



INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL
TRAINING AT THE UNIVERSITY OF HELSINKI 2005–2010

RC-Specific Evaluation of DePoNa – Drug Delivery and Polymer Based Nanotechnology

Seppo Saari & Antti Moilanen (Eds.)



Evaluation Panel: Medicine, Biomedicine and Health Sciences

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Title: International Evaluation of Research and Doctoral Training at the University of Helsinki 2005–2010 : RC-Specific Evaluation of DePoNa – Drug Delivery and Polymer Based Nanotechnology	Type of publication: Evaluations
Summary: Researcher Community (RC) was a new concept of the participating unit in the evaluation. Participation in the evaluation was voluntary and the RCs had to choose one of the five characteristic categories to participate. Evaluation of the Researcher Community was based on the answers to the evaluation questions. In addition a list of publications and other activities were provided by the TUHAT system. The CWTS/Leiden University conducted analyses for 80 RCs and the Helsinki University Library for 66 RCs. Panellists, 49 and two special experts in five panels evaluated all the evaluation material as a whole and discussed the feedback for RC-specific reports in the panel meetings in Helsinki. The main part of this report is consisted of the feedback which is published as such in the report. Chapters in the report: 1. Background for the evaluation 2. Evaluation feedback for the Researcher Community 3. List of publications 4. List of activities 5. Bibliometric analyses The level of the RCs' success can be concluded from the written feedback together with the numeric evaluation of four evaluation questions and the category fitness. More conclusions of the success can be drawn based on the University-level report.	
RC-specific information:	
Main scientific field of research: Medicine, Biomedicine and Health Sciences	RC-specific keywords: Drug delivery, biopharmaceutics, drug formulation, polymer chemistry, nanoparticle, biomaterial
Participation category: 1. Research of the participating community represents the international cutting edge in its field	
RC's responsible person: Urtti, Arto	
Keywords: Research Evaluation, Meta-evaluation, Doctoral Training, Bibliometric Analyses, Researcher Community	

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Foreword

The evaluation of research and doctoral training is being carried out in the years 2010–2012 and will end in 2012. The steering group appointed by the Rector in January 2010 set the conditions for participating in the evaluation and prepared the Terms of Reference to present the evaluation procedure and criteria. The publications and other scientific activities included in the evaluation covered the years 2005–2010.

The participating unit in the evaluation was defined as a Researcher Community (RC). To obtain a critical mass with university-level impact, the number of members was set to range from 20 to 120. The RCs were required to contain researchers in all stages of their research career, from doctoral students to principal investigators (PIs). All in all, 136 Researcher Communities participated in this voluntary evaluation, 5857 persons in total, of whom 1131 were principal investigators. PIs were allowed to participate in two communities in certain cases, and 72 of them used this opportunity and participated in two RCs.

This evaluation enabled researchers to define RCs from the “bottom up” and across disciplines. The aim of the evaluation was not to assess individual performance but a community with shared aims and researcher-training activities. The RCs were able to choose among five different categories that characterised the status and main aims of their research. The steering group considered the process of applying to participate in the evaluation to be important, which led to the establishment of these categories. In addition, providing a service for the RCs to enable them to benchmark their research at the global level was a main goal of the evaluation.

The data for the evaluation consisted of the RCs’ answers to evaluation questions on supplied e-forms and a compilation extracted from the TUHAT – Research Information System (RIS) on 12 April 2011. The compilation covered scientific and other publications as well as certain areas of scientific activities. During the process, the RCs were asked to check the list of publications and other scientific activities and make corrections if needed. These TUHAT compilations are public and available on the evaluation project sites of each RC in the TUHAT-RIS.

In addition to the e-form and TUHAT compilation, University of Leiden (CWTS) carried out bibliometric analyses from the articles included in the Web of Science (WoS). This was done on University and RC levels. In cases where the publication forums of the RC were clearly not represented by the WoS data, the Library of the University of Helsinki conducted a separate analysis of the publications. This was done for 66 RCs representing the humanities and social sciences.

The evaluation office also carried out an enquiry targeted to the supervisors and PhD candidates about the organisation of doctoral studies at the University of Helsinki. This and other documents describing the University and the Finnish higher education system were provided to the panellists.

The panel feedback for each RC is unique and presented as an entity. The first collective evaluation reports available for the whole panel were prepared in July–August 2011. The reports were accessible to all panel members via the electronic evaluation platform in August. Scoring from 1 to 5 was used to complement written feedback in association with evaluation questions 1–4 (scientific focus and quality, doctoral training, societal impact, cooperation) and in addition to the category evaluating the fitness for participation in the evaluation. Panellists used the international level as a point of comparison in the evaluation. Scoring was not expected to go along with a preset deviation.

Each of the draft reports were discussed and dealt with by the panel in meetings in Helsinki (from 11 September to 13 September or from 18 September to 20 September 2011). In these meetings the panels also examined the deviations among the scores and finalised the draft reports together.

The current RC-specific report deals shortly with the background of the evaluation and the terms of participation. The main evaluation feedback is provided in the evaluation report, organised according to the evaluation questions. The original material provided by the RCs for the panellists has been attached to these documents.

On behalf of the evaluation steering group and office, I sincerely wish to thank you warmly for your participation in this evaluation. The effort you made in submitting the data to TUHAT-RIS is gratefully acknowledged by the University. We wish that you find this panel feedback useful in many ways. The bibliometric profiles may open a new view on your publication forums and provide a perspective for discussion on your choice of forums. We especially hope that this evaluation report will help you in setting the future goals of your research.

Johanna Björkroth
Vice-Rector
Chair of the Steering Group of the Evaluation

Steering Group of the evaluation

Steering group, nominated by the Rector of the University, was responsible for the planning of the evaluation and its implementation having altogether 22 meetings between February 2010 and March 2012.

Chair

Vice-Rector, professor **Johanna Björkroth**

Vice-Chair

Professor **Marja Airaksinen**

Chief Information Specialist, Dr **Maria Forsman**

Professor **Arto Mustajoki**

University Lecturer, Dr **Kirsi Pyhälä**

Director of Strategic Planning and Development, Dr **Ossi Tuomi**

Doctoral candidate, MSocSc **Jussi Vauhkonen**

Panel members

CHAIR

Professor Lorenz Poellinger

Cancer biology, cell and molecular biology
Karolinska Institute, Sweden

VICE-CHAIR

Professor Cornelia van Duijn

Genetic epidemiology, Alzheimer's disease and related disorders
Erasmus Medical Centre, the Netherlands

Professor Johanna Ivaska

Molecular cell biology, cell adhesion, cancer biology
University of Turku, VTT Technical Research Centre, Finland

Professor Olli Lassila

Immunology, medical microbiology
University of Turku, Finland

Professor Hans-Christian Pape

Neuroscience, neurophysiology
University of Münster, Germany

Professor Thomas Ruzicka

Dermatology, allergology
Ludwig-Maximilians-Universität (LMU) München, Germany

Professor Lars Terenius

Experimental alcohol and drug dependence research, mental disorders,
preventive medicine
Karolinska Institute, Sweden

Professor Peter York

Physical pharmaceuticals, pharmaceutical chemistry, pharmaceutical
technology
University of Bradford, Great Britain

The panel, independently, evaluated all the submitted material and was responsible for the feedback of the RC-specific reports. The panel members were asked to confirm whether they had any conflict of interests with the RCs. If this was the case, the panel members disqualified themselves in discussion and report writing.

Added expertise to the evaluation was contributed by two evaluators outside the panels and by three members from the other panels.

External Experts

Professor Olli Carpén

Pathology, cancer cell metastasis
University of Turku
Finland

Professor Anders Linde

Oral biochemi
Faculty of Odontology
Göteborg University
Sweden

Experts from the Other Panels

Professor Jan-Otto Carlsson, from the Panel of Natural Sciences

Professor Danny Huylebroek, from the Panel of Biological, Agricultural and Veterinary Sciences

Professor Holger Stark, from the Panel of Natural Sciences

EVALUATION OFFICE

Dr Seppo Saari, Doc., Senior Adviser in Evaluation, was responsible for the entire evaluation, its planning and implementation and acted as an Editor-in-chief of the reports.

Dr Eeva Sievi, Doc., Adviser, was responsible for the registration and evaluation material compilations for the panellists. She worked in the evaluation office from August 2010 to July 2011.

MSocSc Paula Ranne, Planning Officer, was responsible for organising the panel meetings and all the other practical issues like agreements and fees and editing a part the RC-specific reports. She worked in the evaluation office from March 2011 to January 2012.

Mr Antti Moilanen, Project Secretary, was responsible for editing the reports. He worked in the evaluation office from January 2012 to April 2012.

TUHAT OFFICE

Provision of the publication and other scientific activity data

Mrs Aija Kaitera, Project Manager of TUHAT-RIS served the project ex officio providing the evaluation project with the updated information from TUHAT-RIS. The TUHAT office assisted in mapping the publications with CWTS/University of Leiden.

MA Liisa Ekebom, Assisting Officer, served in TUHAT-RIS updating the publications for the evaluation. She also assisted the UH/Library analyses.

BA Liisa Jäppinen, Assisting Officer, served in TUHAT-RIS updating the publications for the evaluation.

HELSINKI UNIVERSITY LIBRARY

Provision of the publication analyses

Dr Maria Forsman, Chief Information Specialist in the Helsinki University Library, managed with her 10 colleagues the bibliometric analyses in humanities, social sciences and in other fields of sciences where CWTS analyses were not applicable.

Acronyms and abbreviations applied in the report

External competitive funding

AF - Academy of Finland
TEKES - Finnish Funding Agency for Technology and Innovation
EU - European Union
ERC - European Research Council
International and national foundations
FP7/6 etc. /Framework Programmes/Funding of European Commission

Evaluation marks

Outstanding (5)
Excellent (4)
Very Good (3)
Good (2)
Sufficient (1)

Abbreviations of Bibliometric Indicators

P - Number of publications
TCS - Total number of citations
MCS - Number of citations per publication, excluding self-citations
PNC - Percentage of uncited publications
MNCS - Field-normalized number of citations per publication
MNJS - Field-normalized average journal impact
THCP10 - Field-normalized proportion highly cited publications (top 10%)
INT_COV - Internal coverage, the average amount of references covered by the WoS
WoS - Thomson Reuters Web of Science Databases

Participation category

Category 1. The research of the participating community represents the international cutting edge in its field.

Category 2. The research of the participating community is of high quality, but the community in its present composition has yet to achieve strong international recognition or a clear break-through.

Category 3. The research of the participating community is distinct from mainstream research, and the special features of the research tradition in the field must be considered in the evaluation.

Category 4. The research of the participating community represents an innovative opening.

Category 5. The research of the participating community has a highly significant societal impact.

Research focus areas of the University of Helsinki

Focus area 1: The basic structure, materials and natural resources of the physical world

Focus area 2: The basic structure of life

Focus area 3: The changing environment - clean water

Focus area 4: The thinking and learning human being

Focus area 5: Welfare and safety

Focus area 6: Clinical research

Focus area 7: Precise reasoning

Focus area 8: Language and culture

Focus area 9: Social justice

Focus area 10: Globalisation and social change

1 Introduction to the Evaluation

1.1 RC-specific evaluation reports

The participants in the evaluation of research and doctoral training were Researcher Communities (hereafter referred to as the RC). The RC refers to the group of researchers who registered together in the evaluation of their research and doctoral training. Preconditions in forming RCs were stated in the Guidelines for the Participating Researcher Communities. The RCs defined themselves whether their compositions should be considered well-established or new.

It is essential to emphasise that the evaluation combines both meta-evaluation¹ and traditional research assessment exercise and its focus is both on the research outcomes and procedures associated with research and doctoral training. The approach to the evaluation is enhancement-led where self-evaluation constituted the main information. The answers to the evaluation questions formed together with the information of publications and other scientific activities an entity that was to be reviewed as a whole.

The present evaluation recognizes and justifies the diversity of research practices and publication traditions. Traditional Research Assessment Exercises do not necessarily value high quality research with low volumes or research distinct from mainstream research. It is challenging to expose the diversity of research to fair comparison. To understand the essence of different research practices and to do justice to their diversity was one of the main challenges of the present evaluation method. Understanding the divergent starting points of the RCs demanded sensitivity from the evaluators.

1.2 Aims and objectives in the evaluation

The aims of the evaluation are as follows:

- to improve the level of research and doctoral training at the University of Helsinki and to raise their international profile in accordance with the University's strategic policies. The improvement of doctoral training should be compared to the University's policy.²
- to enhance the research conducted at the University by taking into account the diversity, originality, multidisciplinary nature, success and field-specificity,
- to recognize the conditions and prerequisites under which excellent, original and high-impact research is carried out,
- to offer the academic community the opportunity to receive topical and versatile international peer feedback,
- to better recognize the University's research potential.
- to exploit the University's TUHAT research information system to enable transparency of publishing activities and in the production of reliable, comparable data.

