

Biosciences Action Plan for the University of Turku and Åbo Akademi University

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The rectors of the University of Turku (UTU) and Åbo Akademi University (ÅAU) nominated us to create a common life sciences action plan for the two institutions. To this end, we organized two panel discussions, the first with members of the board of Turku Center for Biotechnology/BioCity (Turku) and the second with the directors and several other representatives of each BioCity Turku research program. In addition, we designed a questionnaire targeting all BioCity Turku group leaders comprising about 80 professors and senior scientists, and received 45 replies in total. We have also had private discussions with esteemed foreign scientists visiting Turku. This action plan is based on the above discussions and questionnaire responses, in addition to our own analyses, opinions and suggestions.

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1. Summary

The unique interdisciplinary unity of biosciences (Life sciences and Molecular medicine) between the University of Turku (UTU) and Åbo Akademi University (ÅAU) is a significant strength of Turku. Within biosciences, there are no real borders between the universities, although the institutions are still able to develop their own specific agendas and profiles. The close collaboration between the two universities should form a strong basis for the strategic development of biosciences in the future.

In recent years, both universities as well as the City of Turku have invested in the development of biosciences, and contributed to the creation of an internationally renowned research entity. The strength of research related to life sciences and molecular medicine in Turku has been recognized by the Academy of Finland, which has awarded 'Center of Excellence' status to seven consortia directed by BioCity Turku group leaders.

Despite the positive developments in many areas of bioscience in Turku, several problems remain unsolved, and the increasing international and national competition has created significant new challenges. In this action plan, we highlight two issues of utmost importance. Firstly, successful **recruitment and maintenance of the most promising young scientists** under the new premises is a considerable challenge. Another vital aspect is the **provision of state-of-the-art research infrastructure to the best scientists**. In addition, **careful selection of the research areas and technologies that will receive strategic financing** is possibly the best way to ensure success under the current, highly competitive conditions.

Principal research areas

The selected strategic areas should include the existing centers of excellence (CoEs) and other high-quality research groups, which collectively form a critical mass. The specified areas should be sufficiently flexible to allow young, independent researchers to create new CoEs. Furthermore, the strategic areas should benefit from existing investments in research infrastructure, and optimally support the local industry. Working opportunities should be made available for newly qualified Ph.D. scientists.

While the strongest research areas in Turku fall into several categories, the terms **molecular cell biology, molecular imaging** and **systems biology** cover most CoEs and other significant research groups that focus on areas of molecular-orientated biosciences and biomedicine. In the applied bioscience field in Turku, **diagnostics** is considered a strong research area. In addition, chemistry and strong materials research in ÅAU has benefited biosciences in Turku. In this report, we have not analyzed other research areas, such as ecology and environmental science, clinical medicine and chemistry.

It is important to remember that rigid strategies and inflexible fixation on narrow research topics will inevitably compromise the recruitment and career development of new independent research group leaders that do not fall within the scope of the selected topics, thereby suppressing emerging novel research strategies and delaying the implementation of new technologies.

Infrastructure

The University of Turku and Åbo Akademi University have systematically developed the infrastructure for life sciences research in Turku. The strongest technology platforms have been created in **Bioimaging** (PET center, laboratory animal imaging in Turku center of disease modeling, TCDM, cellular imaging in the Turku Center for Biotechnology, CBT), **Systems biology** (Genomics, proteomics and bioinformatics in CBT and VTT) and **Disease models** (TCDM). **Further development of these areas is critical.** In particular, the **salaries of the personnel running the common equipment as well as service costs of the instruments should be secured.**

International recognition of Turku as an important European research center would require the presence of a high-profile research initiative that has a leading position, not only in Finland, but also other Nordic countries. The strategy should be developed in a way that avoids direct competition with Helsinki and Stockholm and favors complementarity with the interests of these regions. Turku PET center contains unique research facilities. Moreover, Turku has long-standing traditions in research on other novel imaging technologies and principles, many of which have been translated into the corporate scene. Recent large investments in animal imaging in TCDM have bridged the molecular imaging of tissues and strong research traditions in Turku in cellular imaging. Indeed, **Turku Bioimaging is among the 24 most important national research infrastructures in Finland, based on the Finnish research infrastructure roadmap.** We propose that the universities should assemble a common high-profile plan together with the Turku Science Park, City of Turku, Hospital District of Southwest Finland and Regional Council of Southwest Finland to **initiate to the generation of an internationally recognized bioimaging technology platform in Turku.** This would be critical in the recruitment of top-level researchers and create new opportunities for all life science and molecular medicine researchers in Turku. **The bioimaging initiative would act as a spearhead project facilitating the development of other important infrastructure areas,** such as systems biology and disease models, in Turku.

Recruitment of new scientists

There is increasing competition to recruit the most promising young researchers among the Finnish universities as well as between Finnish and foreign universities. The universities in Turku should systematically train promising young researchers and offer them a reasonable research environment.

The new **Turku Collegium for Science and Medicine (TCSM)** could serve as a recruitment channel for selected post-doctoral scientists who are in the process of moving back to Finland after working abroad. TCSM may additionally be developed as the main channel to recruit foreign scientists. To achieve these aims, TCSM should obtain permanent funding in the future. **The issue of whether TCSM could act as a recruitment body for both UTU and ÅAU should additionally be considered.** The salary of a researcher in biosciences is insufficient to allow the establishment of a new research group, and thus the recruitment of young scientists should always include a **start-up package.**

Other aspects

We consider a number of other aspects that are important for the successful development of biosciences in Turku in this action plan. Detailed proposed actions are listed as "Development of BioCity Turku", "Connections between research and education", "Technology transfer" and "Turku as a bioscience city".

1.1 Yhteenveto

Biotieteiden, mukaan lukien molekyyli lääketiede, tutkimuksessa Turun yliopisto ja Åbo Akademi ovat pystyneet yhdistämään voimavaransa ainutlaatuisella tavalla. Tämä yhteistyö on Turun yliopistokampuksen suurin voimavara. Biotieteiden tutkimuksessa yliopistojen välisen yhteistyön esteet on pystytty tehokkaasti poistamaan ilman, että yliopistojen päätöksenteon itsenäisyys tai oman profiilin luominen on vaarantunut. Myös tulevaisuudessa biotieteiden kehitysstrategioiden tulee pohjautua tämän yhteistyön jatkamiselle ja syventämiselle.

