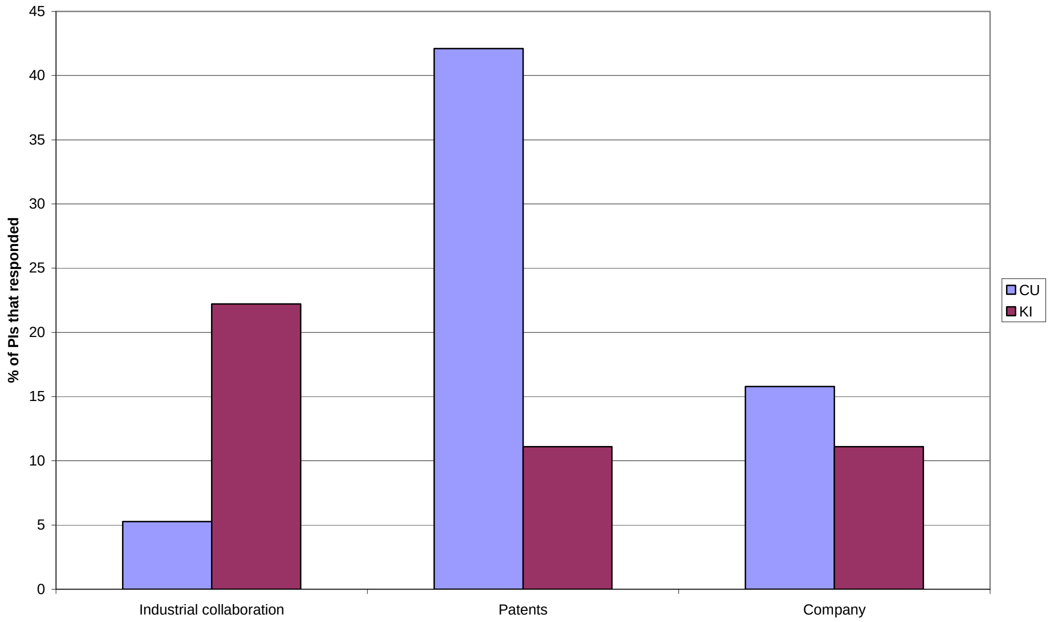
The number of patents registered with a PI as inventor was investigated at the US Patents and Trademark Office (USPTO, www.uspto.gov) and the PIs were also asked about patents in the survey. The majority of the PIs at both departments were not registered as inventors for any patents in the USPTO (Figure 2-1). However, registered patents were somewhat more common at the CU department.

Figure 2-1 Patents in USPTO with PIs as inventor.




The results from the survey (Figure 2-2) confirm the overall results from the USPTO study. However, in a few cases there was a discrepancy in between the answers to the survey and the results from the USPTO. While interpreting the data it is important to remember that patents filed from CU are held by the university while those filed by KI researchers may be held by individuals and/or companies.

Figure 2-2 Survey results for industrial collaborations, patents and companies.




The results suggest that it is more common with **industrial collaborations** at the KI-department. The reasons KI PIs give for collaborations with industry are shared interests and collaboration in technical development and drug discovery. All PIs with industrial collaborations state that they can publish results in a normal way when applicable. The KI PIs in all cases but one claim that the collaborations have not changed the way he/she works. In the one case, the PI writes that it has made him think more about practical issues and applications.

There was only one PI at CU that answered that he has industrial collaborations. The reasons for the collaboration are shared interests and screening expertise. According to the PI, the collaboration has changed the way his lab works as it has brought high-throughput screening (HTS) into the lab that also is used for projects not directly related to the collaboration.

According to the survey, ~10–15per cent of the PIs at both departments are involved in **companies relating to their work**. An example of a company that was formed partly by a member of the CU Department of Neuroscience (although before the department was formed), Professor. Eric Kandel, is Memory Pharmaceuticals Inc. (NASDAQ: MEMY) which develops new innovative drugs to treat neurological disorders of which many affect memory and cognition. The company uses leverage from the expertise in the field of neuronal pathways in memory functions to identify drugs. Much of Memory Pharmaceuticals work is based on Professor Kandels scientific work.

## 2.3 Technology transfer offices

Both CU and KI have technology transfer organizations. However, as intellectual property rights (IPR) are handled differently in the two countries, the way these organizations work are inherently different. In the USA, the university normally has the rights to the researchers results (Bayh-Dole act, 1980) while this is not the case in Sweden. The technology transfer organization at KI is not described here while the corresponding organization at CU is briefly described below.

### 2.3.1 CU Science and Technology Ventures (STV)

According to STV officials, STV works as a bridge between faculty and the business community, to transfer inventions and innovation knowledge to outside organizations for the "benefit for society". The director of the STV is Dr. Michael Cleare. According to officials from the CU department, the STV is very "serviceminded" and in principle does all the work for commercialization. In 2006 the gross revenue from startup companies and licensing was more that 200 million USD. The STV manages more than 600 patents and 250 active licenses and is involved in approximately 70 new companies. In 2005, 272 inventions from faculty and graduate students were made and 160 patents filed for. 72 licenses were executed to existing companies and 10 start-up/small companies were formed.