1.3 Evaluation method

The evaluation can be considered as an enhancement-led evaluation. Instead of ranking, the main aim is to provide useful information for the enhancement of research and doctoral training of the participating RCs. The comparison should take into account each field of science and acknowledge their special character.

¹ The panellists did not read research reports or abstracts but instead, they evaluated answers to the evaluation questions, tables and compilations of publications, other scientific activities, bibliometrics or comparable analyses.

² [Policies on doctoral degrees and other postgraduate degrees at the University of Helsinki.](#)

The comparison produced information about the present status and factors that have lead to success. Also challenges in the operations and outcomes were recognized.

The evaluation approach has been designed to recognize better the significance and specific nature of researcher communities and research areas in the multidisciplinary top-level university. Furthermore, one of the aims of the evaluation is to bring to light those evaluation aspects that differ from the prevalent ones. Thus the views of various fields of research can be described and research arising from various starting points understood better. The doctoral training is integrated into the evaluation as a natural component related to research. Operational processes of doctoral training are being examined in the evaluation.

Five stages of the evaluation method were:

1. Registration – Stage 1
2. Self-evaluation – Stage 2
3. TUHAT³ compilations on publications and other scientific activities⁴
4. External evaluation
5. Public reporting

1.4 Implementation of the external evaluation

Five Evaluation Panels

Five evaluation panels consisted of independent, renowned and highly respected experts. The main domains of the panels are:

1. biological, agricultural and veterinary sciences
2. medicine, biomedicine and health sciences
3. natural sciences
4. humanities
5. social sciences

The University invited 10 renowned scientists to act as chairs or vice-chairs of the five panels based on the suggestions of faculties and independent institutes. Besides leading the work of the panel, an additional role of the chairs was to discuss with other panel chairs in order to adopt a broadly similar approach. The panel chairs and vice-chairs had a pre-meeting on 27 May 2011 in Amsterdam.

The panel compositions were nominated by the Rector of the University 27 April 2011. The participating RCs suggested the panel members. The total number of panel members was 50. The reason for a smaller number of panellists as compared to the previous evaluations was the character of the evaluation as a meta-evaluation. The panellists did not read research reports or abstracts but instead, they evaluated answers to the evaluation questions, tables and compilations of publications, other scientific activities, bibliometrics and comparable analyses.

The panel meetings were held in Helsinki:

- On 11–13 September 2011: (1) biological, agricultural and veterinary sciences, (2) medicine, biomedicine and health sciences and (3) natural sciences.
- On 18–20 September 2011: (4) humanities and (5) social sciences.

³ TUHAT (acronym) of Research Information System (RIS) of the University of Helsinki

⁴ Supervision of thesis, prizes and awards, editorial work and peer reviews, participation in committees, boards and networks and public appearances.

1.5 Evaluation material

The main material in the evaluation was the RCs' self-evaluations that were qualitative in character and allowed the RCs to choose what was important to mention or emphasise and what was left unmentioned.

The present evaluation is exceptional at least in the Finnish context because it is based on both the evaluation documentation (self-evaluation questions, publications and other scientific activities) and the bibliometric reports. All documents were delivered to the panellists for examination.

Traditional bibliometrics can be reasonably done mainly in medicine, biosciences and natural sciences when using the Web of Science database, for example. Bibliometrics, provided by CWTS/The Centre for Science and Technology Studies, University of Leiden, cover only the publications that include WoS identification in the TUHAT-RIS.

Traditional bibliometrics are seldom relevant in humanities and social sciences because the international comparable databases do not store every type of high quality research publications, such as books and monographs and scientific journals in other languages than English. The Helsinki University Library has done analysis to the RCs, if their publications were not well represented in the Web of Science databases (RCs should have at least 50 publications and internal coverage of publications more than 40%) – it meant 58 RCs. The bibliometric material for the evaluation panels was available in June 2011. The RC-specific bibliometric reports are attached at the end of each report.

The panels were provided with the evaluation material and all other necessary background information, such as the basic information about the University of Helsinki and the Finnish higher education system.

Evaluation material

1. Registration documents of the RCs for the background information
2. Self evaluation material – answers to the evaluation questions
3. Publications and other scientific activities based on the TUHAT RIS:
 - 3.1. statistics of publications
 - 3.2. list of publications
 - 3.3. statistics of other scientific activities
 - 3.4. list of other scientific activities
4. Bibliometrics and comparable analyses:
 - 4.1. Analyses of publications based on the verification of TUHAT-RIS publications with the Web of Science publications (CWTS/University of Leiden)
 - 4.2. Publication statistics analysed by the Helsinki University Library - mainly for humanities and social sciences
5. University level survey on doctoral training (August 2011)
6. University level analysis on publications 2005–2010 (August 2011) provided by CWTS/University of Leiden

Background material

University of Helsinki

- [Basic information about the University of the Helsinki](#)
- [The structure of doctoral training at the University of Helsinki](#)
- Previous evaluations of research at the University of Helsinki – links to the reports: [1998](#) and [2005](#)

The Finnish Universities/Research Institutes

- [Finnish University system](#)
- [Evaluation of the Finnish National Innovation System](#)
- [The State and Quality of Scientific Research in Finland. Publication of the Academy of Finland 9/09.](#)

The evaluation panels were provided also with other relevant material on request before the meetings in Helsinki.

1.6 Evaluation questions and material

The participating RCs answered the following evaluation questions which are presented according to the evaluation form. In addition, TUHAT RIS was used to provide the **additional material** as explained. For giving the feedback to the RCs, the panellists received the evaluation feedback form constructed in line with the evaluation questions:

1. Focus and quality of the RC's research

- Description of
 - the RC's research focus.
 - the quality of the RC's research (incl. key research questions and results)
 - the scientific significance of the RC's research in the research field(s)
- Identification of the ways to strengthen the focus and improve the quality of the RC's research

The additional material: TUHAT compilation of the RC's publications, analysis of the RC's publications data (provided by University of Leiden and the Helsinki University Library)

A written feedback from the aspects of: scientific quality, scientific significance, societal impact, innovativeness

- Strengths
- Areas of development
- Other remarks
- Recommendations

Numeric evaluation: OUTSTANDING (5), EXCELLENT (4), VERY GOOD (3), GOOD (2), SUFFICIENT (1)

2. Practises and quality of doctoral training

- Organising of the doctoral training in the RC. Description of the RC's principles for:
 - recruitment and selection of doctoral candidates
 - supervision of doctoral candidates
 - collaboration with faculties, departments/institutes, and potential graduate schools/doctoral programmes
 - good practises and quality assurance in doctoral training
 - assuring of good career perspectives for the doctoral candidates/fresh doctorates
- Identification of the RC's strengths and challenges related to the practises and quality of doctoral training, and the actions planned for their development.

The additional material: TUHAT compilation of the RC's other scientific activities/supervision of doctoral dissertations

A written feedback from the aspects of: processes and good practices related to leadership and management

- Strengths
- Areas of development
- Other remarks
- Recommendations

Numeric evaluation: OUTSTANDING (5), EXCELLENT (4), VERY GOOD (3), GOOD (2), SUFFICIENT (1)

3. The societal impact of research and doctoral training

- Description on how the RC interacts with and contributes to the society (collaboration with public, private and/or 3rd sector).
- Identification of the ways to strengthen the societal impact of the RC's research and doctoral training.

The additional material: TUHAT compilation of the RC's other scientific activities.

A written feedback from the aspects of: societal impact, national and international collaboration, innovativeness

- Strengths
- Areas of development
- Other remarks
- Recommendations

Numeric evaluation: OUTSTANDING (5), EXCELLENT (4), VERY GOOD (3), GOOD (2), SUFFICIENT (1)

4. International and national (incl. intersectoral) research collaboration and researcher mobility

- Description of
 - the RC's research collaborations and joint doctoral training activities
 - how the RC has promoted researcher mobility
- Identification of the RC's strengths and challenges related to research collaboration and researcher mobility, and the actions planned for their development.

A written feedback from the aspects of: scientific quality, national and international collaboration

- Strengths
- Areas of development
- Other remarks
- Recommendations

Numeric evaluation: OUTSTANDING (5), EXCELLENT (4), VERY GOOD (3), GOOD (2), SUFFICIENT (1)

5. Operational conditions

- Description of the operational conditions in the RC's research environment (e.g. research infrastructure, balance between research and teaching duties).
- Identification of the RC's strengths and challenges related to operational conditions, and the actions planned for their development.

A written feedback from the aspects of: processes and good practices related to leadership and management

- Strengths
- Areas of development
- Other remarks
- Recommendations

6. Leadership and management in the researcher community

- Description of
 - the execution and processes of leadership in the RC
 - how the management-related responsibilities and roles are distributed in the RC
 - how the leadership- and management-related processes support
 - high quality research
 - collaboration between principal investigators and other researchers in the RC
 - the RC's research focus
 - strengthening of the RC's know-how
- Identification of the RC's strengths and challenges related to leadership and management, and the actions planned for developing the processes

7. External competitive funding of the RC

- The RCs were asked to provide information of such external competitive funding, where:
 - the funding decisions have been made during 1.1.2005-31.12.2010, and
 - the administrator of the funding is/has been the University of Helsinki
- On the e-form the RCs were asked to provide:
 - 1) The relevant funding source(s) from a given list (Academy of Finland/Research Council, TEKES/The Finnish Funding Agency for Technology and Innovation , EU, ERC, foundations, other national funding organisations, other international funding organisations), and
 - 2) The total sum of funding which the organisation in question had decided to allocate to the RCs members during 1.1.2005–31.12.2010.

Competitive funding reported in the text is also to be considered when evaluating this point.

A written feedback from the aspects of: scientific quality, scientific significance, societal impact, innovativeness, future significance

- Strengths
- Areas of development
- Other remarks
- Recommendations

8. The RC's strategic action plan for 2011–2013

- RC's description of their future perspectives in relation to research and doctoral training.

A written feedback from the aspects of: scientific quality, scientific significance, societal impact, processes and good practices related to leadership and management, national and international collaboration, innovativeness, future significance

- Strengths
- Areas of development

- Other remarks
- Recommendations

9. Evaluation of the category of the RC in the context of entity of the evaluation material (1-8)

The RC's fitness to the chosen participation category

A written feedback evaluating the RC's fitness to the chosen participation category

- Strengths
- Areas of development
- Other remarks
- Recommendations

Numeric evaluation: OUTSTANDING (5), EXCELLENT (4), VERY GOOD (3), GOOD (2), SUFFICIENT (1)

10. Short description of how the RC members contributed the compilation of the stage 2 material

Comments on the compilation of evaluation material

11. How the UH's focus areas are presented in the RC's research?

Comments if applicable

12. RC-specific main recommendations based on the previous questions 1-11

13. RC-specific conclusions

1.7 Evaluation criteria

The panellists were expected to give evaluative and analytical feedback to each evaluation question according to their aspects in order to describe and justify the quality of the submitted material. In addition, the evaluation feedback was asked to be pointed out the level of the performance according to the following classifications:

- outstanding (5)
- excellent (4)
- very good (3)
- good (2)
- sufficient (1)

Evaluation according to the criteria was to be made with thorough consideration of the entire evaluation material of the RC in question. Finally, in questions 1-4 and 9, the panellists were expected to classify their written feedback into one of the provided levels (the levels included respective descriptions, 'criteria'). Some panels used decimals in marks. The descriptive level was interpreted according to the integers and not rounding up the decimals by the editors.

Description of criteria levels

Question 1 – FOCUS AND QUALITY OF THE RC'S RESEARCH

Classification: Criteria (level of procedures and results)

Outstanding quality of procedures and results (5)

Outstandingly strong research, also from international perspective. Attracts great international interest with a wide impact, including publications in leading journals and/or monographs published by leading international publishing houses. The research has world leading qualities. The research focus, key research questions scientific significance, societal impact and innovativeness are of outstanding quality.

In cases where the research is of a national character and, in the judgement of the evaluators, should remain so, the concepts of "international attention" or "international impact" etc. in the grading criteria above may be replaced by "international comparability".

Operations and procedures are of outstanding quality, transparent and shared in the community. The improvement of research and other efforts are documented and operations and practices are in alignment with the documentation. The ambition to develop the community together is of outstanding quality.

Excellent quality of procedures and results (4)

Research of excellent quality. Typically published with great impact, also internationally. Without doubt, the research has a leading position in its field in Finland.

Operations and procedures are of excellent quality, transparent and shared in the community. The improvement of research and other efforts are documented and operations and practices are to large extent in alignment with the documentation. The ambition to develop the community together is of excellent quality.

Very good quality of procedures and results (3)

The research is of such very good quality that it attracts wide national and international attention.