Kuluneina vuosina molemmat yliopistot, kuten myös Turun kaupunki, ovat tehneet merkittäviä panostuksia biotieteiden kehittämiseksi ja panostuksen tuloksena Turusta on kehittynyt kansainvälisestäkin tunnettu biotieteiden tutkimuksen keskus. Myös Suomen Akatemia on huomionut Turun vahvuuden valitessaan huippuyksikköjä. Tällä hetkellä kokonaista seitsemää Suomen Akatemian huippuyksikköä johtaa BioCity Turun tutkimusohjelmiin osallistuva tutkija.

Biotieteiden tutkimus on kehittynyt Turussa suotuisalla tavalla, mutta monia ongelmakohtia on yhä jäljellä. Samanaikaisesti lisääntyvä kansainvälinen ja kansallinen kilpailu on tuonut uusia haasteita. Tässä toimintasuunnitelmassa olemme erityisesti halunneet painottaa kahta asiaa. Ensinnäkin, **nuorten, lahjakkaiden tutkijoiden rekrytoinnin tulee olla tärkeimpiä tavoitteita kun suunnitelmia toteutetaan**. Toinen kriittinen asia on **ajankuvaisen tutkimusinfrastruktuurin luominen ja ylläpitäminen**. Näihin haasteisiin vastaaminen voi onnistua parhaiten, jos huolellisen harkinnan jälkeen valitaan **tutkimuksen ja infrastruktuurin vahvuusalueet**, joiden kehittämiseen panostetaan.

Tutkimuksen vahvuusalueet

Tutkimuksen vahvuusalueiden tulisi rakentua nykyisten huippututkimusyksikköjen ympärille, niin että ne yhdessä muiden saman alan korkeatasoisten ryhmien kanssa saavuttaisivat "kriittisen massan". Vahvuusalueiden pitäisi myös olla riittävän laajoja, jotta ne tukisivat nuorten itsenäisten tutkimusryhmänjohtajien kehittymistä ja uusien huippuyksikköjen muodostumista. Vahvuusalueita valittaessa olisi myös huomioitava infrastruktuuriin tehdyt panostukset. Lisäksi vahvuusalueiden olisi yleisesti tuettava turkulaisen bioalan kehittymistä ja vahvuusalueen tutkimusryhmistä valmistuville tohtoreille olisi oltava tarjolla työpaikkoja.

Nykyiset vahvat tutkimusalat voidaan otsikoida useillakin eri tavoilla. Yksinkertaisimmillaan voitaisiin käyttää termejä **molekulaarinen solubiologia**, **molekyylivälikuvantaminen** ja **systemibiologia**. Nämä termit kattavat useimmissa huippuyksiköissä ja muissa suurissa tutkimusryhmissä tehtävän molekyyli lähtökohtaisen biotieteellisen ja lääketieteellisen tutkimuksen. Soveltavassa tutkimuksessa **diagnostiikka** on Turussa ilmeinen vahvuusalue. Samoin kemian tutkimus ja Åbo Akademin vahva materiaalitutkimus ovat omalta osaltaan hyödyntäneet myös bioalan soveltavaa tutkimusta. Vahvuusalueita arvioitaessa on huomattava, että tässä yhteydessä emme ole käsitelleet ekologista tutkimusta, ympäristötieteitä, kliinistä lääketiedettä tai kemian tutkimusta.

Vahvuusalueista päätettäessä olisi vältettävä liian suppeiden alueiden nimeämistä tai joustamattomien toimintatapojen käyttöönottoa. Liian ahtaat määritelmät estävät nuorten tutkijoiden kehittymisen itsenäisiksi tutkimusryhmänjohtajiksi. Lisäksi vaarana

on, että liian suppeasti määritellyt vahvuusalueet vaarantavat uusien tutkimusteknologioiden käyttöönoton.

Infrastrukturi

Turun yliopisto ja Åbo Akademi ovat systemaattisesti kehittäneet bioalan tutkimusinfrastruktuuria. Pisimmälle kehittyneitä aloja ovat **biokuvantaminen** (PET-keskus, eläinkuvantaminen Turun yliopiston tautimallinnuskeskuksessa, solukuvantaminen Turun biotekniikan keskuksessa, BTK:ssa), **systemibiologia** (genomiikka ja proteomiikka BTK:ssa ja VTT:ssä) ja **tautimallit** (tautimallinnuskeskus). **Näiden infrastruktuurialojen kehittäminen on pystyttävä takaamaan myös tulevaisuudessa.** Erityisen tärkeää on, että **infrastruktuurista huolehtivan henkilökunnan palkat pystytään varmistamaan.** Samoin laitteiden huoltokustannuksista on huolehdittava.

Jotta Turku asema merkittävänä eurooppalaisena tutkimuskeskuksena vahvistuisi, olisi pyrittävä siihen, että Turun kampusalueelle kehitettäisiin tutkimuskeskittymä, joka jollakin biotieteiden erityisalueella yleisesti tunnustettaisiin Pohjoismaiden johtavaksi keskuksiksi. Tätä päämäärää olisi tavoiteltava niin, että suora kilpailu Helsingin tai Tukholman kanssa vältetään ja että Turun vahvuusalueet mieluummin täydentäisivät näiden kaupunkien vahvuuksia. Turun PET-keskus on Suomessa ainutlaatuinen tutkimuskeskus. PET-keskuksen lisäksi Turussa on muutenkin merkittävää kokemusta ja osaamista uusien kuvantamisteknologioiden kehittämisessä ja soveltamisessa. Viime vuosina suurimmat investoinnit tutkimuksen infrastruktuurissa on tehty nimenomaan biokuvantamisen alueelle ja Turun yliopiston tautimallinnuskeskus on luonut ainutlaatuisen mahdollisuuden luoda uutta yhteistyötä kaikkien biokuvantamisen osa-alueiden välillä. **Turun biokuvantaminen on Suomen tutkimusinfrastruktuurin tiekarthanhankkeessa luokiteltu yhdeksi 24:stä kansallisesti merkittävästä infrastruktuurista.** Ehdotammekin, että Turun yliopistot yhdessä Turku Science Park Oy:n, Turun kaupungin, sairaanhoitopiirin ja Varsinais-Suomen liiton kanssa kokoavat näkyvän ja tieteellisesti korkeatasoisen pitkän aikavälin suunnitelman, jonka **päämääränä on kehittää Turusta Pohjoismaiden merkittävin biokuvantamisen keskus.** Tällainen keskus edistäisi merkittävästi parhaiden tutkijoiden hakeutumista Turkuun. Hanke toimisi **keihäänkärkenä, jonka avulla myös muita keskeisiä infrastruktuurialueita** (systemibiologia ja tautimallit) **voitaisiin kehittää.**