The role of the STV is to:

- Identify and patent or copyright new inventions.
- Interact with industry to negotiate collaborative sponsored research agreements.
- Advise industry of new inventions and negotiate license agreements.
- Apprise venture capital groups and other investors of new inventions and facilitate startup of new companies based on Columbia faculty research.
- Facilitate the material transfer agreements (MTA) that enable researchers to advance their work. (MTAs are agreements between institutions or between an institution and a company allowing the investigator at an institution to have access to some asset such as experimental animals, cell lines or other).

Below (Box 1) is the STV list over the main steps in the technology transfer process (source: STV website).

**Box 1 Steps in the Technology Transfer Process**

| Tech. transfer officer | Principal Investigator | |
|---|---|---|
| | | **Research/Discovery Disclosure** |
| • | • | Identify research activity of potential commercial interest |
| | • | Disclose research results to STV via Invention Report Form* |
| | | **Opportunity Assessment** |
| • | | Provide feedback to PI regarding commercial potential |
| • | • | Participate in review of invention for patentability with patent counsel |
| | | **Patenting (working with patent counsel)** |
| • | • | Assist in the preparation, filing, and signing of patent applications |

| | | |
|---|---|---|
| | • | Provide copies of known supporting materials (prior art) |
| | • | Report dates for all public disclosures prior to patent applications |
| • | • | Review completed patent application for accuracy and claim coverage |
| | | **Marketing to Potential Licensees** |
| • | • | Protect confidentiality of invention through nondisclosure agreement |
| • | • | Develop commercialization strategy and contact list |
| • | | Prepare nonconfidential marketing materials |
| | • | Champion inventions to confer credibility |
| | | **Licensing** |
| • | | Negotiate Option/License Agreement |
| • | | Seek approval of Columbia attorney on license terms |
| • | • | Present, demonstrate, and discuss technology |
| • | • | Facilitate transfer of technology to licensee |
| | | **Monitoring Contractual Obligations** |
| | • | Fulfill conflict-of-interest reporting obligations |
| | • | Sign inventors' revenue-sharing agreement |
| • | | Monitor license agreements and pay patent fees |
| • | | Distribute net income in accordance with Columbia policy |
| | | **Sponsored Research Agreements** |
| • | • | Attract new corporate funding partners |
| | • | Include STV as RASCAL approver for IP issues |
| • | | Set up appropriate accounts through your Sponsored Projects Office (OPG or OGC) |
| • | | Tailor the agreement to PI needs through Columbia attorney |
| • | • | Develop ongoing business relationship with the corporate funding partner |

**RASCAL= Web-based application to simplify research compliance and research administration processes at CU.*

**Revenue** from a venture is normally split between CU, the inventor and the inventors research. In some cases the department and school also receives a share.

If the net revenue is less than 100 000 USD:

- the inventor receives 50 per cent,
- the inventors research receives 25 per cent and
- the university receives 25 per cent.

If the net revenue is more than 100.000 USD it is split in the following way:

- Inventor: 25 per cent
- Inventors research: 25 per cent
- School: 8 1/3 per cent
- Department 8 1/3 per cent
- University: 33 1/3 per cent

### 2.3.2 Expressed opinions about the technology transfer offices at CU and KI

Few individuals at the two departments have used the technology transfer systems and it is therefore difficult to make assessment of how the system is seen from the point of view of a researcher.

*CU*

Out of the few (4–5 in survey) PIs that have hade any experience in dealings with the STV, few expressed any view of how the experience had been. One PI said that the process usually is “appallingly inefficient” while another said that “technology transfer at CU works well”. A third PI said that technology transfer at CU is “moderately efficient”. The experience ranged from patent filing to formation and management of companies.

*KI*

At the KI department even fewer researchers have any experience from the university technology transfer system. One PI has a company which is partly run and owned by the KI system while another is in contact with KI innovations AB concerning the filing of patents.

## 2.4 Summary and Discussion

The majority of the researchers at both departments have no patents or companies that relate to their work. While patents appear to be more common at the CU department, industrial collaborations are more common at the KI department. This may reflect the research profile of the departments or that researchers and industry more actively seek collaborations at the KI department. It may also be function of the different economic realities the departments live in (see chapter 7). The research performed at the departments is in both cases mostly of a basic science character (although more clinically oriented research exists as well) which seems to be reflected in the very few scientists that have stated that they have experience of the commercialization systems at the respective universities.

# 3 Environment

Neuroscience-related research is widespread at both universities and both of them see research concerning neuroscience including neurodegenerative diseases as an important research area. At CU as well as at KI, neuroscience-related research is being performed in many departments and in many constellations. Networks and collaborations exist both within and outside the universities and with both academic environments and industrial companies. Academic collaborations are often made because the collaborators techniques, research interests and expertise complement each other. Collaborations with industry, from the researchers point of view, may be made, for instance, to acquire funds, out of scientific interest, to get access to or develop techniques or to take the research into the next step towards for instance drug discovery and/or commercialization. Companies collaborated with range from small start-up companies to “big pharma” such as AstraZeneca. In addition to collaborations with companies not directly related to the researcher, some scientists work with companies that are spin-offs from their own or their colleges work.

Some neuroscience-containing initiatives/departments at the two universities are listed below.