Operations and procedures are of very good quality, transparent and shared in the community. The improvement of research and other efforts are documented and operations and practices are to large extent in alignment with the documentation. The ambition to develop the community together is of very good quality.

Good quality of procedures and results (2)

Good research attracting mainly national attention but possessing international potential, extraordinarily high relevance may motivate good research.

Operations and procedures are of good quality, shared occasionally in the community. The improvement of research and other efforts are occasionally documented and operations and practices are to large extent in alignment with the documentation. The ambition to develop the community together is of good quality.

Sufficient quality of procedures and results (1)

In some cases the research is insufficient and reports do not gain wide circulation or do not have national or international attention. Research activities should be revised.

Operations and procedures are of sufficient quality, shared occasionally in the community. The improvement of research and other efforts are occasionally documented and operations and practices are to some extent in alignment with the documentation. The ambition to develop the community together is of sufficient quality.

Question 2 – DOCTORAL TRAINING

Question 3 – SOCIETAL IMPACT

Question 4 – COLLABORATION

Classification: Criteria (level of procedures and results)

Outstanding quality of procedures and results (5)

Procedures are of outstanding quality, transparent and shared in the community. The practices and quality of doctoral training/societal impact/international and national collaboration/leadership and management are documented and operations and practices are in alignment with the documentation. The ambition to develop the community together is of outstanding quality. The procedures and results are regularly evaluated and the feedback has an effect on the planning.

Excellent quality of procedures and results (4)

Procedures are of excellent quality, transparent and shared in the community. The practices and quality of doctoral training/societal impact/international and national collaboration/leadership and management are documented and operations and practices are to large extent in alignment with the documentation. The ambition to develop the community together is of excellent quality. The procedures and outcomes are evaluated and the feedback has an effect on the planning.

Very good quality of procedures and results (3)

Procedures are of very good quality, transparent and shared in the community. The practices and quality of doctoral training/societal impact/international and national collaboration/leadership and

management are documented and operations and practices are to large extent in alignment with the documentation. The ambition to develop the community together is of very good quality.

Good quality of procedures and results (2)

Procedures are of good quality, shared occasionally in the community. The practices and quality of doctoral training/societal impact/international and national collaboration/leadership and management are documented and operations and practices are to large extent in alignment with the documentation. The ambition to develop the community together is of good quality.

Sufficient quality of procedures and results (1)

Procedures are of sufficient quality, transparent and shared in the community. The practices and quality of doctoral training/societal impact/international and national collaboration/leadership and management are occasionally documented and operations and practices are to some extent in alignment with the documentation. The ambition to develop the community together is of sufficient quality.

Question 9 – CATEGORY

Participation category – fitness for the category chosen

The choice and justification for the chosen category below should be reflected in the RC's responses to the evaluation questions 1–8.

1. *The research of the participating community represents the international cutting edge in its field.*
2. *The research of the participating community is of high quality, but the community in its present composition has yet to achieve strong international recognition or a clear break-through.*
3. *The research of the participating community is distinct from mainstream research, and the special features of the research tradition in the field must be considered in the evaluation.* The research is of high quality and has great significance and impact in its field. However, the generally used research evaluation methods do not necessarily shed sufficient light on the merits of the research.
4. *The research of the participating community represents an innovative opening.* A new opening can be an innovative combination of research fields, or it can be proven to have a special social, national or international demand or other significance. Even if the researcher community in its present composition has yet to obtain proof of international success, its members can produce convincing evidence of the high level of their previous research.
5. *The research of the participating community has a highly significant societal impact.* The participating researcher community is able to justify the high social significance of its research. The research may relate to national legislation, media visibility or participation in social debate, or other activities promoting social development and human welfare. In addition to having societal impact, the research must be of a high standard.

An example of outstanding fitness for category choice (5)⁵

The RC's representation and argumentation for the chosen category were convincing. The RC recognized its real capacity and apparent outcomes in a wider context to the research communities. The specific character of the RC was well-recognized and well stated in the responses. The RC fitted optimally for the category.

- Outstanding (5)
- Excellent (4)
- Very good (3)
- Good (2)
- Sufficient (1)

The above-mentioned definition of outstanding was only an example in order to assist the panellists in the positioning of the classification. There was no exact definition for the category fitness.

⁵ The panels discussed the category fitness and made the final conclusions of the interpretation of it.

1.8 Timetable of the evaluation

The main timetable of the evaluation:

- | | |
|--|-----------------------|
| 1. Registration | November 2010 |
| 2. Submission of self-evaluation materials | January–February 2011 |
| 3. External peer review | May–September 2011 |
| 4. Published reports | March–April 2012 |
| - University level public report | |
| - RC specific reports | |

The entire evaluation was implemented during the university's strategy period 2010–2012. The preliminary results were available for the planning of the following strategy period in late autumn 2011. The evaluation reports will be published in March/April 2012. More detailed time schedule is published in the University report.

1.9 Evaluation feedback – consensus of the entire panel

The panellists evaluated all the RC-specific material before the meetings in Helsinki and mailed the draft reports to the evaluation office. The latest interim versions were on-line available to all the panellists on the Wiki-sites. In September 2011, in Helsinki the panels discussed the material, revised the first draft reports and decided the final numeric evaluation. After the meetings in Helsinki, the panels continued working and finalised the reports before the end of November 2011. The final RC-specific reports are the consensus of the entire panel.

The evaluation reports were written by the panels independently. During the editing process, the evaluation office requested some clarifications from the panels when necessary. The tone and style in the reports were not harmonized in the editing process. All the reports follow the original texts written by the panels as far as it was possible.

The original evaluation material of the RCs, provided for the panellists is attached at the end of the report. It is essential to notice that the exported lists of publications and other scientific activities depend how the data was stored in the TUHAT-RIS by the RCs.

2 Evaluation feedback

2.1 Focus and quality of the RC's research

- *Description of*
 - *the RC's research focus*
 - *the quality of the RC's research (incl. key research questions and results)*
 - *the scientific significance of the RC's research in the research field(s)*
- *Identification of the ways to strengthen the focus and improve the quality of the RC's research*

ASPECTS: Scientific quality, scientific significance, societal impact, innovativeness

DePoNa is composed of a cohort of 57 researchers led by a group of PIs, and is based within three academic units of the University of Helsinki (UH) – Centre for Drug Research, Division of Pharmacy and Pharmacokinetics and the Laboratory of Polymer Chemistry, with the Laboratory of Polymer Chemistry already recognized as a Centre of Excellence in Finland. Four of the PIs joined the RC during the period of assessment. The multidisciplinary and focused research lies in drug delivery and polymer based nanotechnology, successfully bringing together the range of expertise and resource required for studies in these fields. The three groups in the RC are clearly linked via collaborative research outputs and in teaching. The research topics are important, in terms of fundamental scientific knowledge and applications in the design of medicines for drug delivery to challenging clinical targets, including brain, ophthalmics and cancer tumours. With these topics representing areas of major unmet clinical need, the societal impact is clearly demonstrated.

Whilst being composed of a relatively new integration of four PIs and groups into the RC, DePoNa has demonstrated a very good performance during the assessment period with important contributions to the field. Highlights of the research include the design of polymeric hybrid systems which respond to external triggers and nanoparticulate delivery of DNA. The overlap for life sciences and related applications can still be increased with the polymer topics concerning bioconjugates etc. Whilst there was some evidence of publications in high impact journals, this aspect of the dissemination of research findings at the highest level should be addressed by the RC, and it is evident from the submitted evaluation material that this is an action in progress by the RC.

Future plans which propose directing research to aid in building nanoparticle discovery pipelines are exciting yet realistic given the expertise within the RC, although attention should be given to establishing collaborative procedures to take forward leading candidate systems to animal or even clinical testing. The RC may also wish to consider opportunities to source new actives from RCs in UH or other centres in Finland.

Overall, the RC is at a high level nationally and performing well at the international level. With a proven quality track record over the evaluation period, the RC has a well thought out research strategy and potential for continuing success and progress in the future.

Numeric evaluation: 3 (Very good)

2.2 Practises and quality of doctoral training

- *Organising of the doctoral training in the RC. Description of the RC's principles for:*
 - *recruitment and selection of doctoral candidates*
 - *supervision of doctoral candidates*
 - *collaboration with faculties, departments/institutes, and potential graduate schools/doctoral programmes*
 - *good practises and quality assurance in doctoral training*
 - *assuring of good career perspectives for the doctoral candidates/fresh doctorates*

- *Identification of the RC's strengths and challenges related to the practises and quality of doctoral training, and the actions planned for their development.*
- *Additional material: TUHAT compilation of the RC's other scientific activities/supervision of doctoral dissertations*

ASPECTS: Processes and good practices related to leadership and management

The procedures of the doctoral training programmes indicate a well structured and coordinated process with high quality supervisory systems in place, covering all aspects from student recruitment to thesis defence. The international positioning of the RC is confirmed by the fact that 40% of the academic researchers are from outside of Finland. With 14 staff acting as supervisors for a current cohort of 32 doctoral students, the detailed requirements placed on students to achieve a high level of critical appraisal of their work, and the need to obtain 60 ECTS points, the quality of the programme is evident. The increased attention to publish full reports in high quality journals is both important and challenging but appropriate to the fields of study in this RC. The infrastructure for doctoral training is augmented by numerous collaborations within and without the Department of Chemistry and Faculty of Pharmacy, broadening the experience of the doctoral candidates.

The career progression and employment of doctoral graduates has been excellent with the extensive national and international contacts and collaborations of RC staff facilitating opportunities.

Plans to encourage additional multidisciplinary in doctoral supervisory panels should be carried out. The time needed for the teaching workload should be considered. The challenge highlighted by the RC in completing 4-5 quality publications by doctoral candidates in a 4 year programme for the current PhD thesis format is recognised, and perhaps this issue could be raised and discussed more widely as this issue will not be exclusive to this RC. A flexible and quality oriented evaluation would be better than a strictly quantitative oriented one.

Numeric evaluation: 4 (Excellent)

2.3 The societal impact of research and doctoral training

- *Description on how the RC interacts with and contributes to the society (collaboration with public, private and/or 3rd sector).*
- *Identification of the ways to strengthen the societal impact of the RC's research and doctoral training.*
- *Additional material: TUHAT compilation of the RC's other scientific activities.*

ASPECTS: Societal impact, national and international collaboration, innovativeness

The research topics of DePoNa have major impact on society, especially with regard to the design of efficient and efficacious medicine for several areas of unmet clinical need. The education of the public is another significant area of societal impact. Recognized contributions of the RC include conference presentations, duties for journal work, organization of conferences and membership of professional and scientific committees at both national and international levels. Other excellent work with the media for the wider public has also been performed.

Importantly the RC has a wide number of interactions and collaborations with the national and international sectors of the pharmaceutical and biopharmaceutical industry. With over 20 patents and patent applications, and one invention linked to a current application for regulatory approval for a medicine, the vitality and innovative potential of the discoveries from the RC and their value to the community are demonstrated. These successes are excellent and most impressive.

As a result, the RC is recruiting a research manager to market the available expertise and innovations and encourage links to CROs to evaluate the drug delivery systems in cell models. With continuing progress, the RC may wish to reflect on preparing a route to taking leading candidate formulations to animal and clinical studies.

Numeric evaluation: 5 (Outstanding)

2.4 International and national (incl. intersectoral) research collaboration and researcher mobility

- *Description of*
 - *the RC's research collaborations and joint doctoral training activities*
 - *how the RC has promoted researcher mobility*
- *Identification of the RC's strengths and challenges related to research collaboration and researcher mobility, and the actions planned for their development.*

ASPECTS: Scientific quality, national and international collaboration

Almost all the publications from DePoNa involve external collaboration, with impressively over 65% international collaborators. With an international group of academic researchers working in the RC, and long term visits by overseas researchers funded by foreign agencies, a strong culture of external collaboration is embedded in the philosophy of the RC. This aspect is reinforced through extensive national collaboration within the UH and other academic centres in Finland. The international collaboration network will be further enhanced if the current application for CoE status is approved. The good contact to industry and the increased exchange with regulatory administrations in health organisations is highlighted and should be kept/further increased.

The mobility of home RC researchers abroad is stated to be less than external visitors, and this situation should be addressed, and encouragement should be given to improve the international experience of home doctoral students and research staff. Extensive international contacts and collaborations are in place and could be exploited in this task. An initiative for an EU-grant under the leadership of the RC members may increase the international visibility.

Numeric evaluation: 4 (Excellent)

2.5 Operational conditions

- *Description of the operational conditions in the RC's research environment (e.g. research infrastructure, balance between research and teaching duties).*
- *Identification of the RC's strengths and challenges related to operational conditions, and the actions planned for their development.*

ASPECTS: Processes and good practices related to leadership and management

Research infrastructure is very good and sound. Whilst the maintenance and renewing of expensive equipment remains a continuous challenge, recent grant successes have helped. Several core facilities not available within the RC are located in Helsinki, Aalto and Tampere Universities in Finland and Trieste University in Italy and are important, and links need to be carefully managed.