Nuorien tutkijoiden rekrytointi

Äskettäin perustettu **Turun Luonnontieteiden ja lääketieteen kolleegio (LLK)** on suunniteltu toimimaan rekrytointikanavana, jonka tuella esimerkiksi ulkomailla postdoktoraalivaiheen menestyksellisesti suorittaneet tutkijat voivat palata takaisin Suomeen. LLK voisi huolehtia myös ulkomaalaisten tutkijoiden rekrytoinnista. Jotta LLK voisi tulevaisuudessa huolehtia näistä tehtävistä sille olisi saatava pysyvä rahoitus. **Myös Åbo Akademi voisi osallistua LLK:n toimintaan, jolloin LLK toimisi molempien yliopistojen rekrytointielimenä.** Biotieteissä pelkkä tutkijan palkkaaminen ei mahdollista tieteellistä tutkimustyötä ja uusia aloittavia tutkimusryhmiä olisi kyettävä tukemaan myös pienten laboratoriolaitteiden ja tutkimusreagenssien alkuhankinnoissa.

Lahjakkaimmista nuorista tutkijoista käydään kovaa kilpailua sekä kansallisella että kansainvälisellä tasolla. Menestyäkseen tässä kilpailussa Turun yliopistojen olisi

systemaattisesti koulutettava ja värvättävä nuoria lupauksia ja pystyttävä tarjoamaan heille heitä tyydyttävä tutkimusympäristö.

Muut kehitettävät asiat

Tässä toimintasuunnitelmassa olemme myös pohtineet useita muita toimepiteitä, jotka edistäisivät biotieteiden kehitystä Turussa. Olemme listanneet joukon yksityiskohtaisia ehdotuksia, jotka koskevat BioCity Turun organisaatiota, perus- ja jatkokoulutusta, teknologiansiirtoa ja Turkuu tiedekaupunkina.

1.2 Sammanfattning

I samband med den biovetenskapliga forskningen har Åbo Akademi och Åbo Universitet kunnat förea sina resurser på ett unikt sätt. Detta samarbete är den viktigaste resursen vi har på Åbo-campus. I den biovetenskapliga forskningen har hindren för universitetssamarbetet effektivt kunnat röjas utan att för den skull äventyra universitetens självständiga beslutanderätt eller profilering. Även i framtiden bör universitetens utvecklingsstrategier basera sig på att detta samarbete skall fortgå och ytterligare fördjupas.

Under de gånga åren har båda universiteten liksom även Åbo Stad gjort betydande satsningar för att utveckla den biovetenskapliga sektorn och som ett resultat av dessa satsningar har Åbo utvecklats till ett framstående centrum för biovetenskaplig forskning. Även Finlands Akademi har noterat Åbos styrka på biosektorn i samband med valet av toppforskningsenheter. F.n. leds hela sju toppforskningsenheter av forskare som inbegrips i BioCitys forskningsprogram.

Den biovetenskapliga forskningen har utvecklats i Åbo på ett gynnsamt vis men många problemområden återstår. Samtidigt ställer den ökande internationella konkurrensen nya utmaningar. I denna strategiplan har vi speciellt velat poängtera följande två aspekter. För det första, **rekryteringen av unga, begåvade forskare bör höra till de viktigaste målsättningarna när strategiplaner verkställs**. En annan viktig fråga är **skapandet och upprätthållandet av en tidsenlig infrastruktur**. Dessa utmaningar kan framgångsrikt tacklas om man efter noggrann övervägning väljer de **styrkeområden inom forskning och infrastruktur** som det är speciellt klokt att fokusera sig på .

Forskningens styrkeområden

Forskningens styrkeområden bör byggas kring de existerande toppforsknings-enheterna så att de tillsammans med andra framstående grupper inom samma område kunde ha möjlighet att uppnå "kritisk massa". Styrkeområdena bör även vara tillräckligt breda för att de skulle stöda utvecklingen av självständiga unga forskare och uppkomsten av nya toppforskningsenheter. Vid valet av styrkeområden borde man speciellt stöda utvecklingen av den aboensiska biobranschen och det borde även finnas garantier för att de doktorer som utexamineras från styrkeområdena skulle få ett arbete.

De existerande starka forskningsområdena kan rubriceras på många olika vis. Den enklaste rubriceringen kunde innefatta termerna **molekylär cellbiologi, molekylär visualisering (imaging) och systembiologi**. Dessa termer täcker största delen av den molekylbaserade biovetenskapliga och medicinska forskning som f.n. bedrivs i toppforskningsenheterna och i andra stora forskargrupper. I tillämpad forskning är **diagnostik** ett uppenbart styrkeområde. Vidare har den tillämpade bioforskningen i Åbo gagnats av kemins forskning och Åbo Akademis starka materialforskning. I samband med evalueringen av styrkeområden bör man även notera att i detta sammanhang har vi inte beaktat den ekologisk eller miljöforskning, klinisk medicin eller kemisk forskning.

I samband med valet av styrkeområden bör man undvika alltför snäva forskningsområden eller tillämpning av alltför styva verksamhetsmönster. Alltför snäva definitioner hindrar unga forskare att utvecklas till självständiga forskare. Vidare finns det risk för att alltför snävt definierade styrkeområde äventyrar utnyttjandet och tillämpning av nya forskningsteknologier.