## 3.1 Examples of KI neuroscience initiatives

- Department of Neuroscience
- Department of Clinical Neuroscience
- Neuroscience in the Department of Physiology and Pharmacology
- Neuroscience in the Department of Woman and Children Health.
- Department of Neurobiology, Care Sciences and Society
- Neuroscience in the Department of Cell and Molecular Biology
- Center of Excellence in Developmental Biology (CEDB)
- Center for Molecular Medicine
- Center for Spinal Cord research

The department is strongly involved in CEDB which aims to become a world-leading research center in developmental biology with a focus on cellular differentiation in the nervous system.

### 3.1.1 Stockholm Brain Institute

At KI there are some formal neuroscience initiatives that span outside the university. One of the most interesting is the relatively recently formed Stockholm Brain Institute (SBI, www.stockholmbrain.se) which is a consortium primarily for cognitive, computational and neural science.

SBI is a joint venture primarily between researchers at KI, Stockholm University (SU) and the Royal Institute of Technology (KTH). There are 10 main research groups within the SBI and a number of industrial partners including AstraZeneca (AZ) and IBM. The AZ collaboration has enabled SBI to get access to state-of-the-art PET imaging equipment. Through the collaboration with IBM, SBI researchers have got access to a Bluegene supercomputer for image analysis and treatment as well as for modeling studies. Part of the motivational ground for AZ and IBM to collaborate with SBI is that they need collaborations with some of the best research groups available and also, in IBMs case, need to test materials and algorithms in frontline applications. SBI also collaborates with the health care system.

One objective of the SBI is to create an innovative and interactive environment by moving some of the PIs and their research groups into the same building physically. SBI has made or are in the process of making several recruitments on different levels in imaging, modeling, Betula-register studies and cellular and neural network neuroscience, to strengthen its approach.

The funding structure is not described in detail here but is in excess of 150 MSEK (in addition to direct funding of the research groups that are part of SBI). Among the most importing funding bodies are the Swedish Research Council, VINNOVA, the Swedish Foundation for Strategic Research (SSF) and industry.

Another interesting neuroscience initiative is the national ***Swedish Brain Power initiative*** which ultimately aims to improve early diagnosis, treatment and care of persons affected by neurodegenerative diseases.

## 3.2 Neuroscience initiatives at CU

### 3.2.1 The CU Department of Neuroscience

The Department of Neuroscience is a new organization that started its operation during 2007. However, in principle all its entities were present at CU also earlier. Replacing the previous Center for Neurobiology and Behavior with a new Department of Neuroscience has, according to the chairman, professor Koester three major benefits: “(1) It makes possible a focused, cutting edge approach to training and research in a fundamental area of modern basic neuroscience – the development, structure and function of neural circuits. (2) It provides an efficient and cohesive platform for recruitment, development, and promotion of faculty (Previously, each faculty member recruited to the Center for Neurobiology and Behavior received their primary appointment in a department). (3) It better reflects the reality of the present situation in that: (a) the Center for Neurobiology and Behavior already had the responsibilities and scope of activities of a basic science department; and (b) neuroscience has become a recognized academic discipline. A major goal of the transition is to ensure that the successful role the Center for Neurobiology and Behavior has played for 25 years in promoting scholarly interactions between neuroscientists at the Medical School is not lost. A potential concern arises because in limiting the faculty of the new department to a reasonable size and focus, a number of outstanding teacher/researchers who have played important roles in the activities of the Center have not been included. This is unlikely to create a serious problem, however, for three reasons. (1) They will all remain members of the doctoral program in Neurobiology and Behavior, which serves a major integrative role in the neuroscience community at Columbia. (2) Since the inception of the Center for Neurobiology and Behavior 25 years ago a number of new organizations have evolved at Columbia that serve a similar general aim – bringing together researchers from various departments who share common interests in neuroscience. Although these new organizations are each more focused in their own special areas of interest than is the Center, their memberships overlap extensively both with that of the Center and with each other. Thus there now is less of a need for the

Center's role as a catalyst for interaction between neuroscientists from different departments than was the case when it was founded. (3) The new Mind, Brain and Behavior initiative (see section 4.3.2) will fulfill many of the integrative, umbrella-like activities of the current Center for Neurobiology and Behavior, but on a larger scale that will involve neuroscientists on both campuses, as well as faculty in computational sciences, nanotechnology, bioengineering, physics, chemistry, psychology, anthropology, philosophy and the social sciences."

### 3.2.2 Other Neuroscience initiatives at CU

Research in neuroscience is being made in many departments and centers at CU. A list of the different initiatives and centers can be found in appendix 1. More information and links to the many of the centers can also be found on the CU neuroscience website http://www.neuroscience.columbia.edu/. Below, two important examples are described briefly.

### 3.2.3 Specific examples of CU initiatives

*Center for Neuroscience Initiatives (CNI)*

The role of the CNI (launched in 2005) is to develop, implement and coordinate new neuroscience initiatives at CU. The CNI focuses on the launch of new programs and centers that will enhance the translation of results from research into new insights and potential therapies. CNI has launched and currently supports the:

- Columbia University Center for Motor Neuron Biology and Disease
- Center for Theoretical Neuroscience
- Gatsby Initiative in Brain Circuitry

*The Mind, Brain and Behavior initiative and the Jerome L. Greene Science Center*

In 2004, CU president Lee Bollinger announced plans to launch a new Mind, Brain and Behavior initiative that will improve the linking of research in the neurosciences to that in other disciplines such as physics, engineering, chemistry, and psychology. A new Jerome L. Greene Science Center in Manhattanville (West Harlem, NYC) where Columbia scientists will explore the causal relationship between gene function, brain wiring, and behavior is planned to be built. The center is largely based on a gift (> 200 MUSD) from Dawn M. Greene and the Jerome L. Greene Foundation. The Center will be led by professors Thomas Jessell, Eric Kandel and Richard Axel.