Teaching loads are not limiting research and are regarded as a positive input for preparing high quality new doctoral students. This positive attitude and forward look is encouraging to hear.

As will be the case for other RCs, basic funding needs to be supplemented via grant income to maintain a high quality, internationally leading research effort. Much researcher's time is spent on this task in preparing and submitting grant applications and is seen as a challenge. One option the RC might consider is the recruitment of a grants coordinator to project to manage this widespread effort, with the possibility of this post being shared across several RCs who have a similar challenge.

The need for a protein engineering unit may be faced at first instance by cooperation with other RCs (e.g. PhaBio) which have larger biotechnology facilities installed. The same may be true for other needs which may be covered by accessing other high quality facilities at UH in the same way.

2.6 Leadership and management in the researcher community

- *Description of*
 - *the execution and processes of leadership in the RC*
 - *how the management-related responsibilities and roles are distributed in the RC*
 - *how the leadership- and management-related processes support*
 - *high quality research*
 - *collaboration between principal investigators and other researchers in the RC*
 - *the RC's research focus*
 - *strengthening of the RC's know-how*
- *Identification of the RC's strengths and challenges related to leadership and management, and the actions planned for developing the processes*

ASPECTS: Processes and good practices related to leadership and management

The organizational structure appears adequate and the RC is searching for optimal operation. The appointment of the research manager can be expected to improve the logistics. This may especially be true since it is one of the larger RC within UH and since external funding is essential to maintain the high level of research.

2.7 External competitive funding of the RC

- *The RCs were asked to provide information of such external competitive funding, where:*
 - *the funding decisions have been made during 1.1.2005–31.12.2010, and*
 - *the administrator of the funding is/has been the University of Helsinki*
- *On the e-form the RCs were asked to provide:*
 - 1) *The relevant funding source(s) from a given list (Academy of Finland/Research Council, TEKES/The Finnish Funding Agency for Technology and Innovation, EU, ERC, foundations, other national funding organisations, other international funding organizations), and*
 - 2) *The total sum of funding which the organisation in question had decided to allocate to the RCs members during 1.1.2005–31.12.2010.*

Competitive funding reported in the text is also to be considered when evaluating this point.

ASPECTS: Scientific quality, scientific significance, societal impact, innovativeness and future significance

The total funding from national and international sources over the assessment period was over €13m, which is an extremely commendable amount, and the RC should be congratulated on securing this level of funding. A number of agencies awarded major sums – the Academy of Finland, TEKES, EU – which demonstrates a positive breadth of external support for the RC from both academic and industrial/technical grant agencies, a positive feature.

EU grants and leadership should be envisaged within the future plans.

2.8 The RC's strategic action plan for 2011–2013

- *RC's description of their future perspectives in relation to research and doctoral training.*

ASPECTS: Scientific quality, scientific significance, societal Impact, processes and good practices related to leadership and management, national and international collaboration, innovativeness, future significance

The planning and future perspectives with regard to research and doctoral training have been highlighted in part in sections 2.1–2.7 above. These are well considered and ambitious, yet achievable, for this RC.

2.9 Evaluation of the category of the RC in the context of entity of the evaluation material (1-8)

The RC's fitness to the chosen participation category.

Category 1. The research of the participating community represents the international cutting edge in its field.

From the information and evidence provided in the evaluation material with regard to the quality of research and doctoral training, the Panel were of the view that a more appropriate participation category for the RC at this stage of its development would be participation category 2: The research of the participating community is of high quality, but the community in its present composition has yet to achieve strong international recognition or a clear break-through. The attention clearly being given by the RC to publish more of their research findings in leading, high impact journals, and success in this activity will undoubtedly add value to the growing strength and recognized quality of the RC.

Numeric evaluation: 3 (Very good)

2.10 Short description of how the RC members contributed the compilation of the stage 2 material

Appropriate and fair, with comments sought from all RC personnel before final compilation.

2.11 How the UH's focus areas are presented in the RC's research

Focus area 5: Welfare and safety

The RC has selected UH focus area 5 – Welfare and safety. This is totally appropriate and relevant to the fields of research and training being performed by this RC.

2.12 RC-specific main recommendations

The RC is clearly working in areas of importance in creating knowledge in the fields of drug delivery science and polymer-based nanotechnology. The Panel, encouraged to see the evidence of success in research and in particular the doctoral training provided by the RC, were supportive of the approach being adopted to focus further attention on the publication strategy when disseminating the outcomes of their work. Success in this activity is important in achieving a stronger reputation and standing for the RC.

The contributions to societal impact of the research and doctoral training were thought to be especially impressive, particularly from the evidence of numerous patents and the advanced stage of application of several of the inventions in commercial uptake. Given the increasing attention of the RC to bringing forward new drug delivery systems and nanobased systems, a recommendation is that the RC considers identifying partners, possibly existing within the UH, to continue studies on their prototype systems to the next steps in the value chain. Access to both animal and even clinical facilities would provide an exciting and potentially valuable resource.

2.13 RC-specific conclusions

The RC has, over the evaluation period, operated successfully in a multidisciplinary dimension between three centres. Such breadth and cooperativeness is essential in making strong impact in the topics and areas of research being undertaken by the RC. The Panel were most encouraged to note the research

successes of the RC, particularly in the aspects of their doctoral training programme and the contributions made to societal impact. Especially important is the strategy being implemented by the RC to address the need for publication of the outputs of their research in high impact journals, which will strengthen their reputation and standing and be increasingly recognized at the highest levels.

3 Appendices

- A. Original evaluation material
 - a. Registration material – Stage 1
 - b. Answers to evaluation questions – Stage 2
 - c. List of publications
 - d. List of other scientific activities
- B. Bibliometric analyses
 - a. Analysis provided by CWTS/University of Leiden
 - b. Analysis provided by Helsinki University Library (66 RCs)



International evaluation of research and doctoral training
at the University of Helsinki 2005-2010

RC-SPECIFIC MATERIAL FOR THE PEER REVIEW

NAME OF THE RESEARCHER COMMUNITY:

Drug Delivery and Polymer Based Nanotechnology (DePoNa)

LEADER OF THE RESEARCHER COMMUNITY:

Professor Arto Urtti, Faculty of Pharmacy, Centre for Drug Research

RC-SPECIFIC MATERIAL FOR THE PEER REVIEW:

- Material submitted by the RC at stages 1 and 2 of the evaluation
 - STAGE 1 material: RC's registration form (incl. list of RC participants in an excel table)
 - STAGE 2 material: RC's answers to evaluation questions
- TUHAT compilations of the RC members' publications 1.1.2005-31.12.2010
- TUHAT compilations of the RC members' other scientific activities 1.1.2005-31.12.2010
- Web of Science(WoS)-based bibliometrics of the RC's publications data 1.1.2005-31.12.2010 (analysis carried out by CWTS, Leiden University)

NB! Since Web of Science(WoS)-based bibliometrics does not provide representative results for most RCs representing humanities, social sciences and computer sciences, the publications of these RCs will be analyzed by the UH Library (results available by the end of June, 2011)



INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL TRAINING AT THE
UNIVERSITY OF HELSINKI

RC-SPECIFIC STAGE 1 MATERIAL (registration form)

1 RESPONSIBLE PERSON

Name: Urtti, Arto

E-mail:

Phone: 0405402279

Affiliation: Centre for Drug Research

Street address: Viikinkaari 5 E, Helsinki

2 DESCRIPTION OF THE PARTICIPATING RESEARCHER COMMUNITY (RC)

Name of the participating RC (max. 30 characters): Drug Delivery and Polymer Based Nanotechnology

Acronym for the participating RC (max. 10 characters): DePoNa

Description of the operational basis in 2005-2010 (eg. research collaboration, joint doctoral training activities) on which the RC was formed (MAX. 2200 characters with spaces): Drug delivery is an increasingly important part of drug discovery and development, since improved drug delivery systems are needed to foster the development of improved medical treatments. Delivery issues are particularly critical in the delivery of biotechnological drugs (such as genes, siRNA, proteins), drugs with difficult target sites (retina, brain, tumours), and drugs with serious adverse effects (anti-cancer drugs). Polymers capable of forming defined nanostructures offer versatile possibilities to improve drug and gene delivery, cell therapy and cell model development for biopharmaceutics. Successful research and doctoral education in this applied field of science requires multidisciplinary research environment. This RC combines research and doctoral education programmes at Centre for Drug Research (Arto Urtti), Division of Biopharmacy and Pharmacokinetics (Marjo Yliperttula), and Laboratory of Polymer Chemistry (Heikki Tenhu) to provide adequate spectrum of methods and expertise that is needed for successful research and graduate education programme in drug delivery and polymer-based nanotechnology. The RC encompasses expertise and infrastructures in biopharmaceutics, polymer synthesis and characterisation, self-assembly of polymeric nanostructures, protein engineering, molecular and cell biology, bioactivity screening, computational modeling, and imaging. RC groups have substantial track record of collaboration in research and doctoral training. The RC is a part of a larger consortium that was selected to the final stage in the national call for Centres of Excellence in 2010 (application pending, to be decided by Academy of Finland in June 2011). That consortium, Finnish Centre of Excellence in Pharmaceutical Nanotechnology (led by Arto Urtti), includes also Macromolecular Structure and Assembly group (Sarah Butcher, Institute of Biotechnology, University of Helsinki) and High Throughput Biology group (VTT Medical Biotechnology, Roland Grafström). In the coming years the research activity of the RC will be mostly focused around the CoE theme.

3 SCIENTIFIC FIELDS OF THE RC

Main scientific field of the RC's research: medicine, biomedicine and health sciences



INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL TRAINING AT THE
UNIVERSITY OF HELSINKI

RC-SPECIFIC STAGE 1 MATERIAL (registration form)

RC's scientific subfield 1: Pharmacology and Pharmacy

RC's scientific subfield 2: Nanoscience and Nanotechnology

RC's scientific subfield 3: Materials Science, Biomaterials

RC's scientific subfield 4: Chemistry, Applied

Other, if not in the list: polymer science, eye research

4 RC'S PARTICIPATION CATEGORY

Participation category: 1. Research of the participating community represents the international cutting edge in its field

Justification for the selected participation category (MAX. 2200 characters with spaces): Drug delivery is an increasingly important part of drug discovery and development, since improved drug delivery systems are needed to foster the development of improved medical treatments. Delivery issues are particularly critical in the delivery of biotechnological drugs (such as genes, siRNA, proteins), drugs with difficult target sites (retina, brain, tumours), and drugs with serious adverse effects (anti-cancer drugs). Polymers capable of forming defined nanostructures offer versatile possibilities to improve drug and gene delivery, cell therapy and cell model development for biopharmaceutics. Successful research and doctoral education in this applied field of science requires multidisciplinary research environment. This RC combines research and doctoral education programmes at Centre for Drug Research (Arto Urtti), Division of Biopharmacy and Pharmacokinetics (Marjo Yliperttula), and Laboratory of Polymer Chemistry (Heikki Tenhu) to provide adequate spectrum of methods and expertise that is needed for successful research and graduate education programme in drug delivery and polymer-based nanotechnology. The RC encompasses expertise and infrastructures in biopharmaceutics, polymer synthesis and characterisation, self-assembly of polymeric nanostructures, protein engineering, molecular and cell biology, bioactivity screening, computational modeling, and imaging. RC groups have substantial track record of collaboration in research and doctoral training. The RC is a part of a larger consortium that was selected to the final stage in the national call for Centres of Excellence in 2010 (application pending, to be decided by Academy of Finland in June 2011). That consortium, Finnish Centre of Excellence in Pharmaceutical Nanotechnology (led by Arto Urtti), includes also Macromolecular Structure and Assembly group (Sarah Butcher, Institute of Biotechnology, University of Helsinki) and High Throughput Biology group (VTT Medical Biotechnology, Roland Grafström). In the coming years the research activity of the RC will be mostly focused around the CoE theme.