Infrastrukturer

Åbo universitet och Åbo Akademi har systematiskt utvecklat biofältets infrastrukturer. Till de mest framstående områdena är **bioimaging-sektorn** (PET-centret, djurvisualisering vid Centret för sjukdomsmodeller vid Åbo universitet samt cellvisualisering vid Åbo bioteknikcentrum), **systembiologin** (genomik och proteomik vid BTC och VTT) samt **sjukdomsmodellsektorn** (Centret för sjukdomsmodeller). **Utvecklandet av dessa infrastrukturerområden måste garanteras även i framtiden.** Speciellt viktigt är det att **trygga lönerna för den personal som sköter om essentiell infrastruktur** och på samma gång trygga apparaturens servicekostnader.

För att förstärka Åbos ställning som ett betydelsefullt europeiskt forskningscentrum bör man sträva efter att utveckla ett forskningsfokus som på något av biovetenskapernas specialområde skulle erkännas som ett ledande centrum inom Norden. Denna målsättning bör eftersträvas så att direkt tävling med Helsingfors eller Stockholm undviks utan att Åbos intressen hellre blir komplementära till de styrkeområden som utvecklas i dessa områden. Åbo PET-centrum är en unik forskningsenhet i Finland. Förutom PET-centret finns det i Åbo även i övrigt en stark tradition och mångsidigt kunnande i utvecklandet och tillämpning av avancerade visualiseringsteknologier. De senaste årens största investeringar på forskningsinfrastruktur har uttryckligen gjorts på biovisualiseringens område och Sjukdomsmodellcentret har gett unika möjligheter att utveckla samarbetet på alla biovisualiseringens delområden. Biovisualiseringen är den enda aboensiska forskningsinfrastrukturen som kandiderar för att bli antagen till roadmap-kartan för finska infrastrukturer. Med hänvisning till ovanstående motiveringar föreslår vi därför att Turku Science Park Ab, Åbo stad, sjukvårdsdistriktet och Egentliga Finlands förbund sammanställer en högklassig långtidsplan vars **avsikt är att utveckla Åbo till Nordens mest framstående centrum på biovisualiseringens område.** Ett sådant centrum skulle på ett märkbart sätt befrämja nyrekrytering av de mest framstående forskarna till Åbo. Projektet skulle fungera som en **spjutspets med vars hjälp man även kunde utveckla andra centrala forskningsområden** (systembiologi och sjukdomsmodeller).

Rekrytering av unga forskare

Det nyligen grundade **Åbo Naturvetenskapliga och Medicinska Kollegium** (ÅNMK) har planerats att utgöra en rekryteringskanal med vars hjälp t.ex. framgångsrika postdoktorala forskare kan efter avslutad utlandsvistelse återvända till Finland. ÅNMK kunde även ta hand om rekryteringen av utländska forskare. För att ANMK skall kunna även i framtiden ta hand om dessa uppdrag så borde kollegiet få en permanent finansiering. **ÅNMK kunde utgöra rekryteringsplattform för både Åbo Akademi och Åbo universitet, vilket är en aspekt som borde snarast utredas.** I bioforskningen räcker det inte enbart med att avlöna en forskare för att möjliggöra aktiv forskning och etablering av nya forskargrupper utan man måste även kunna stöda i initialanskaffningarna av mindre laboratorietrustning och forskningsreagenser.

Det råder en hård tävling om de mest begåvade unga forskarna både på nationell och internationell nivå. För att vara framgångsrik i denna tävling borde Åbos universitet systematiskt skola och värva unga löften och erbjuda dem en tillfredsställande forskningsmiljö.

Andra aspekter som bör utvecklas

I denna strategiplan har vi även övervägt andra åtgärder som skulle befrämja biovetenskapernas utveckling i Åbo. Vi har listat en mängd specifika förslag som gäller BioCitys organisation, grundundervisning och forskarskolning, teknologiöverföring samt Åbo stad som en vetenskapsstad.

2. Introduction - Biosciences in Turku

The term "biosciences" is commonly used to describe all life science and molecular medicine-related research areas, both basic and applied, targeted at analyzing the various functions of biomolecules. The research groups working on these areas are members of the BioCity Turku biocenter. Our action plan covers research on "clinical medicine", "environmental science" or "ecology" only in cases where obvious molecular aspects are under investigation.

The outset of this plan is the unique interdisciplinary unity of biosciences between both universities, a feature that is a significant strength of Turku. Within biosciences, there are no real borders between the universities, although the institutions are still able to develop their own specific agendas and profiles. Hence, the virtues of a joint "Academy" have become true in biosciences, which is a strongpoint and asset that this report is building upon.

The strategy of the University of Turku defines "Biosciences" as the largest of the strong research areas (1). In the recently published Times Higher Education listing of world universities (2), UTU was ranked number 167 in the area of life sciences and biomedicine, and 246 overall. Other than UTU and the University of Helsinki, no other Finnish universities were ranked among the top 300 institutions with regard to life sciences and biomedicine. Among the Nordic countries, UTU was ranked sixth in the life sciences and biomedicine area, which was higher than any Norwegian university. Life sciences and biomedicine were clearly the highest ranked research areas in UTU.

Biosciences provide a true stronghold for ÅAU. Similar to UTU, ÅAU classifies Biosciences as a key strategic interest area. ÅAU has a bioscience-related Center of Excellence (CoE) in Cell Stress Signaling and one in Functional Materials with significant ramifications on biosciences. Notable examples of successful ÅAU-related interest areas are those initiated as interdisciplinary joint ventures with UTU, including the PET center, the Turku Center for Biotechnology, as well as recent imaging-related initiatives. Biosciences also comprise a significant proportion of the basic and higher examinations of ÅAU.

The Finnish university cities were evaluated in 2005 on the basis of the quality of their bioscience research environments by the Ministry of Education (3). Turku was awarded the best total score, in view of the high volume of research combined with close collaboration with private enterprises and well developed "culture" of translational research.