## 3.3 Summary and Discussion

Neuroscience is an important research area at both KI and CU. In both cases neuroscience-related research is performed at many departments, centers as well as in other constellations. The Department of Neuroscience at CU was formed recently to strengthen neuroscience at CU even further. Both universities contain interdepartmental neuroscience-initiatives. In Stockholm, the Stockholm Brain Institute (SBI) is an important and relatively recent initiative for interdepartmental and interuniversity collaboration within neuroscience. In addition to researchers/research groups, the SBI also contains industrial partners and collaborations with the health care system. At CU, the Mind, Brain and Behavior initiative is an important example of how the university works to improve the linking between neuroscientific research and other disciplines. At CU, nearly all such initiatives are within the university.

# 4 Research areas and relation to clinical needs

## 4.1 Research areas

Neuroscience is, as mentioned before, an important research area at both CU and KI and both departments have high-profile research in many aspects of neuroscience. At the KI department officials state that the department primarily is a “basic science” department. Nevertheless there are some researchers at the department that have a clear translational approach to neuroscience. One example is Dr. Rochellys Heijtz Diaz approach to ADHD with collaborations with the Karolinska hospital. This is however only one example. On the other hand many researchers at both departments are primarily working on basic science questions concerning the mechanisms and operation of the nervous system. Both departments use animal experimentation to a large degree.

General descriptions of the research at the departments can be found below (source: Department. websites):

**CU**

> *“The 35 faculty members in the department use a wide range of approaches to study fundamental aspects of neural circuit development, organization, and function. They share a common goal of relating the biology of such circuits to the control of behavior. A broad array of animal models, as well as human subjects, are examined using a wide range of approaches, including electrophysiology, biophysics, molecular and cell biology, systems neuroscience, imaging, behavior and theory. Interdisciplinary research is facilitated by widespread collaboration between different labs. Several research projects in the department are focused on animal models of nervous system disease.”*

**KI**

The department has several areas of strength such as research concerning spinal, cortical and developmental mechanisms.

> *“The Department of Neuroscience incorporates research divisions dealing with different aspects of the function of the nervous system, both under normal conditions and during different diseases. Research projects include a broad range of studies at the molecular and cellular levels, the network level and at the level of the overall organisation of the nervous system. Much of the basic research carried out at the department is aimed at understanding the functional role of various neurotransmitters and neuropeptides, the ionic and biochemical mechanisms involved, the molecular basis of transmitter release, and the neurophysiology of neural networks controlling behaviour and brain function. Extensive research is also carried out on the regulation of nerve cell growth and factors involved in neuronal regeneration and degeneration, and which are important in conditions such as Parkinson's disease, Alzheimer's disease and spinal cord injury.”*

## 4.2 Stated research fields, relation to clinical needs and collaborations with the clinical system

At both departments the research can be described as being mostly of basic science biomedical neuroscience character and much of it is clearly connected to clinical questions, neurodegenerative conditions and/or neuronal development. In the survey, the PIs were asked to describe their research field in a few words. They were also asked if their research has a clear coupling to clinical needs and if they have collaborations with clinicians and/or the health care system. Out of the research leaders answering the survey, 13 (72 %) KI PIs and 11 (58 %) CU PIs stated that their research is clearly related to clinical questions.

Collaborations with clinicians are somewhat less common at CU (5 of 19 PIs, 26 %) than at KI (7 of 18 PIs, 39 %). At KI, most stated collaborations were with units at the Karolinska University Hospital. When studying the results it should also be remembered that the terms “clinical relevance” and “clinical needs” can be interpreted in different ways. Some of the results can be seen in box 2 below.

## 4.3 Summary and Discussion

Both departments show highly successful research in a number of areas. In principle both departments can be said to, to a large degree, contain research that is of a basic science-character. The leadership of the KI department specifically point this out as desirable also from a strategic point of view. However, both departments also contain research that clearly has translational elements. Most PIs at both departments state that their research is clearly coupled to clinical needs. Collaborations with clinicians appear to be somewhat more common at the KI department.