5 DESCRIPTION OF THE RC'S RESEARCH AND DOCTORAL TRAINING

Public description of the RC's research and doctoral training (MAX. 2200 characters with spaces): This RC is a multidisciplinary consortium that carries out cutting edge research in the fields of drug delivery and polymer-based nanotechnology. Polymer chemistry is the key scientific discipline in the development of nanostructures for technological and medical uses. Laboratory of Polymer Chemistry is highly qualified unit in the design, synthesis and characterisation of self-assembling polymers and their nanoassemblies. Centre for Drug Research has specialised in drug discovery tools, drug delivery and pharmaceutical nanotechnology. Division of Biopharmacy and Pharmacokinetics has expertise in nanotechnology, surface



INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL TRAINING AT THE UNIVERSITY OF HELSINKI

RC-SPECIFIC STAGE 1 MATERIAL (registration form)

chemistry, and pharmacokinetics. Combined research in the RC generates versatile spectrum of expertise, skills and infrastructure that will foster the multidisciplinary research and doctoral education in the central fields of drug delivery and polymer-based nanotechnology. The research work of RC informs about the polymeric nanostructures and drug delivery in various ways ranging from physical and chemical properties to the cell biology and in vivo pharmacokinetics. The RC aims to generate new understanding of platform for hybrid nanomaterials for drug delivery. This is an important goal, since shortcomings in drug delivery are hampering the development of new treatments based on biotechnological drugs, and on delivery into the retina, brain and tumours. Doctoral training in this international and multidisciplinary RC helps students acquire skills and expertise at the interface of the disciplines, an important asset for their later career in the academia, industry and regulatory organisations. It is noteworthy that several level members of the RC at career levels of III and IV have also long and relevant industrial experience.

Significance of the RC's research and doctoral training for the University of Helsinki (MAX. 2200 characters with spaces): The RC is strategically important for the University of Helsinki. Biomedical science is in the phase of major changes. Human genome has been sequenced, chemical biology platforms inform about the biological effects of the chemical structures, high throughput methods reveal mechanisms of diseases, and new therapeutic modalities, such as gene silencing RNA provide avenues towards new treatments. UH is one of the leading biomedical Universities in Europe, but translation of the recent advances towards therapeutic applications is often hampered by the problems of drug delivery. International level group in drug delivery and drug discovery tools has important strategic role in bridging the advances of basic science towards the applications. Polymer science, imaging, modeling and many other technologies of this RC are needed to fulfill this task. Laboratory of Polymer Chemistry is strategically as important, because nanotechnology is one of the major international trends in science and technology. In EU-FP programmes nanotechnology is one the main fields of funding. Polymer chemistry, particularly self-assembling polymeric nanostructures, is a key area of nanotechnology. Therefore, strong polymer chemistry research and doctoral education is critically important for UH in the era of nanotechnology. In this RC bioinspired approaches, like protein engineering, biomolecule conjugation, and virus inspired approaches, are combined with synthetic polymer chemistry to generate new functionalities at the interface of chemistry and biology. Furthermore, drug delivery is one of the most appealing applications of polymer-based nanotechnology. The RC is closely and broadly linked to the Finnish scientific and industrial community, including Biocenter Finland, network of key core laboratories. The RC is involved in the core laboratories in "Drug Discovery and Chemical Biology" and "Stem Cells and Biomaterials". Centre for Drug Research is has important strategic importance in the Faculty of Pharmacy, and the focus of the RC is in line with the focus areas of the Faculty.

Keywords: Drug delivery, biopharmaceutics, drug formulation, polymer chemistry, nanoparticle, biomaterial

6 QUALITY OF RC'S RESEARCH AND DOCTORAL TRAINING

Justified estimate of the quality of the RC's research and doctoral training at national and international level during 2005-2010 (MAX. 2200 characters with spaces): Research. RC is carrying out cutting edge research in its fields. Nationally the success is evidenced by the fact that Laboratory of Polymer Chemistry is part of Finnish Center of Excellence in Functional Materials, since 2008. Application for CoE in



INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL TRAINING AT THE
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RC-SPECIFIC STAGE 1 MATERIAL (registration form)

Pharmaceutical Nanotechnology was the only pharmaceutical or pharmacological CoE application that was selected to the final round from the 1st stage of evaluation. International position of the RC during 2005-2010 is evidenced by publication activity (about 150), international expert duties, invited presentations, citations (> 5000), and five EU grants.

Doctoral education. The RC has been an recognized international training site and partner in doctoral education (EU Marie Curie EST training grant GALENOS; GPEN Network Member). The graduated Ph.D. students have obtained good positions and many of them have successfully continued the career in science. The RC is also attracting foreign students and it provides modern and multidisciplinary learning environment.

Time perspective. It should be noted that many PIs in the RC started at University of Helsinki in 2005 or later. The RC is relatively new and in fast progress.

Comments on how the RC's scientific productivity and doctoral training should be evaluated (MAX. 2200 characters with spaces): Suggestions. It is important that the panel has broad and top-level expertise that spans the spectrum of this multidisciplinary RC. We hope that the panel will give useful advice about the following aspects: 1) Quality of publications in 2005-2010. Are they at the cutting edge of the field? Are there research topics that should be discontinued or missing aspects? 2) Are infrastructure and personnel well planned? 3) Comments about the international competitiveness and visibility. 4) Assess the quality of the doctoral training. What elements are missing? 5) Work plan. The RC will increase the collaboration substantially in 2011 and onwards within the framework of the CoE application. Critical assessment of the plan is important, since we would like to benefit maximally from the consortium of the CoE application. Publication strategy. The RC prefers to publish large reports including multiple methods, often ranging from physical chemical studies to cell biological experiments. Preferable forums are the leading journals in the relevant fields of science. The strategy is demanding, but it is worthwhile for many reasons: 1) Drug delivery systems, cell models and transport processes are not 'isolated' systems defined by a single parameter. Rather, they must be assessed rigorously. We are not selling our research and technologies, but rather we want to investigate them carefully to obtain reliable information that lays basis for the future drug development. 2) Polymer synthesis and characterisation of the self-assembling nanostructures are demanding tasks. Careful and versatile material characterisation is critically important. 3) Self-critical publishing approach strategy provides healthy basis for the doctoral training. The doctoral students acquire methodological expertise, skills enabling them to operate in different positions, including ability to discuss with people from many disciplines, a feature that we consider very important in modern research and development in the fields of pharmaceuticals and polymer science.

LIST OF RC MEMBERS

NAME OF THE RESEARCHER COMMUNITY:		DRUG DELIVERY AND POLYMER BASED NANOTECHNOLOGY (DePoNa)			
RC-LEADER		A. Urtti			
CATEGORY		1			
	Last name	First name	PI-status (TUHAT, 29.11.2010)	Title of research and teaching personnel	Affiliation
1	Urtti	Arto	x	professor	Centre for Drug Research
2	Antopolsky	Maxim		post doctoral researcher	Centre for Drug Research
3	Hakli	Marika		post doctoral researcher	Centre for Drug Research
4	Tammela	Päivi	x	university researcher	Centre for Drug Research
5	Murtomäki	Lasse	x	university researcher	Centre for Drug Research
6	Bergstrom	Kim	x	university researcher	Centre for Drug Research
7	Laukkanen	Antti		post doctoral researcher	Centre for Drug Research
8	Kidron	Heidi		post doctoral researcher	Centre for Drug Research
9	Raki	Mari		post doctoral researcher	Centre for Drug Research
10	Sarkhel	Sanjay		Senior researcher	Centre for Drug Research
11	Takashima	Yuuki		professor	Centre for Drug Research
12	Ravina	Manuela		post doctoral researcher	Centre for Drug Research
13	Hornof	Margit		post doctoral researcher	Centre for Drug Research
14	del Amo	Eva		doctoral candidate	Centre for Drug Research
15	Lehtinen	Julia		doctoral candidate	Centre for Drug Research
16	Subrizi	Astrid		doctoral candidate	Centre for Drug Research
17	Vellonen	Kati-Sisko		doctoral candidate	Centre for Drug Research
18	Kontturi	Leena		doctoral candidate	Centre for Drug Research
19	Schmitt	Metchild		doctoral candidate	Centre for Drug Research
20	Linnankoski	Johanna		doctoral candidate	Centre for Drug Research
21	Malinen	Melina		doctoral candidate	Centre for Drug Research
22	Paasonen	Lauri		doctoral candidate	Centre for Drug Research
23	Kotha	Sreevani		doctoral candidate	Centre for Drug Research
24	Yamada	Kazuhito		doctoral candidate	Centre for Drug Research
25	Lajunen	Tatu		doctoral candidate	Centre for Drug Research
26	Wang	Chang-Fang		doctoral candidate	Centre for Drug Research
27	Bhattacharya	Madhuashree		post doctoral researcher	Centre for Drug Research / Division of Biopharmacy and Pharmacokinetics
28	Tenhu	Heikki	x	Professor	HU, Department of Chemistry, Laboratory of Polymer Chemistry
29	Aseyev	Vladimir	x	University lecturer	HU, Department of Chemistry, Laboratory of Polymer Chemistry
30	Hietala	Sami	x	University lecturer	HU, Department of Chemistry, Laboratory of Polymer Chemistry
31	Plamper	Felix		Postdoctoral Researcher	HU, Department of Chemistry, Laboratory of Polymer Chemistry
32	Zaremba	Anna		Postdoctoral Researcher	HU, Department of Chemistry, Laboratory of Polymer Chemistry
33	Holappa	Susanna		Doctoral Candidate	HU, Department of Chemistry, Laboratory of Polymer Chemistry
34	Nuopponen	Markus		Doctoral Candidate	HU, Department of Chemistry, Laboratory of Polymer Chemistry
35	Hirvonen	Sami-Pekka		Doctoral Candidate	HU, Department of Chemistry, Laboratory of Polymer Chemistry
36	Karesoja	Mikko		Doctoral Candidate	HU, Department of Chemistry, Laboratory of Polymer Chemistry
37	Karjalainen	Erno		Doctoral Candidate	HU, Department of Chemistry, Laboratory of Polymer Chemistry
38	Alhoranta	Anu		Doctoral Candidate	HU, Department of Chemistry, Laboratory of Polymer Chemistry
39	Larin	Sergey		Doctoral Candidate	HU, Department of Chemistry, Laboratory of Polymer Chemistry
40	Niskanen	Jukka-Pekka		Doctoral Candidate	HU, Department of Chemistry, Laboratory of Polymer Chemistry
41	Pulkkinen	Petri		Doctoral Candidate	HU, Department of Chemistry, Laboratory of Polymer Chemistry
42	Valtola	Lauri		Doctoral Candidate	HU, Department of Chemistry, Laboratory of Polymer Chemistry
43	Wiktorowicz	Szymon		Doctoral Candidate	HU, Department of Chemistry, Laboratory of Polymer Chemistry
44	Yliperttula	Marjo	x	Professor	Division of Biopharmacy and Pharmacokinetics
45	Viitala	Tapani		Senior researcher	Division of Biopharmacy and Pharmacokinetics
46	Kortejärvi	Hanna		post doctoral researcher	Division of Biopharmacy and Pharmacokinetics
47	Lu	Yan-Ru		post doctoral researcher	Division of Biopharmacy and Pharmacokinetics
48	Kallinteri	Paraskevi		post doctoral researcher	Division of Biopharmacy and Pharmacokinetics
49	Wikström	Jonna		doctoral candidate	Division of Biopharmacy and Pharmacokinetics
50	Hanzlikova	Martina		doctoral candidate	Division of Biopharmacy and Pharmacokinetics
51	Granqvist	Niko		doctoral candidate	Division of Biopharmacy and Pharmacokinetics
52	Galli	Emilia		doctoral candidate	Division of Biopharmacy and Pharmacokinetics
53	Polina	Iliina		doctoral candidate	Division of Biopharmacy and Pharmacokinetics
54	Huamin	Liang		doctoral candidate	Division of Biopharmacy and Pharmacokinetics
55	Tengvall	Unni		doctoral candidate	Division of Biopharmacy and Pharmacokinetics
56	Marvola	Janne		doctoral candidate	Division of Biopharmacy and Pharmacokinetics
57	Laitinen	Leena		doctoral candidate	Division of Biopharmacy and Pharmacokinetics/Centre for Drug Research



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RC-SPECIFIC STAGE 2 MATERIAL

BACKGROUND INFORMATION

Name of the RC's responsible person: Urtti, Arto

E-mail of the RC's responsible person:

Name and acronym of the participating RC: Drug Delivery and Polymer-Based Nanotechnology, DePoNa

The RC's research represents the following key focus area of UH: 5. Hyvinvointi ja turvallisuus – Welfare and safety

Comments for selecting/not selecting the key focus area: RC is working on polymer based drug delivery, an important part of drug discovery and development. Pharmaceuticals are one of the main components in the treatment of diseases. Thus it is obvious that the RC is working in the field of welfare. Health is the most important component of human welfare. The RC is also linked to the basic structure, materials and natural resources of the physical world. The investigations of the RC inform about the nanoscale structures and principles of their formation.