BioCity Turku is an umbrella organization established in 1994 by UTU and ÅAU. At present, BioCity Turku contains more than 80 research groups comprising 1000 researchers and graduate students working at the different departments and centers of the universities, as well as at the National Public Health Institute in Turku (KTL/Turku) and VTT Medical Biotechnology unit. BioCity Turku has six official research programs, five of which are supported by the Medical Faculty in UTU (4).

Turku Center for Biotechnology (CBT) is a special unit established by UTU and ÅAU in 1989. CBT harbors some of the most important core facilities in Turku, including the Finnish DNA microarray center, CBT/VTT proteomics center, and the Cell Imaging

Core. The Laboratory animal center (KEK) is administratively located under CBT. The other large research technology platforms include the Turku Center for Disease Modeling (TCDM) under the Faculty of Medicine and Turku Positron Emission Tomography (PET) Center, a special unit jointly owned by UTU and ÅAU. Other centers that often participate in the common activities of the bioscience community in Turku include the Turku Biomaterials Center (Medical Faculty) and Functional Food Forum (special unit at UTU).

The strength of life science and molecular medicine-related research in Turku is recognized by the Academy of Finland, which has awarded Center of Excellence status to seven consortia directed by BioCity Turku group leaders. Twelve graduate schools participate in "the Turku Bionet" network organized by BioCity Turku (4).

3. Challenges and opportunities - Aims of the action plan

Despite positive developments in many aspects of research in biosciences in Turku, several problems remain unsolved. Moreover, increasing international and national competition has created significant new challenges. On a national level, the new rules and laws governing our universities and their activities will markedly change the outset of how these institutions should be operated. While this new order is associated with greater operational and economical flexibility, the universities will also be more stringently responsible for their economical activities, and hence the role of external funding in the overall financial structure will be considerably more prominent. International recognition and scientific excellence will play increasingly important roles, and the numbers of generated academic degrees and examinations will become less imperative. Success under these new conditions will be particularly challenging in terms of recruiting and maintaining the most promising young scientists. Another vital aspect is providing state-of-the-art research infrastructure to the best scientists. Obviously, this new scene not only imposes challenges but also offers abundant opportunities for independent decisions and bold strategies. As the scope and content of the new university rules have only recently become clear, this is a favorable time for strategy planning and adopting new directions.

At the outset described above, this action plan is aimed at the following goals:

- Improving high-quality biosciences research
- Improving recruitment and career development
- Improving the possibility of establishing new centers of excellence
- Maintaining and improving infrastructures
- Establishing significant new bodies of infrastructures, and creating national and European networks
- Strengthening interdisciplinary cross-science approaches to biosciences research
- Improving areas of expertise in biosciences
- Strengthening the infrastructure and know-how for continued undergraduate and graduate student-level training in biosciences
- Increasing the national and international recruitment of undergraduate and graduate students
- Employing biosciences research for new innovations, translational research, and applications

4. Recognition of strong research areas and technology platforms

A commonly suggested solution for improved recruitment, competitiveness, and improved infrastructures is specialization in selected research areas that represent real strongholds. Indeed, no university campus can afford to provide top-line research equipment in all infrastructure areas. Careful selection of research areas and technologies that will receive strategic financing is the optimal way to ensure success in the competitive future era. However, it is equally important to remember that rigid strategies and inflexible fixation to narrow research topics will inevitably compromise recruitment and career development of new independent research group leaders that do not fall within the scope the selected topics, thereby suppressing emerging novel research strategies and delaying implementation of new technologies.

The request to specialize has created a need to recognize the strongest research areas and technology platforms. This request has been rationalized by the fact that it may be easier for large research units to fulfill high international standards ("critical mass"). Furthermore, the increasing prices of research equipment allow only a limited number technology platforms in each of the Finnish university cities. On the other hand, it is very important to remember that rapid development of biosciences and related research technologies makes it extremely difficult to predict future trends and needs. Therefore, selection of research areas for strategic development must be executed in a manner that does not compromise the development of young scientists as independent researchers who can select timely research topics. Similarly, the building of strong technology platforms should not compromise the use of new emerging technologies in the future.

The selection of research areas for strategic development cannot be based simply on the retrospective evaluation of existing research groups. The following criteria should be taken in account during the selection process: i) the strategic areas should include the existing CoEs and other high-quality research groups that collectively form a critical mass, ii) the designated areas should be sufficiently flexible to allow young, independent researchers to create new CoEs, keeping in mind that new CoEs are never exact clones of the old ones, iii) the strategic areas should benefit the existing investments on research infrastructure, and iv) optimally, strategic areas should support the local industry, and working opportunities should be made available for newly qualified Ph.D. scientists.

The existing CoEs in within biosciences include five Academy of Finland areas, namely, Host defense, Molecular imaging, Photosynthesis and bioenergy, Evolutionary genetics and Translational genomics. In addition, two CoEs in materials science participate in the activities of BioCity Turku research programs (Functional materials and Process chemistry). ÅAU has selected its own CoEs, two (Cell stress signaling and Intelligent materials) of which are active participants in BioCity Turku activities. The European Research Council (ERC) supports one research group in BioCity Turku, which focuses on Molecular cell biology.

Based on the above criteria, it is possible to identify the following strong research areas with potential for further development:

1. *Molecular cell biology and immunology* (including CoEs of Host defense, Cell stress signaling, Molecular cell biology ERC project, and supported by CoEs of Molecular imaging, Photosynthesis and bioenergy)
2. *Molecular imaging of cells and tissues* (including Molecular imaging CoE supported by Host defense and Cell stress signaling CoEs and the Molecular cell biology ERC project)
3. *Plant cell biology and bioenergy* (including Photosynthesis and bioenergy CoE)
4. *Translational systems biology* (including Translational genomics CoE, supported by Host defense CoE, Cell stress signaling CoE, Molecular cell biology ERC-project)
5. *Evolutionary genetics* (including Evolutionary genetics CoE)

Applied biosciences can be evaluated on the basis of different criteria, including number of patents and spin-off companies. In applied science in Turku, *diagnostics* is considered a strong research area. Moreover, research on chemistry and strong materials in ÅAU has benefited the biosciences field in Turku.