**Box 2 Stated research areas and relation to clinical needs**

**CU**

- Cellular & Molecular mechanisms of learning and memory
- Neural stem cells
- Neurobiology of visual perception (*)
- Developmental neurobiology relating to the visual system and the Cerebellum (*)
- Theoretical neuroscience
- Synapse formation and plasticity (*)
- Development of the motorsystem (*)
- Neurogenetics (*)
- Neural circuits
- Neural development and dendrite morphogenesis
- Molecular mechanisms of memory (*)
- Visual attention and spatial perception (*)
- Neural development and degeneration (*)
- Theoretical neuroscience, circuits of the cerebral cortex
- Neurophysiology and imaging (*)
- Neural circuit assemblies (*)
- Cognitive neuroscience
- Ion channels and synaptic plasticity (*)

**KI**

- Cellular properties of neural network neurons involved in locomotor patterns and motor control
- Synaptic transmission and molecular neuropharmacology (*)
- Synaptic transmission and plasticity in pain pathways (*)
- Neuronal bases of motor functions (spinal cord, Basal ganglia etc.) (*)
- Neuronal mechanisms in the Striatum (*)
- Molecular neurobiology of development, Stem cells (*)
- Cerebral cortex and cortical dynamics
- Neurobiology of ADHD (*)
- Pain and depression (*)
- Neurotrauma (*)
- Molecular mechanisms of endocytosis (*)
- Neuroendocrine and hypothalamic control of food intake/body weight (*)
- Neurovirology
- Organization and operation of neural networks involved in motor behavior (*)
- Electrophysiology and neuroanatomy of corticothalamic and hypothalamic pathways
- Health effects of electromagnetic fields and electrohypersensitivity (*)
- Synaptic transmission
- Parkinsons disease, spinal cord injury, central nervous system plasticity, development, neurotrophic factors (*)

**= The PI states that the research has a clear coupling to clinical needs.*

# 5 Personnel structure

Below is listed the different personnel categories in the two departments. In the case of the ***CU-department, the listing is only for part of the department and constitutes approximately 50 per cent (18) of the PIs.*** It was not possible to find data for the remaining part as the department recently was formed. However, according to department officials the personnel structure for the remaining part of the department can be extrapolated from the listing and increased by 70–90 per cent.

**KI**

14 professors

5 university lecturers

8 assistant professors

15 senior researchers

68 graduate students (of which 59 employed at KI)

21 postdocs (of which 11 employed, 10 on stipends)

12 administrators

9 laboratory personnel

15 technical personnel

4 other

**CU** (corresponding to 50–60 % of department)

11 professors

3 associate professors

4 assistant professors

42 postdocs

23 associate research scientists

7 adjunct associate research scientists

2 research scientist

1 research specialist

1 computer analyst

10 administrators

31 support staff of which:

- 2 medical illustrators
- 9 research support assistants
- 5 senior technicians

1 technical specialist

12 technicians

1 research worker

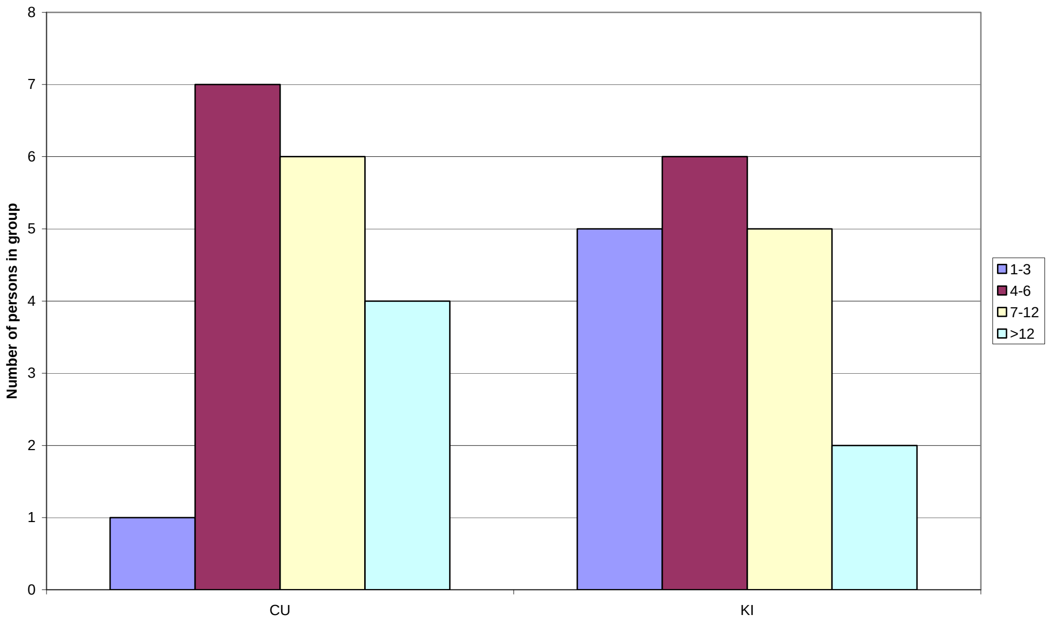
1 lab assistant

52 students on the interdepartmental Neurobiology and Behavior program have chosen the lab of a Department of Neuroscience faculty members as his/hers dissertation lab.

## 5.1 Group size

In the survey, the PIs were asked to state the approximate size of their research group. From the results (fig. 4) it appears that it is more common with small research groups at the KI department compared to at the CU department.

Figure 5-1 Survey results for group size.




## 5.2 Recruitments

Recruitments can be made in different ways. At **CU** the financial source is often intra-university funds. The department together with the school and university decides on recruitments and at present (October 2007) two researchers on the assistant professor/tenure-track level are being recruited as well as one senior scientist. Representatives of the department stress that there is a strong competition between top US universities for top junior scientists and CU therefore works to identify these early (on the postdoctoral level). The recruitments are usually not being made in a tightly defined research area but are kept more open. In particular PIs with funding from the Howard Hughes foundation (see chapter 7) attract many postdocs.