1 FOCUS AND QUALITY OF RC'S RESEARCH (MAX. 8800 CHARACTERS WITH SPACES)

- **Description of the RC's research focus, the quality of the RC's research (incl. key research questions and results) and the scientific significance of the RC's research for the research field(s).**

RESEARCH FOCUS. This RC is a multidisciplinary consortium that carries out research in the fields of drug delivery and polymer-based nanotechnology. The RC consists of research groups from Laboratory of Polymer Chemistry, Centre for Drug Research and Division of Biopharmacy and Pharmacokinetics. The research of RC in 2005-2010 has informed about the polymeric nanostructures (synthesis, characterisation, modeling, nanoassemblies, drug and gene delivery properties) and about the tools for drug discovery and delivery (computational, physical, cellular, and in vivo imaging methods). The delivery targets have included the eye, skin, tumours, and microbes.

Even though polymer chemistry laboratory and pharmaceutical groups have had collaboration for several years, the integration of the groups into the RC is still fairly new development. Many PIs within the RC joined University of Helsinki recently, during the period 2005-2010 (Arto Urtti, Marjo Yliperttula, Kim Bergström, Lasse Murtomäki). The RC aims to focus and integrate its activities further in order to generate new materials, understanding and analytical methods for the field of nanotechnological drug delivery. This is an important goal, since shortcomings in drug delivery are limiting the development of new drug treatments.

QUALITY. Several factors indicate that the research of the RC is at the forefront internationally. 1) The RC is part of "Finnish Center of Excellence (CoE) in Functional Materials" (2008-); 2) The first stage application "Finnish CoE in Pharmaceutical Nanotechnology" received maximum rating (6/6 twice; top1% in its field) and was selected to the 2nd stage evaluation (will be completed in June 2011); 3) The RC publications were cited more than 5000 times in 2005-2010; 4) The RC has raised successfully funding from European Union and other national and international sources; 5) During 2005-2010 the RC published about 150 publications, mostly in the leading journals of its fields; 6) Centre for Drug Research and Laboratory of Polymer Chemistry received previously excellent international evaluations (2006, 2010, 2011); 7) Group leaders have received awards, hold international expert duties (editor-in-chief, editorial advisory board positions) and serve as experts in several international funding organisations; 8) The RC laboratories have attracted large number of foreign investigators.



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The research of the RC resulted in important basic science findings in the fields of polymeric nanostructures (defined novel copolymers, metal-polymer hybrids, metal-lipid nanostructures, DNA-polymer complexes) and barriers and processes affecting drug transport in the eye, skin, intestine and, inside cells. Applied research involved investigations on tailored smart nanomaterials (responsive to light, electricity, temperature), materials for drug delivery (controlled release, cell encapsulation, intracellular delivery), and methods for drug discovery and delivery (computational, cell models, screening assays).

Examples

1) Self-assembling amphiphilic and/or water soluble polymers including polyelectrolytes have been synthesised using modern methods of controlled radical polymerisation. Of special interest have been responsive polymers which discontinuously change their conformation, shape, and solubility upon an external trigger. The trigger may be temperature, pH, ionic strength, light, or even electric field (Adv Polym Sci 196: 1, 2006, Macromolecules 42: 7254, 2009). Nanocomposites comprising inorganic core materials, such as gold (Chem Comm 44: 4580, 2007, Macromolecules 42: 5317, 2009), silver (Colloid Polym Sci 288: 543, 2010), or montmorillonite have been prepared. At present some of the topical research areas include star block copolymers (Polymer 51: 3108, 2010) and polymerised ionic liquids. Also, polyelectrolyte complexes have been actively studied.

2) Nanoparticulate delivery of DNA. Nanoparticles based on complexation of cationic polymer and DNA are potential delivery system in non-viral gene therapy. The efficacy of these nanoparticles in gene transfer does not match that of viruses, but the mechanisms of DNA complexation and delivery are still poorly understood. The RC revealed with a new time-resolved spectroscopy method that the mobility of DNA in nanoparticles varies depending on the complexing polymer (J Am Chem Soc 130: 11695-11700, 2008) and this may explain our earlier findings that showing even 100 fold differences in transfection activity per DNA copy delivered to the cell nucleus (J Gene Med 9: 479-486, 2007). In vivo experiments with DNA nanoparticle eye drops demonstrate strategy to overcome the barrier of corneal epithelium by converting it protein secreting platform (J Gene Med 9: 208-216, 2007).

3) Light activated hybrid nanoparticles for drug delivery. Hybrid system of functionalised gold nanoparticles embedded in liposomes were developed. Proof-of-concept study showed that contents release was selectively triggered with light signal (J Control Rel 122: 86-93, 2007). Mechanistic study revealed that the gold absorbed the light energy, released it to the lipid bilayer as heat, and caused phase change in the bilayer (J Control Rel 147: 136-143, 2010).

THE SCIENTIFIC SIGNIFICANCE

The research work of the RC is significant and promotes the field of polymer based nanotechnology and drug delivery.

1) Research on new polymers has revealed relationships between polymer structure and its assembly and triggered functions. This promotes understanding and generation of new materials.

2) Organotypic cell models (particularly epidermal and RPE models) are useful tools for drug discovery and development. Likewise, drug delivery related QSAR models (intestinal and ocular absorption) and kinetic models (oral and periocular administration) reveal important parameters in drug delivery.



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- 3) Characterisation of transporter expression in the eye promotes understanding of the basic ocular pharmacokinetic mechanisms.
- 4) Basic research on physical nanoparticle assembly and its intracellular transfer mechanisms build the basis for understanding the non-viral gene delivery.
- 5) Research on nanoparticle carriers with triggered functions offer new drug development scenarios.

• **Ways to strengthen the focus and improve the quality of the RC's research.**

Research quality will be improved by taking full advantage from the multidisciplinary expertise and infrastructure in the RC. This will be done in the context of the CoE application that presents novel multidisciplinary approach to build nanoparticle discovery pipeline (see 8 "Action plan"). Only closely integrated RC can achieve that goal. Integration involves joint grants, laboratories, supervisions, and positions.

Research at the chemistry – biology interface is a key element. The multidisciplinary skills of the RC set the stage for polymer based bioconjugates (with peptides, proteins, oligonucleotides), that are important building tools in drug delivery.

Importantly Francoise Winnik (professor of Polymer Chemistry and Pharmacy, University of Montreal) is willing to join the RC for several years as visiting FIDIPro professor. Decision on this FIDIPro grant application (professor, 2 post docs and consumables) will be done by TEKES in the Spring 2011.

The RC policy will be to publish less, but high publications. This policy guides the research towards higher quality.

2 PRACTISES AND QUALITY OF DOCTORAL TRAINING (MAX. 8800 CHARACTERS WITH SPACES)

- How is doctoral training organised in the RC? Description of the RC's principles for recruitment and selection of doctoral candidates, supervision of doctoral candidates, collaboration with faculties, departments/institutes, and potential graduate schools/doctoral programmes, good practises and quality assurance in doctoral training, and assuring good career perspectives for the doctoral candidates/fresh doctorates.

Recruitment and selection. Doctoral candidates are selected using many mechanisms. Some of them have been Master's students in the RC and they are recruited based on their performance and motivation in the Master's program, particularly during the M.Sc. thesis project. Sometimes the doctoral candidates are selected based on open call (e.g. graduate schools). Overall, the doctoral candidates in the RC are representing many scientific disciplines (e.g. biopharmaceutics, pharmaceutical technology, pharmacology, biochemistry, polymer chemistry, biotechnology) and origins (e.g. Finland, Switzerland, Czech Republic, Croatia, India, China, Russia, Italy, Spain). International and multidisciplinary approach provides broader base of students for recruiting and matches with the multidisciplinary requirements of modern pharmaceutical research.

Supervision of doctoral candidates. The doctoral education in this RC immensely benefits from the multidisciplinary nature of the RC. The doctoral candidates are exposed to the expertise in the following fields, all highly relevant in polymer based nanotechnology and drug delivery: polymer synthesis and characterisation, self-assembly and colloid chemistry, peptide and oligonucleotide synthesis, protein engineering, surface chemistry, physical chemistry, spectroscopy, molecular and cell biology, stem cell biology, biomaterial based organotypic cell culture, radiochemistry and imaging, bioactivity screening,



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pharmacokinetic modeling, chemoinformatics and molecular dynamics, biopharmaceutics and drug delivery. The doctoral candidates develop skills of social communication in international surroundings when they are educated in the RC with personnel of 40% foreigners.

Each doctoral candidate has two or more supervisors, in many cases from different research groups within the RC. The ratio of doctoral level researchers and graduate students is about ½. This facilitates hands-on supervision in the laboratory. Regular supervision meetings are held, international research training visits are encouraged. The presentation skills of doctoral candidates are practised in regular laboratory meetings. Furthermore, the Ph.D. students apply for stipends that involves writing of the research proposals. Importantly, the Ph.D. Theses are composed of publications and summary. Thus, the doctoral candidates learn to write publications and are exposed to the peer-review system of the journals. In the normal way, the Ph.D. students must carry out program of 60 ECTS points during their doctoral studies. This program includes both compulsory and optional elements. The courses and book exams are compiled in multidisciplinary manner with the supervisors.

Collaboration with faculties and departments. This multidisciplinary RC is operating in the Department of Chemistry and Faculty of Pharmacy. The RC has been linked to several national graduate schools (Pharmaceutical Research, ESPOM, NANO) and utilises the courses organised by these networks. The RC groups have plenty of research collaborations in the University of Helsinki, with other universities in Finland and elsewhere. These collaborations have influence on the doctoral training, because the students are exposed to new research methods and viewpoints.

Good practises and quality assurance in doctoral training. High quality training of doctoral candidates should result in Ph.D. level researchers who have learned how good research is done, i.e. how to identify important questions, design experiments, analyse results, report the findings in objective and critical manner in the light of prior knowledge. In addition, the doctoral candidates should learn adequate breadth of methods. Doctoral projects in the RC are demanding, since they involve usually broad selection of methods and challenging research problems. For example, a publication may involve generation of nanoparticles, physical and chemical characterisation, cell based experimentation and molecular biology methods, and finally in vivo testing and imaging in animals. Multidisciplinary RC is important asset in this context. In the case of problems, broad range of experts are found within the same RC and the research can be modified in a flexible manner. Six Ph.D. students from RC groups have become successful professors. This shows quality of the education.

Publishing the research in high level international journals is another quality assurance method.

Doctoral candidates have a mid-term check point, defence of the research proposal. The candidates must report their prior research and write a plan for the rest of the Ph.D. thesis project. The report and plan are discussed with three senior level researchers, representing usually different disciplines. The panel gives recommendations and critique to the student. Critical evaluation of science is trained in the RC. The students read manuscripts that are submitted to the journals, evaluate them critically, and write the reviewer statement together with the supervisor.

Assuring good career perspectives. Career perspectives for the graduating Ph.D.s in the RC are good. During 2005-2010 employment has been excellent. The doctors are employed easily both in academia and private sector. Industrial projects and contacts of the RC help in the industrial employment. Likewise, the international contacts have made it easy to organise post-doctoral positions abroad. Obviously, there is need for doctors in pharmaceutical science and polymer chemistry. Upon integration



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of the RC the employment should become even better as the doctoral candidates will get full benefit from the methodological wealth of the RC.

- RC's strengths and challenges related to the practises and quality of doctoral training, and the actions planned for their development.

Strengths. Multidisciplinary environment is the strength in the doctoral education. Joint supervisions are ongoing and will be increased. Nano-bio fusion is expected to be highly important future trend; not only in drug delivery, but also in much broader scientific context. Employment is our strength.

Challenges. Sometimes the completion of Ph.D. degree takes too long. Combination of challenging research, 4-5 high quality publications and four year Ph.D. program is a difficult combination. Quality of research and doctoral education can be improved only by abandoning the 4-5 paper thesis format. Another improvement will be the integration of the RC activities and building a systematic Ph.D. program for the RC (chemistry, nanotechnology, biopharmaceutics interface). Other future improvements include industrial and regulatory training periods for Ph.D. students.

3 SOCIETAL IMPACT OF RESEARCH AND DOCTORAL TRAINING (MAX. 4400 CHARACTERS WITH SPACES)

- Description of how the RC interacts with and contributes to the society (collaboration with public, private and/or 3rd sector).

Education of experts to the public and private sectors is the main societal impact of the RC.

Public sector.

In the public sector the RC is providing services to scientific community. These include many duties of editor, editorial board member, and referee in scientific journals. In addition, the RC members have been active in organizing scientific conferences, evaluating research proposals for national and international funding organisations, and as members of research councils in Academy of Finland. The RC members have informed the public about the fields of pharmaceutical science and polymer chemistry. The instruments include public lectures, lectures to school kids, and interviews in magazines, radio and TV. The work of the RC is also related to the development of alternatives to animal testing (such as organotypic cell culture models and computer models). The RC is part of Biocenter Finland networks "Stem Cells and Biomaterials" and "Drug Discovery and Chemical Biology". The RC offers services to the academic community via these networks in the fields of bioactivity screening, chemoinformatics, ADMET and biomaterials for cell culture and gene transfer.