Strong research areas can also be listed under different titles, for example, in a more simplified but less precise manner, as "*Molecular cell biology*", "*molecular imaging*" and "*systems biology*". This action plan only partially covers research areas, such as ecology and environmental science, clinical medicine or materials science, and we are uncertain whether parts of these research fields should be selected as strong research areas.

UTU and ÅAU have systematically developed the infrastructure for life sciences research in Turku. The strongest technology platforms have been created in:

- 1) *Bioimaging* (PET center, laboratory animal imaging in TCDM, cellular imaging in CBT, development of novel bioimaging technologies at the Laboratory of Medical Physics, Bioimaging software development projects)
- 2) *Systems biology* (Genomics, proteomics and bioinformatics in CBT and VTT)
- 3) *Disease models* (TCDM).

In the new Biocenter Finland organization, Turku is the coordinator of bioimaging and quantitative biology (including proteomics and bioinformatics) (5). These infrastructure areas include special technologies, making Turku nationally important as a provider of services that are unique in Finland.

5. Development of BioCity Turku

5.1 Organization

At present, BioCity Turku is run by a scientific director nominated for a five-year period by the rector of UTU. In addition to the duties involved, the director is expected to work full-time on his/her own professorship. The scientific director is also the chairperson of the common board of CBT and BioCity Turku. Board members are nominated by the rectors of UTU and ÅAU, and proposed by two faculties in each university. An additional board member represents the local bioindustry. BioCity Turku has one academic coordinator (50%). The board of CBT/BioCity Turku has nominated a scientific advisory board (SAB) composed of Nordic specialists.

Proposed measures

1. BioCity Turku SAB should play a more prominent role. Meetings of SAB should be organized every year in Turku. During these meetings, the SAB should provide status reports and submit recommendations to the university rectors and boards.
2. CBT should remain a special unit directly positioned under the central administration of both universities, and not relocated under one or several faculties. Subsequently, the issue of whether KEK should be established as part of TCDM, rather than CBT, should be examined. In our opinion, KEK would benefit to a much greater degree from synergies with TCDM than with CBT.
3. A common board for both CBT and BioCity Turku is a more practical arrangement. The board should play a bigger role in strategic planning.

5.2 Research programs

BioCity Turku has selected six research programs for the present five-year period. Prior to selection, the programs were evaluated by the SAB. The programs annually receive minor financial support from BioCity Turku, and typically use the funds in organizing common seminars or meetings, supporting the travel of graduate students and postdoctoral scientists or the development of core facilities. Five of the programs are also supported financially by the Medical Faculty of UTU. The programs have had freedom to choose the research groups that are listed that are accepted to the program. [In general, a large majority of the senior scientists in BioCity Turku support the present system, and unanimously oppose a more strict selection of research groups allowed to participate in the common activities.

Proposed measures

1. In the future, BioCity Turku should continue to use the same basic strategy to select official research programs.
2. Each research program should be evaluated by outside specialists to provide new ideas on improving scientific quality and common activities. The evaluations should be organized in-house by the programs themselves.
3. In case Biocenter Finland or any other organization can provide financing to directly support the research groups, BioCity Turku should organize the targeting of specific funding to the best researchers.

4. The universities should increase financial support for BioCity Turku research programs, which has remained unchanged for almost 10 years to date.
5. BioCity Turku and the Medical Faculty in UTU should also act together in selecting the research programs. This collaboration should be extended to include ÅAU and the Science Faculty in UTU.

5.3 BioCity Turku seminars and symposia

The BioCity Turku seminar series “Frontiers of Science” and BioCity Symposium have developed into highly established structures, both with important roles in graduate student and post-doctoral training. Furthermore, the seminars serve as an important site of interactions between different disciplines and constitute a “brand”, i.e., hallmark of our university campus. These functions should be further stabilized, and the profile raised even further. The concepts are excellent and should not be altered, but care should be taken not to let them get uninteresting due to lack of new ideas. The turnover of responsible persons should be sufficiently rapid.

Proposed measures

1. There should be more practical ("hands-on") training for graduate students and postdoctoral scientists. BioCity Turku should consider organizing an annual summer or winter school in collaboration with the graduate schools. These one-week courses could be targeted to developing novel emerging technologies, and would aid in establishing Turku as a renowned center of life science research.

6. Development of research infrastructure

Instant access to up-to-date research equipment is one of the most important requirements for a research-oriented university. Moreover, in the absence of a proper infrastructure, it is impossible to recruit competitive scientists.

Special requirements for the development of research infrastructure should be carefully considered, bearing in mind the different levels of infrastructure necessary:

1. Infrastructure frequently used by individual research groups, which should be located on the same floor or building as the researchers
2. Centralized infrastructure used by several research groups in the campus area
3. National-level technology platforms
4. International-level technology platforms

At present, level 1 infrastructure is provided by individual research groups, university departments or faculties. Centralized infrastructure (level 2) is most often localized in special units. Pieces of equipment have often been purchased using budget funding from the universities, special project grants from the Ministry of Education, or financial support from the Academy of Finland or private foundations. Financing of the research infrastructure in Finland has remained an unsolved problem for several years, and many important units are currently old and out-of-date. Despite this unsatisfactory situation,

Turku has successfully provided services for other universities at national-level technology platforms created in the areas of bioimaging, systems biology, and disease models. The national-level infrastructures are generally supported by special project funding from the Ministry of Education. However, this funding has partially ended, and will be completely discontinued by the end of 2009. Biocenter Finland has applied for financing for the most essential national-level technology platforms commencing from 2010, but procurement of this bursary is not guaranteed (5). The salaries of the trained personnel working in different core laboratories are critically dependent on the continuation of this funding. Furthermore, the increasing maintenance expenses for the equipment further compromise and jeopardize the continuation of competitive and high-quality life science research in Finland. European-level infrastructure networks are presently organized in the ESFRI program. Finnish biocenters may be able to participate in the different networks through Biocenter Finland, Center for Scientific Computing (CSC), and Finnish Institute for Molecular Medicine (FIMM).