At the **KI** department, the process for recruitment is different from the one at CU. On the assistant professor level, recruitments can either be made directly by the department or as a result of that the applicant has received funding from another source (e.g. a research council). Organizations such as the Stockholm Brain Institute (SBI) may decide to fund a position for a specific purpose or an open position and place it at a department. SBI has recently made such a recruitment at the KI department for the study of cellular and neural network neuroscience. Recruitments for senior positions may also be made by the department, jointly by departments or alike. Strategic recruitments made during the last years include Professor Ole Kiehn and Dr. Ola Hermanson. The original funding for the recruitments was time limited.

In reality, most PIs at both departments need to cover a large part of their activities including salaries by attracting research grants. It is common that this applies also for the PIs own salary.

### 5.2.1 Recruitment of and situation for assistant professors/tenure-track positions

*CU*

Recruitment to junior tenure-track positions are being made on the department-level (although the school and university may be involved). The process is extremely competitive and the department tries to identify promising postdocs from the whole world. As CU is a high profile-university, it competes with universities such as Harvard and Stanford universities in the recruitment of the best candidates.

When a junior researcher has been recruited he or she is given a startup grant connected to the position. This grant is usually in the range of 1 – 1.3 million USD and is intended to enable the researcher to acquire equipment and hire personnel and thereby start the research quickly. The startup grant does not normally include the researchers own salary.

At CU, a tenure-track position usually lasts 7-8 years although the researcher does not get a contract for the whole tenure-track. Evaluations are being made after approximately 1 year and also later during the course of the track. During the $7^{th}$ year a rigorous evaluation is being made to decide if the researcher should be offered tenure (a permanent position). According to department officials approximately 70–80 per cent of those that are being evaluated are offered tenure.

After a 3-year startup period, the assistant professor typically receives 30–35 per cent salary-support from the department, which in turn gets it from the medical school. The funds originally comes from the extramural grant overhead (ICR), tuition charges, endowment income and gifts. Faculty in the 4th year & beyond are expected to pick up about 65 per cent of their salaries and all of their research expenses from extramural grants (mostly, but not only, from the National Institutes of Health (NIH)).

A new system has been proposed. In this system, all ***tenured*** faculty will receive the equivalent of the annual interest from the smallest endowed chair. This is approximately 110 000 USD/year, which could be used for salary, research costs, staff, trainees or saved for later use. After benefits, this translates into a 85 000 USD salary per year. If a tenured faculty member were to lose all grants and stop participating, this amount is the minimum salary that would have to be provided under the tenure system. At present there is no decision to implement this idea and the details are therefore not yet known. For instance how much of this money would come from the school and how much from the departments?

*KI*

Assistant professorship (forskarassistent) positions are usually applied for from the Swedish Research Council (Vetenskaprådet, VR). As mentioned before, in some cases funding for positions are given by academic departments or organizations such as the Stockholm Brain Institute. The competition for positions is hard but if an applicant has managed to secure funding, he/she is usually accepted by the department as long as the proposed research falls within the wider scope of the department. Already at the time of the application to VR it is necessary for the applicant to have reached an agreement with the department that it will hire him/her and that there is space available if he/she manages to get funding for the position. The positions last four years and may be prolonged for 1–2 years by the department. The department performs smaller yearly evaluations of the researchers but as Sweden does no have a tenure-track system there is no tenure-evaluation. It is common that grants are connected with the position. These are usually in the range of 300 000 to 400 000 SEK (2007). In some cases an increased project grant is given during the first year (825 000 SEK, 2007).

## 5.3 Situation for graduate students

*CU*

During the first two years, students in the program are fully supported by a combination of school funds and extramural training grants and fellowships. The students are however taking a number of classes during those two years period and are therefore not engaged full-time in research. After the first two years, students are in the lab full-time, and are typically supported by extramural training grants or individual fellowships (40 %), and by their mentor's research grants (60 %).

*KI*

Graduate students are usually supported by their supervisor research budget, through special programs (e.g. the EU Marie Curies fellowships), or through KIs internal funding system. Funding through the internal system is fiercely competitive and even if the student and supervisor manage to secure funds in this way, it only provides part funding for the student. During approximately the first 28 months as graduate student, the student may be supported by “utbildningbidrag” which is relatively “inexpensive” for the supervisor as no social costs are added to this type of “salary”. However, from month 29 the rules stipulate that the student has to have a graduate student position (doktorandtjänst) which carries significantly higher costs.

## 5.4 Retirement

As a result of legislation adopted approximately 15 years ago, it is not possible to force anyone to retire solely because he/she has reached a certain age in the American system. However, at 65 years of age most Americans have the right to participate in the subventioned Medicare-programs and at 70 the individual, in practical terms, need to start to claim some of his/her pension. At KI, the formal retirement age is 65 although an employee has the right to continue working until 67 years of age. It is, however relatively common that professors continue to be active also later.