Private sector. The RC has extensive industrial collaboration with chemical and pharmaceutical industries (see funding). The RC is collaborating with the industry also in the TEKES funded university projects with industrial observers. Computational pharmacokinetic tools for prediction of drug delivery were developed in the RC and these tools are used now in a Finnish pharmaceutical company. The RC has researcher exchange with industry, including also international pharmaceutical industry. The RC members hold more than 20 patents and patent applications. One of them is a polymer for controlled drug delivery that is in the final stages of the path towards regulatory acceptance. Another one is nanofiber biomaterial for 3D cell culture. This invention was patented and sold to industry. The RC is carrying out collaborative research with device company and pharmaceutical industry to develop innovative analytical technology and controlled release formulations. It is noteworthy that several senior level researchers of the RC have long and relevant industrial experience and they have contributed to many products in the market.



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- Ways to strengthen the societal impact of the RC's research and doctoral training.

Societal impact of the RC will be further improved. Research manager will be hired to the Centre for Drug Research in the Summer 2011. He/she will market the expertise of the RC to the industry in Finland and abroad and carries out systematic patent searches. International industrial collaboration will be increased, and the RC will apply for IMI funding. Nanomaterials and nanoparticles cause fears in the population and their toxicity has raised concerns. Nanoparticle discovery pipeline (see #8) will produce systematic information about cellular toxicity of nanoparticles. The RC will search contacts to the European Chemical Agency in Helsinki; the agency is responsible for the execution of REACH legislation on chemical safety. The RC will actively link with CRO companies and service laboratories (such as FICAM), to transfer the cell models to real drug and chemical testing. Biocenter Finland activity will be continued and possibly evolved to EATRIS system.

4 INTERNATIONAL AND NATIONAL (INCL. INTERSECTORAL) RESEARCH COLLABORATION AND RESEARCHER MOBILITY (MAX. 4400 CHARACTERS WITH SPACES)

- Description of the RC's research collaborations and joint doctoral training activities and how the RC has promoted researcher mobility.

Research collaboration is essential for the RC. Nearly all publications of the RC include either national and/or international collaborations. About 50% of the publications include international collaboration. National collaborative projects are often based on TEKES projects (see funding) that always involve industrial collaboration. Several EU-FP projects of the RC facilitate international collaboration (see funding). Industrial collaboration has been very active (see funding). About 40% of the RC personnel are foreigners (e.g. from UK, Germany, The Netherlands, Switzerland, Spain, Italy, Russia, China, Japan, India, Portugal). There has been also some long-term visits funded by foreign funding agencies in Japan, Germany and Spain. In addition, there is also mobility as post docs from the RC to abroad, but actually this is less than the mobility to the RC. The RC supports and encourages short visits in association of research collaborations.

International doctoral training activities include following networks: Marie Curie EST Galenos , GPEN, ESF network STIPOMAT.

The RC has promoted the collaborations and researcher mobility financially (usually by grant funds) and by giving advice in fund raising. The RC is not asking bench fee from foreign visiting researchers.

- RC's strengths and challenges related to research collaboration and researcher mobility, and the actions planned for their development.

Strengths.

It is obvious that the RC is already well linked. The academic collaborative links nationally and internationally are excellent. Particularly, the academic international network in the CoE application will be very fruitful for the research programme. Industrial networking in Finland is very good, but internationally not as extensive. Possible FIDiPro visit (F. Winnik) would be an asset to the RC.

Challenges.

Mobility of the RC researchers to abroad should be steadily increased and co-supervision arrangements with international partners should be more intense. Interactions and collaboration with international industry should be increased (IMI important funding option). We should also increase the use of www and social networks as tools in international communication.



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5 OPERATIONAL CONDITIONS (MAX. 4400 CHARACTERS WITH SPACES)

- Description of the operational conditions in the RC's research environment (e.g. research infrastructure, balance between research and teaching duties).

RESEARCH INFRASTRUCTURE. In general the research infrastructure is good, but it is difficult to maintain and renew the aging medium scale equipment. The RC has actively raised competitive funds for infrastructure. During 2005-2010 micro-SPECT/CT laboratory, array plotter, confocal high content analysis instrument, 500 MHz NMR, a zeta sizer, and circular dichroism instruments have been obtained. The RC is utilizing the shared use laboratories (core laboratories) in Helsinki and elsewhere. Particularly important core laboratories include laboratories of Institute of Biotechnology (light microscopy unit, EM lab, proteomics laboratory, bioinformatics unit), Aalto University's high resolution EM facility, laser spectroscopy laboratory of Tampere University of Technology, and ELETTRA beamline (SAXS) in Trieste. CSC provides the fast computing facilities to Finnish universities.

Balance between research and teaching. In the RC everybody contributes to both teaching and research. Overall, the teaching load is not limiting the research. The teaching tasks are shared, and the high level of external funding facilitates teaching as well. Rather, teaching is excellent training of the doctoral candidates and post docs, and it attracts new students to the research programme.

Overall laboratory space is adequate, but the laboratories of the pharmaceutical part of the RC are highly fragmented (in six different floors). This complicates the daily logistics.

Basic funding of the RC would not allow research work. The external grant funding level is very good. Often the funding policies are unpredictable, and the funding periods are fairly short (1-3 years). When individual grants are fairly small maintaining large research group means continuous grant applications and reporting. This takes too much time, and disturbs concentrating on the science.

Administrative support is variable. In some respects it is good, but often the administrative systems are complicated and inefficient. Particularly, in 2010 the financial logistics of the grant funding became much more complex and time-consuming compared to the earlier system.

- RC's strengths and challenges related to operational conditions, and the actions planned for their development.

Strengths. The RC hosts strong multidisciplinary and broad arsenal of equipment and expertise. The researchers are motivated, atmosphere is good and relaxed. Importantly, the research funding and infrastructure allow modern researcher education in this field.

Challenges. The fragmented laboratory space is a problem. The space situation will be investigated in 2011. Hopefully, this results in improvements. Protein engineering unit is needed in the RC. Such unit would enable engineering of large numbers of proteins as building blocks for nanostructures and other drug delivery systems. This is highly important element in polymeric based bioconjugates. Small and medium scale devices are difficult to get funded, and maintenance of older instruments in working condition is difficult.



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6 LEADERSHIP AND MANAGEMENT IN THE RESEARCHER COMMUNITY (MAX. 4400 CHARACTERS WITH SPACES)

- Description of the execution and processes of leadership in the RC, how the management-related responsibilities and roles are distributed in the RC and how the leadership- and management-related processes support high quality research, collaboration between principal investigators and other researchers in the RC, the RC's research focus and strengthening of the RC's know-how.

Centre for Drug Research (CDR) has a written strategy for the years 2010-2014. The strategy and results are evaluated by the International Advisory Board. This board will be used to evaluate the RC activity regularly in association of CDR evaluations. The leadership in the RC forms a steering group (Arto Urtti, Heikki Tenhu, Marjo Yliperttula). CDR research manager will be the secretary in steering group meetings and takes care of many administrative duties in the RC. The steering group decides the direction and strategy of the RC. The decisions will be executed by the senior level scientists, who have responsibilities of different segments of the RC depending on the expertise field of each senior researcher. Senior scientists from various disciplines act in concert. Steering group and senior researchers will also have joint meetings and brainstorming workshops about the science in the field of the RC.

The RC promotes the careers of the senior researchers so that they are encouraged to apply grants and to form research groups within the RC. Tutoring is provided in grant proposal writing. This facilitates academic growth and maturation and makes the RC less vulnerable.

We believe that these arrangements support high quality research. The RC has culture of critical scientific discussion.

Collaboration between principal investigators and other researchers in the RC includes shared responsibilities, regular group meetings and seminars of groups.

The RC's research focus is supported by grant applications, i.e. the grants are applied in the focus area of the RC. Infrastructure of RC available for all the researchers.

Strengthening of the RC's know-how. Key personnel has been recruited during 2005-2010 in the fields that are needed for the RC research programme. Thus, experts have been hired in the fields of protein engineering, peptide and oligonucleotide synthesis, molecular modeling, surface chemistry, cell biology, in vivo imaging, cancer research, and controlled syntheses of polymers.

- RC's strengths and challenges related to leadership and management, and the actions planned for developing the processes.

Strengths. Researchers are trusted, atmosphere is good and easy going. The RC has healthy balance of personnel at various levels. Regular development discussions.

Challenges. The RC is fairly large and thus the increased involvement of senior level researchers is essential in the management of the RC. Fund raising is a challenge, but larger involvement of senior researchers and the support of research manager should improve the logistics. The RC is relatively new consortium, and it is still searching for the best ways of operation.



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7 EXTERNAL COMPETITIVE FUNDING OF THE RC

- Listing of the RCs external competitive funding, where:
 - the funding decisions have been made during 1.1.2005-31.12.2010, and
 - the administrator of the funding is/has been the University of Helsinki
- Academy of Finland (AF) - total amount of funding (in euros) AF has decided to allocate to the RC members during 1.1.2005-31.12.2010: 3221 400
- Finnish Funding Agency for Technology and Innovation (TEKES) - total amount of funding (in euros) TEKES has decided to allocate to the RC members during 1.1.2005-31.12.2010: 4430 000
- European Union (EU) - total amount of funding (in euros) EU has decided to allocate to the RC members during 1.1.2005-31.12.2010: 2246 000
- European Research Council (ERC) - total amount of funding (in euros) ERC has decided to allocate to the RC members during 1.1.2005-31.12.2010:
- International and national foundations – names of international and national foundations which have decided to allocate funding to the RC members during 1.1.2005-31.12.2010, and the amount of their funding (in euros).
 - names of the foundations: Finnish Cultural Foundation, Eemil Aaltonen Foundation, Magnus Ehrnrooth Foundation, Alfred Kordelin Foundation, Fortum Foundation
 - total amount of funding (in euros) from the above-mentioned foundations: 110 000
- Other international funding - names of other international funding organizations which have decided to allocate funding to the RC members during 1.1.2005-31.12.2010, and the amount of their funding (in euros).
 - names of the funding organizations: European Science Foundation, DAAD, Pharmaceutical and Life Science University of Tokyo, Santen Ltd, Spanish Government, Chinese Research Council, INTAS
 - total amount of funding (in euros) from the above-mentioned funding organizations: 527 600
- Other national funding (incl. EVO funding and Ministry of Education and Culture funded doctoral programme positions) - names of other national funding organizations which have decided to allocate funding to the RC members during 1.1.2005-31.12.2010, and the amount of their funding (in euros).
 - names of the funding organizations: Chemical industries, University of Helsinki (CoE contribution), SaIWe, Orion, Santen, BioNavis, Ark Therapeutics, Biocenter Finland
 - total amount of funding (in euros) from the above-mentioned funding organizations: 3218 000

8 RC'S STRATEGIC ACTION PLAN FOR 2011–2013 (MAX. 4400 CHARACTERS WITH SPACES)

- Description of the RC's future perspectives in respect to research and doctoral training.

The CoE plan for generation of nanoparticle discovery pipeline is the core of the RC future action. The CoE plan requires concerted multidisciplinary effort to be successful. The goal, nanoparticle discovery pipeline, thrives to generate systematic understanding to the field of nanoparticle drug delivery. So far, very few nanoparticle products have reached the market despite decades of research. This is due to the complexity of the delivery process and enormous number of possible nanoparticle formulations. This



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plan integrates the bioinspired approaches, combinatorial assembly of nanoparticle libraries, automated cellular screening, mechanistic studies (physical, chemical, biological), and imaging studies to a systematic research platform. The targets of the project are retinal pigment epithelium and prostate cancer. This kind of systematic, drug discovery like, research platform is needed to gain understanding of the complex process of drug delivery. The pipeline will most likely provide also new lead nanoparticles for further development.

The plan involves the RC and two partners (Macromolecular Structure and Assembly group (Sarah Butcher, University of Helsinki) and High Throughput Biology group (Roland Grafström: VTT, Medical Biotechnology, Turku). Multidisciplinary international collaborating laboratories are integrated to the work packages. These groups are involved in synthesis of polymers and bioconjugates (Durham, Nijmegen, Montreal), measurements with expensive infrastructures (Karolinska, Trieste), and in vivo experiments with animal disease state models (Tübingen, Santa Barbara, Leiden).

There will be also other research projects and activities in the RC in line with the research carried out in 2005-2010, but building the nanoparticle discovery pipeline is expected to be the major effort.

9 SHORT DESCRIPTION OF HOW THE RC MEMBERS HAVE CONTRIBUTED TO THE COMPILATION OF THE STAGE 2 MATERIALS (MAX. 1100 CHARACTERS WITH SPACES).

Comments on stage 2 material were collected from the entire personnel. Action plan (#8) was discussed among the senior level scientists during the Autumn 2010.