The Turku Campus would provide the necessary space for core facilities and research groups if the new Micromedicum building is constructed as planned.

Proposed measures

1. The technology platforms created in the areas of bioimaging, systems biology and disease models should be developed further, but in collaboration with other biocenters to avoid overlapping activities and investments. The three platforms are critically dependent on each other, and contain technology and equipment that are unique to Finland. At present, each platform is classified as national-level technology. Their further development should be guaranteed, even if funding through Biocenter Finland is not possible.
2. Salaries of personnel overseeing the common equipment as well as the service costs of the instruments should be secured.
3. The purchase of common instrumentation and expensive equipment should be carefully considered, together with special units and faculties to minimize overlap and maximize synergy. We propose that Research Vice-Rectors should organize biannual meetings with the Deans (Vice Deans) of the bioscience-related faculties and directors of the special units, with a view to exchanging information about ongoing plans to purchase new instrumentation.
4. Unless particular reasons are stipulated, special units and centers, such as CBT, PET center and TCDM, are natural locations for bulky common equipment. It is additionally important to ensure that all research buildings contain the basic instrumentation required for daily work.
5. Each core facility should actively contribute to the Biocenter Finland network and maximize the possibility of taking advantage of the ESFRI networks.
6. Each core facility should consider whether all the services provided are cost-effective, compared to commercially available services. It is not reasonable to use expensive equipment and personnel to produce services that can be bought elsewhere if the external price is significantly lower, the service faster, or the results more accurate. The core facilities should concentrate on the production of more challenging services and development of new technologies.

7. In cases where it is rational to purchase outside services, the core facilities should be involved in selecting and recommending providers of the best quality of service and optimal cost efficiency, making favorable deals with the service providers, and informing researchers about these possibilities.

8. In many cases, it is not possible to locally provide emerging technologies for BioCity researchers, but analysis services are commercially available. In these situations, the core facilities should inform researchers about the newly available possibilities, and provide assistance with preparation, quality control and shipment of samples.

7. Requirement for one high-profile technology platform at the Turku campus

International recognition of Turku as an important European research center requires the presence of a high-profile research initiative that has a leading position, not only in Finland but also other Nordic countries. The strong position of the University of Helsinki in Finland and the worldwide reputation of some Nordic universities, such as the Karolinska Institute, present difficulties in Turku gaining a leading position in life sciences or molecular medicine. A strategy should be developed so that direct competition with Helsinki and Stockholm is avoided. Instead, spearheading should be ideally directed to areas complementing those of Helsinki and Stockholm, and the core facilities should be made attractive for use by research groups from these cities. The strongest research and technology areas in Turku (specified above) are additionally often dominant in other leading Life sciences departments of Universities in Nordic countries. However, the unique research facilities in the Turku PET center are a clear exception. Furthermore, Turku has long-standing traditions in research on novel imaging technologies and principles, many of which have been translated into the corporate scene. Recent substantial investments in animal imaging in TCDM have facilitated the bridging of molecular imaging of tissues and strong research traditions in cellular imaging in Turku. The initiative, designated 'Turku Bioimaging' is aimed to coordinate the development of molecular imaging. The leading position of the Turku PET center in Nordic countries, in combination with the numerous other imaging technologies in Turku that do not exist anywhere else in Finland (STED microscopy, top-of-line biological atomic force microscopy, and laboratory animal PET/CT), provides an opportunity to create a leading technology platform in Northern Europe. Turku Bioimaging is among the 24 most important national research infrastructures in Finland, based on the Finnish research infrastructure roadmap (6). The Turku Bioimaging technology platform does not compete with other important technology platforms in Turku, but strongly supports the development of proteomics, bioinformatics and disease models, which are incorporated in this initiative.

Proposed measures

Universities should create a common, high-profile plan in collaboration with the Turku Science Park, City of Turku, Hospital District of Southwest Finland, and the Regional Council of Southwest Finland to initiate the development of an internationally recognized bioimaging technology platform, which would be critical in the recruitment

of top-level researchers and create new opportunities for all researchers in the life sciences and molecular medicine areas in Turku.

8. Recruitment of new scientists

A classical research career in biosciences is composed of three phases: graduate student, post-doctoral researcher, and independent group leader. An increasing number of students are members of one of the many graduate schools in Finland. In Turku alone, students in life sciences and molecular medicine are members of 12 different graduate schools. Collaborations and exchange of information among the graduate schools are organized by the Turku Bionet network in BioCity Turku (4). The post-doctoral researchers are not independent scientists, and work as members of research groups under the guidance of senior researchers. Despite the high scientific expertise of many Finnish research groups, it is highly recommended that Finnish Ph.D. students work abroad for some years as post-doctoral fellows. In the Finnish system, the best way to advance in a career as an independent research scientist is to obtain a researcher position from the Academy of Finland. These are five-year positions that include funding for research expenses. However, there is a problematic gap between researcher and tenure positions in Finnish universities.

Recruitment of high-quality researchers is critical for developments in any scientific area. Finnish universities have no resources to compete with the best universities in Europe, North America or Asia in terms of recruitment of high-profile leaders of various research fields. However, Finnish institutions can systematically train young scientists and offer them a reasonable research environment. There is increasing competition to recruit the most promising young researchers among the Finnish universities, as well as between Finnish and foreign universities.

Proposed measures

1. In future, all graduate students should be members of the graduate schools.
2. The most talented new Ph.D. students should be motivated and encouraged to move abroad to work as post-doctoral fellows. Graduate schools and Turku Bionet should organize training to prepare the students to seek out the best possible international research groups.
3. The new Turku Collegium for Science and Medicine (TCSM) may serve as an effective recruitment channel for selected post-doctoral scientists in the process of moving back to Finland after working abroad. TCSM could also be developed as the main channel to recruit foreign scientists. To fulfill these tasks, TCSM should obtain permanent funding. Optimally, TCSM may aid in the annual recruitment of 5-10 new researchers.
4. The salary of a researcher in biosciences is not sufficient to allow the establishment of a new research group, and thus recruitment of young scientists should always include a start-up package. Optimally, TCSM should have the resources to provide this support to new scientists.
5. The issue of whether TCSM can act as a recruitment body for both UTU and ÅAU requires consideration.