## 5.5 Summary and Discussion

The two departments have approximately the same number of PIs. However, the total number of scientific staff (researchers, postdocs, lab assistants, associate researchers etc.) appears to be higher at the CU department which probably reflects a higher number of people in the average research group there. One possible explanation for this is that the funding of the PIs is better at CU, and that they therefore, on the average, easier can hire for instance associate researchers, technicians, postdocs and graduate students. The economic situation for assistant professors starting their research is clearly better at CU where they are given substantial start-up grants. It is therefore likely that it is more common that younger researchers have small research groups at the KI department. Another difference between KI and CU is that the KI-department graduate students are tied to a research lab from the day they start their graduate studies while the CU students instead choose their dissertation lab later. In contrast to in Sweden, forced retirement based on age alone is not allowed in the USA.

# 6 Extramural research funding

In this section is described the extramural research funding and how overhead is handled at the two departments. It is important to keep it mind that while the overhead in percentage is higher at CU, the actual benefits generated by the overhead may vary substantially in between the institutions making a direct comparison difficult. Furthermore the listing of the extramural grants at CU in table 4 is likely to be an underestimation. Intramural and non-competitive funding (fakultetsanslag) has not been included in the study.

## 6.1 CU

Figure 6-1 Extramural research funding.

| Funding by source | Total | Per grant |
|---|---|---|
| **NIH** | 56 697 128 | 1 318 538* |
| **NSF** | 1 335 808 | 667 904 |
| **HHMI** | 24 286 242 | 4 857 248 |
| **Other** | 33 533 242 | 779 587* |
| **Total** | **115 841 420** | |

Amounts ***after overhead*** has been deducted (when applicable) in **SEK** calculated on an exchange rate of 6.50 SEK/USD. *= Many different types of grants exist and the grant size may therefore vary substantially. HHMI=Howard Hughes Medical Institute. NSF=National Science Foundation.

Most grants from private sources do not pay overhead. However grants from organizations such as NIH and the National Science Foundation (NSF) do. The amount of overhead (indirect cost rate, ICR) is predetermined by negotiations between the organization and the university. The rates vary widely between universities even for a single organization such as NIH, and are often between 50-70 per cent (of the direct costs (= what the researcher "can use")). They are, as remarked above, not directly comparable to those in the Swedish system. At Columbia, 61 per cent overhead is paid on grants from the NIH and the NSF while 20 per cent overhead is paid on grants from New York State.

A new model is being proposed at CU and is currently being discussed. It would be likely to involve the following moments:

- The Deans office would charge approximately 30 per cent of all ICR for general services, such as library etc. The rest, and some of the tuition income (not yet specified), would go back to the departments.
- Departments would pay rent for their space ($50 per $ft^2$ for dry (e.g. office space) and $100 per $ft^2$ for lab space.
- The university would tax the departments 7.3 per cent for operating overhead on every direct cost dollar, regardless of how it is spent.
- There would be a head tax to departments on all personnel of 1 050 USD per full time person and year.

- There would be a head tax to departments of 3 400 USD per student and year.

There is not a straight 1:1 relation between the ICR generated and what an individual faculty member receives back, in part because departments may have other sources of income in addition to ICR such as endowments, patent incomes and other.

In return for the overhead, faculty receives space and about 25–35 per cent salary support from the school. The department must take out some of this return to use, together with other sources of income, for administrative staff, seminar series, teaching expenses, student recruiting costs, equipment, supplies etc. In general, there will be some link between the overhead generated and space but program values of the department must be counted in along with the ability to generate income (e.g. teaching and service should be rewarded). Some fields that are highly valued may not be able to generate as much ICR as others.

## 6.2 KI

Table 6-1 Extramural research funding.

| Funding by source | Total | Comment |
|---|---|---|
| **Research council (VR)** | 29 025 000 | Medicine, NT, Infrastructure, Other |
| **Formas** | 860 000 | |
| **SIDA** | 95 000 | |
| **Djurskyddsmyndigheten** | 830 000 | |
| **Swedish foundations** | 24 249 000 | of which 2 264´ KI Stiftelser |
| **Industry** | 2 277 000 | of which AstraZeneca (1725´), AFA |
| **European Union** | 16 071 000 | coordinator in 5 grants, Partner in 10 |
| **NIH** | 5 746 000 | |
| **Other foreign** | 5 019 000 | |
| **Total** | **84 172 000** | |

Amounts are ***before overhead*** has been deducted. SIDA= Swedish International Development Cooperation Agency.

13.33 per cent is charged in overhead on all grants. When allowed, rent for space is charged with 12.59 per cent. Rent is charged per square meter. If the amount charged for rent is insufficient, funds need to be added for this. On the combined sum off the grants, overhead and rent, tax (högskolemoms) of 8 per cent is charged. Such tax is not charged on grants from the European Union or the Swedish research Council. The European Union only allows overhead of 20 per cent. Some foundations do not allow overhead to be deducted at all.

## 6.3 Summary and Discussion

The biggest source for extramural grants is the Swedish research council (VR) for the KI department and NIH for the CU department. However, PIs at both departments receive grants from many different sources including the European Union (KI) and the Howard Hughes Medical Institute (HHMI, CU). It is interesting to note that some researchers at the KI department also receive support from the NIH. For CU, the largest individual grants come from the HHMI. These are however given to relatively few researchers.

In total, the CU department clearly has a better extramural grant situation per PI compared to the KI department. The overhead, at CU, on grants from federal sources such as the NIH and NSF is higher than the corresponding grants from the Swedish research council at KI. The size of the overhead is however not easily comparable as the return from it in terms of for instance core facilities, space, services and economic benefits vary substantially between the universities. The difference in actual funding levels between the two departments is likely to be even larger than what is shown here due to differences in funding system and how the departments have reported their grants.

# 7 Discussion and Conclusions

The aim of this study has been to make a limited comparison between the Department of Neuroscience at the Karolinska Institute in Stockholm, Sweden and the Department of Neuroscience at Columbia University in New York City, USA. Neuroscience is an important area at both universities and the two departments are important key parts of the research and education efforts in the area at their respective universities. In both cases there are, however, also a large number of other neuroscience initiatives.

The research at the two departments is mostly concerned with basic neuroscience questions although there are, in both cases, also research that address clinical questions and/or have a translational character. The majority of the PIs answering our survey, at both departments, consider their research to be clinically relevant.

At both departments there are, among the scientists, some that are among the most cited in the world, and the departments published approximately the same number of original research articles per PI during 2006. However, the average impact factor per researcher or article is higher at the CU department than at the KI department. In the light of this, it should be stressed that both departments publish articles in journals of a high scientific quality. The CU department does however publish more in top-ranked journals such as Science, Neuron and Cell. The conditions for the two departments vary fairly much. For instance the handling of intellectual property rights is different in the USA compared to in Sweden. In Sweden, the researcher has the rights to any commercial potential from his/her research while this belongs to the university in America. Patents as well as spin-off companies are somewhat more common at the CU department. Industrial collaborations are more common at KI. That patents and spin-off companies are relatively rare at both departments reinforces the impression that both departments ***essentially*** are basic science departments.

Both departments have approximately the same number of PIs although the number of total staff is higher at CU. The differences in staff and publications may reflect the better economic situation at the CU department. The economic differences are evident, for instance for assistant professors, that receive a very large startup grant (approximately 7 MSEK) at CU. Furthermore, in contrast to at KI, CU assistant professors are usually in a tenure-track system and have the possibility of being evaluated for tenure (a permanent position) during the $7^{th}$ year. In addition, an assistant professor position lasts longer at CU (seven contra four years) which together with the generous startup funding enables the “young” scientist to do innovative high-risk research and to get started quickly.

The teaching load on researchers was not addressed in this study. However, most PIs at the two departments are involved in teaching of some kind. In general, it is more common in the USA that senior professors are involved in teaching of undergraduate students.

Finally a word of caution: The Swedish and American university systems vary relatively much and some factors described in this report may therefore be difficult to compare. This concerns, in particular, the system for overhead and the handling of intellectual property rights.

# 8 Methods and References

This study was primarily made with interviews of key personnel, literature studies, web searches and analysis of the collected material. Among the most important www sources were the Web of Science (Thompson Scientific Inc), Pubmed (National Library of Medicine), the websites of Columbia University and the Karolinska Institute, Stockholm Brain Institute website and the US Patents and Trademark Office (USPTO).

**Interviews**

Dr. Tim Corless (CU)

Professor Staffan Cullheim (KI)

Professor Stefan Eriksson (KI)

Professor Bertil Fredholm (KI)

Professor Sten Grillner (KI)

Professor Thomas Jessell (CU)

Dr. Beth Kauderer (CU)

Professor Ole Kiehn (KI)

Professor John Koester (CU)

**Websites**

www.ki.se

www.columbia.edu

www.neuroscience.columbia.edu

www.neuro.ki.se

www.pubmed.com

http://portal.isiknowledge.com

http://216.191.73.202/devenv/department_of_neuroscience/index.php

# 9 Commonly used abbreviations

CU = Columbia University

EU = European Union

HHMI = Howard Hughes Medical Institute

KI = Karolinska Institute

NIH = National Institutes of Health

NSF = National Science Foundation

PI = Principal investigator

SBI = Stockholm Brain institute

SIDA = Swedish International Development Agency

STV = Science and Technologies Venture at Columbia University

USPTO = US Patents and Trademark Office

VR = Vetenskapsrådet (The Swedish Research Council)

# Appendix 1 Linked list of neuroscience centers at CU

- Center for Bioethics
- The Gertrude H. Sergievsky Center
- Motor Neuron Center
- Mailman School
- New York-Presbyterian Hospital
- The Neurological Institute of New York
- Center for Memory and Behavioral Disorders
- Center for Molecular Recognition
- Center for Motor Neuron Biology and Disease
- Center for Movement Disorder Surgery
- Center for Neuro-Oncology
- Center for Neuroscience Initiatives
- Center for Psychoanalytic Training and Research
- Center for Theoretical Neuroscience
- Cerebrovascular Center
- Columbia Comprehensive Epilepsy Center
- Columbia Genome Center
- Columbia Multiple Sclerosis Clinical Care Center
- Dystonia Research Center
- Eleanor and Lou Gehrig MDA/ALS Center
- Functional Magnetic Resonance Imaging Research Center
- Gertrude H. Sergievsky Center
- H. Houston Merritt Center for Neuromuscular Disorders
- Huntington's Disease Center of Excellence
- Irving Center for Clinical Research
- Jerome L. Greene Science Center
- Lieber Schizophrenia Research Center
- Lucy G. Moses Center for Memory and Behavior

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