6. A new support system is needed for young scientists to ensure a reasonable career transition and continuation after termination of a researcher position from the Academy of Finland, which may be implemented by TCSM following the required financial measures.

9. Connection between research and education

High-quality basic undergraduate education provides the foundation for all biosciences, and is the only way to ensure that graduate students have the necessary conceptual tools and skills for a successful academic or industry-oriented career. However, the resources for undergraduate education in biosciences are severely limited at present. Furthermore, in many cases, the working conditions have deteriorated to the extent that intermediate teaching positions are not attractive for highly qualified scientists, especially as they usually do not involve tenure track possibilities.

Proposed measures

1. One possibility to support career opportunities in biosciences and obtain high-quality educators is to improve the working conditions in teaching positions to ensure more attractive packages for highly qualified scientists. An increase in the volume of scientists involved in teaching is required to reduce the teaching load of individual lecturers.

2. An international masters degree programs is one way of acquiring more resources and ensuring maximal benefits from the different areas of expertise on the campus. Establishment of these programs is additionally of crucial importance for the international recruitment of students and future graduates.

3. A further step is the maximal utilization of teaching resources and expertise from the whole campus for a cause that is of common interest. There are several examples of individual courses employing scientists from different departments of both universities. In dominant research areas, this type of interdisciplinary approach to teaching can be employed for establishing an international masters program that would, in turn, yield more resources and a better recruitment base for new students. In several specialist areas, teaching could to a higher extent be joint and coordinated effort for the most rational use of available resources.

10. Technology transfer

Turku hosts more than half the biotechnology-related industry in Finland. In addition to large pharmaceutical and diagnostics companies, there are several small and medium-sized companies, including university spin-offs. The university researchers in Turku have a long and successful history of collaboration with commercial enterprises. Turku Science Park is owned by the city of Turku, and aims to coordinate the relationships between academic and industrial researchers. However, in Finland, major problems in the commercialization of inventions produced by the academic researchers have to be overcome.

Patenting of inventions is supported by the Foundation for Finnish Inventions (keksintösäätiö/uppfinningsstiftelsen). Furthermore, UTU and ÅAU have a common Innovation Manager and Innovation Coordinator, who help in the protection and exploitation of inventions. The TULI project ("From Research to Business") is planned to partially fund these activities. However, it is often financially impossible to develop the findings in basic science to the level where they are considered inventions. This process would require special funding for "proof-of-concept" type of projects.

While the present supporting mechanisms are intended for inventions produced in applied science, no strategy exists to advance the development of the basic science-related observations to the invention level. There is an urgent need for new funding instruments that would fill the gap between the basic science projects financed by the Academy of Finland, and the applied science projects funded by TEKES and private companies. Biocenter Finland has applied for funding from the Ministry of Education for new proof-of-concept grants (5). However, it is uncertain whether this new form of funding will be granted.

Proposed measures

1. BioCity Turku should continue its collaboration with Turku Science Park. The goals should include the establishment of better connections between academic researchers and local companies. In addition, with the aid of Turku Science Park, BioCity Turku researchers may form new connections with international research centers, such as those in the Stockholm area and Heidelberg.

2. UTU and ÅAU should create a common strategy to accelerate the commercialization of basic science-related observations. This would need a local fund to support proof-of-concept research. The university-associated foundations and/or Uuden Teknologian Säätiö/Stiftelsen för Ny Teknologi could be included in the strategy.

3. Turku Innovation Platform (TIP) is a novel initiative, which includes the idea to offer concomitant M.B.A. and Ph.D. training for selected graduate students. We support this proposal, and recommend that ÅAU and graduate schools in life sciences and molecular medicine in Turku are included in future planning.

11. Turku as a bioscience city

The City of Turku supports both science and bioscience disciplines in different ways through Turku Science Park and other organizations. However, Turku does not profile itself as a science city and major university town, either in terms of strategy or in the context of its "branding" or PR material (although the presence of the universities is acknowledged as the crux of economical "clusters" of the city). In view of the number of active students and personnel within the universities and all the resulting economic ramifications, these institutions are the dominant features of the economical scene in Turku. Comparable cities in which universities play a prominent role include Lund, Uppsala, Umeå, Odense, Bergen, Heidelberg, Göttingen, and Dijon, among others. Turku may benefit from a more close relationship with the universities, as it would profile itself as a city of knowledge and advanced technology. On the other hand, the universities may present improved profiles with firm support from the city. Thus, a

closer interrelationship would benefit both partners, and have a significant economical impact in case Turku becomes the host of a major European infrastructure. The dual aspect of Turku as a science city and university town does not jeopardize its profiling of different technologies. On the contrary, a university town is likely to be more credible as an innovator.

Proposed measures

1. As biosciences represents a leading science sector on the Turku campus, BioCity Turku takes the initiative of starting a dialog with the city of Turku through suitable representatives. This dialog could take place together with Turku Science Park.

2. The main aim is that Turku adopts the universities as main features of its future strategy. Ultimately, the city of Turku should have its own strategy for promoting science and its universities. Biosciences should have a prominent role in this strategy. Turku should also play an important role in the recruitment of scientists, as the way in which the city welcomes its new foreign inhabitants will affect how well newly recruited scientists thrive.

3. The city of Turku could also help in improving the Turku university campus. Compared with many prominent university towns, the Turku campus should be significantly improved in terms of attractiveness and stimulation of interactions and well-being. While some parts are rather pleasant, a significant proportion of the biomedical campus lacks planning that would favor cohesion and well-being. For example, Turku Science Park with its most prominent buildings, BioCity, Pharmacy, and the ICT building, and the campus of biomedicine stretching into the university hospital constitute a mostly hostile environment, with very few areas displaying the comfort and appeal of a traditional campus and almost complete absence of green areas. Improvement of these areas should not only be included in the discussions with the city, but also considered within the universities.

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