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RC-SPECIFIC TUHAT COMPILATIONS OF PUBLICATIONS DATA 2005-2010

DePoNa/Urtti

1 Analysis of publications

- Associated person is one of Arto Urtti , Maxim Antopolsky , Marika Häiki , Päivi Tammela
, Lasse Murtomäki , Kim Bergström , Antti Petteri Laukkanen, Heidi Kidron ,
Mari Raki , Sanjay Sarkhel , Margit Hornof, Julia Lehtinen , Astrid
Elena Subrizi , Kati-Sisko Vellonen , Leena Kontturi , Mechthild Schmitt ,
Johanna Linnankoski , Melina Malinen , Lauri Joonas Paasonen ,
Sreevani Kotha , Tatu Lajunen , Heikki Tenhu , Vladimir
Aseyev , Sami Hietala , Anna Viktorovna Zarembo, Susanna Helmi Elisabet Holappa, Markus Nuopponen, Sami-
Pekka Hirvonen , Mikko Karesoja , Erno Johannes Karjalainen , Anu Alhoranta ,
Jukka Niskanen , Petri Pulkkinen , Lauri Antero Valtola ,
Szymon Jan Wiktorowicz , Marjo Yliperttula , Tapani Viitala , Hanna-Sisko
Kortejärvi , Yan-Ru Lou , Paraskevi Kallinteri , Jonna Wikström ,
Martina Hanzlikova , Niko Granqvist , Emilia Marie Claudia Galli ,
Huamin Liang , Unni Kaarina Tengvall , Janne Marvola ,

Publication type	Publication year						Total Count 2005 - 2010
	2005	2006	2007	2008	2009	2010	
A1 Refereed journal article	33	32	27	47	26	33	198
A2 Review in scientific journal	1	1	1				3
A3 Contribution to book/other compilations (refereed)			1	2	1	2	6
A4 Article in conference publication (refereed)		2		2	2	2	8
B1 Unrefereed journal article		1		1	2	1	5
B2 Contribution to book/other compilations (non-refereed)					1		1
B3 Unrefereed article in conference proceedings	1	1	1	1		1	5
D3 Article in professional conference proceedings	1						1
E1 Popular article, newspaper article				2			2
H1 Patents					2	1	3



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RC-SPECIFIC TUHAT COMPILATIONS OF PUBLICATIONS DATA 2005-2010

DePoNa/Urtti

2 Listing of publications

A1 Refereed journal article

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RC-SPECIFIC TUHAT COMPILATIONS OF PUBLICATIONS DATA 2005-2010

DePoNa/Urtti

Wang, Z, Reinach, PS, Zhang, F, Vellonen, K, Urtti, A, Turner, H, Wolosin, JM **2010**, 'DUSP5 and DUSP6 modulate corneal epithelial cell proliferation', **Molecular Vision**, vol 16, no. 183-84, pp. 1696-1704.

Yaghmur, A, Paasonen, L, Yliperttula, M, Urtti, A, Rappolt, M **2010**, 'Structural Elucidation of Light Activated Vesicles', **Journal of Physical Chemistry Letters**, vol 1, pp. 962-966.

Yohannes, G, Wiedmer, SK, Elomaa, M, Jussila, M, Aseyev, V, Riekkola, M **2010**, 'Thermal aggregation of bovine serum albumin studied by asymmetrical flow field-flow fractionation', **Analytica Chimica Acta**, vol 675, no. 2, pp. 191-198.

A2 Review in scientific journal

2005

Hornof, M, Toropainen, E, Urtti, A **2005**, 'Cell culture models of the ocular barriers', **European Journal of Pharmaceutics and Biopharmaceutics**, vol 60, pp. 207-225.

2006

Raki, M, Rein, DT, Kanerva, A, Hemminki, A **2006**, 'Gene transfer approaches for gynecological diseases', **Molecular therapy**, vol 14, no. 2, pp. 154-163.

2007

Kanerva, A, Raki, M, Hemminki, A **2007**, 'Gene therapy of gynaecological diseases: [review]', **Expert Opinion on Biological Therapy**, vol 7, no. 9, pp. 1347-1361.

A3 Contribution to book/other compilations (refereed)

2007

Laukkanen, A, Tenhu, H **2007**, 'Thermally responsive polymers with amphiphilic grafts: smart polymers by macromonomer technique', **Smart polymers**, CRC Press, Boca Raton, FL, pp. 115-135.

2008

Laukkanen, A, Tenhu, H **2008**, 'Thermally responsive polymers with amphiphilic grafts: smart polymers by macromonomer technique', in I Galaev, B Mattiasson (eds), **Smart Polymers. Applications in Biotechnology and Biomedicine**, 2nd edn, CRC Press, pp. 115-136.

Raki, MP, Rajeci, MK, Kirn, D, Hemminki, AE **2008**, 'Oncolytic viruses for treatment of cancer', in N Templeton (ed.), **Cell and Gene Therapy . Therapeutic Mechanisms and Strategies**, 3 edn, Marcel Dekker, New York.

2009

Urtti, A **2009**, 'Ophthalmic Delivery of Protein and Peptide Therapeutics', in A Dougherty, R Mrsny (eds), **Pharmacokinetic, Pharmacodynamic and Metabolic Aspects of Therapeutic Proteins and Peptides**, Informa healthcare.

2010

Aseyev, V, Tenhu, H, Winnik, F **2010**, 'Non-ionic Thermoresponsive Polymers in Water', **Self Organized Nanostructures of Amphiphilic Block Copolymers**, **Advances in Polymer Science**, Springer Berlin Heidelberg, pp. 1-61.

Urtti, A **2010**, 'Ocular drug delivery systems: transscleral drug delivery to the posterior eye segment', **Biodrug Delivery Systems**, Informa healthcare, New York, pp. 187-193.

A4 Article in conference publication (refereed)

2006

Lehtinen, J, Subrizi, A, Bunjes, H, Urtti, A **2006**, *Anionic lipid coating protects cationic DNA-polymer complexes from glycosaminoglycans*, European Journal of Pharmaceutical Sciences 28 ELSEVIER BV.

Tenhu, H **2006**, *Self-assembling of aqueous polyelectrolytes: Polyelectrolyte complex particles and micellar structures*,.

2008

Hanzlikova, M, Galli, E, Urtti, A, Raasmaja, A, Ruponen, M, Yliperttula, M **2008**, *The role of free polyethylene imine (PEI) in gene delivery by DNA-PEI complexes*, Human Gene Therapy 19 MARY ANN/LIEBERT, INC. PUBLISHERS.



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RC-SPECIFIC TUHAT COMPILATIONS OF PUBLICATIONS DATA 2005-2010

DePoNa/Urtti

Subrizi, A, Antopolsky, M, Urtti, A **2008**, *Design and in vitro characterization of Tat derived cell-penetrating peptides*, Human Gene Therapy 19 MARY ANN/LIEBERT, INC. PUBLISHERS.

2009

Alakurtti, SA, Sacerdoti-Sierra, N, Pohjala, L, Jaffe, CL, Tammela, P, Yli-Kauhaluoma, J **2009**, 'Pharmaceutical Applications of Birch Bark Extractive Betulin', in **Science and technology of biomasses: advances and challenges (from forest and agricultural biomasses to high added value products, processes and materials)**, pp. 165-168.

Cerullo, V, Pesonen, S, Diaconu, I, Escutenaire, S, Arstila, P, Ugolini, M, Nokisalmi, P, Raki, M, Laasonen, L, Rajcecki, M, Kangasniemi, L, Guse, K, Joensuu, T, Kanerva, A, Hemminki, A **2009**, *Ad5-D24-GMCSF, an oncolytic adenovirus coding for GMCSF, induces anti-tumoral immunity in human cancer patients*, Human Gene Therapy 20 MARY ANN/LIEBERT, INC. PUBLISHERS.

2010

Hanzlíková, M, Raula, J, Hautala, J, Kauppinen, E, Urtti, A, Yliperttula, M **2010**, *Preparation of solid DNA nanoparticles for use in gene therapy*, Drug Discovery Today 15 23-24 ELSEVIER.

Mirza, S, Miroshnyk, I, Mohammadi, G, Alakurtti, SA, Hussain, M, Yli-Kauhaluoma, J, Urtti, A **2010**, *Electrospinning platform for fabrication of monodispersed nanoparticles for pharmaceutical applications*, Paper presented at **2010 FIP Pharmaceutical Sciences World Congress, New Orleans**, United States. 14. - 18. November, 2010. AAPS Journal 12 S2 SPRINGER NEW YORK LLC.

B1 Unrefereed journal article

2006

Urtti, A **2006**, 'Ocular drug delivery', **Advanced Drug Delivery Reviews**.

2008

Kairemo, K, Bergström, K **2008**, 'The role of radiopharmaceuticals in drug discovery', **Current Radiopharmaceuticals**, vol 1, no. 1, pp. 1.

2009

Subrizi, AE, Yliperttula, M, Tibaldi, L, Schacht, E, Dubruel, P, Joliot, A, Urtti, A **2009**, 'Optimized transfection protocol for efficient in vitro non-viral polymeric gene delivery to human retinal pigment epithelial cells (ARPE-19)', **Protocol Exchange**, no. 78.

Tenhu, H **2009**, 'In Memoriam', **Muovi : Muoviyhdistys ry:n jäsenlehti**, vol 5, pp. 31.

2010

Tuohimaa, P, Kuuslahti, M, Lou, Y **2010**, 'Vitamin D3: Is there an upper limit?', **BMJ : British Medical Journal**.

B2 Contribution to book/other compilations (non-refereed)

2009

Tuohimaa, P, Lou, Y **2009**, 'New Aspects of Vitamin D Endocrinology', in SR Malone (ed.), **VITAMIN D: NUTRITION, SIDE EFFECTS AND SYMPTOMS**, Nova Science Publishers, Hauppauge, NY, USA, pp. 119-131.

B3 Unrefereed article in conference proceedings

2005

Hiltunen, M, Maunu, SL, Tenhu, H **2005**, 'Synthesis and characterizations of new cellulose derivatives with controlled chemical structure of grafts by using RAFT polymerization', in **59th Appita Annual Conference**, pp. 143-146 **Appita Annual Conference**, vol. 3.

2006

Muhonen, J, Lipponen, T, Bergström, K **2006**, *Ion trap mass spectrometry in the qualitative analysis of [¹⁸F] MPPF*, European Journal of Nuclear Medicine and Molecular Imaging 33 SPRINGER.

2007

Hiltunen, M, Maunu, SL, Tenhu, H **2007**, 'New cellulose copolymers with controlled chemical structure of grafts via RAFT polymerization', in **14th International Symposium for Wood, Fibre & Pulp Chemistry**.

2008



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RC-SPECIFIC TUHAT COMPILATIONS OF PUBLICATIONS DATA 2005-2010

DePoNa/Urtti

Järvi, PK, Olszewska, A, King, AWT, Granström, M, Hietala, SHO, Kipeläinen, I, Argyropoulos, D **2008**, 'Study of Rheological Behaviour of Microcrystalline Cellulose Dissolved in Two Different Ionic Liquids', in **10th European Workshop on Lignocellulosics and Pulp (Proceedings)**, pp. 177-180.

2010

Kivelä, R, Hietala, S, Sontag-Strohm, T, Turner, B, Bansil, R **2010**, 'Oat β -glucan affects the viscoelastic properties of gastric mucin at pH conditions of intestine.', in **The 2nd Conference of Gluten Free products and Beverages**, pp. 63-64.

D3 Article in professional conference proceedings

2005

Säkkinen, M, Marvola, J, Marvola, M **2005**, 'Are chitosan granules mucoadhesive in the human stomach - a gamma scintigraphic study in man.', in **Proceedings of the 1st BBBB Conference on Pharmaceutical Sciences**, pp. 224.

E1 Popular article, newspaper article

2008

Sundholm, F, Tenhu, H **2008**, 'J. Johan Lindberg polymeerikemian uuttera uranuurtaja: in memoriam', **Kemia - Kemi**, vol 35, no. 5, pp. 81.

Törmälä, P, Tenhu, H **2008**, 'J. Johan Lindberg *18.9.1921 +28.6.2008: in memoriam', **Suomalainen Tiedeakatemia. Vuosikirja**, pp. 107-110.

H1 Patents

2009

Maijala, J, Merta, J, Shan, J, Tenhu, H **2009**, *Novel particles and method of producing the same.*,

Shan, J, Pulkkinen, P, Merta, J, Känsäkoski, A, Tenhu, H Sep. 24 2009, *Novel materials based on nanoparticles having a metallic core and a protective amine wrapping.*, WO2009115643 (A2).

2010

Yli-Kauhaluoma, J, Koskimies, S, Alakurtti, SA, Bergström, P, Mäkelä, T, Vuorela, P, Tammela, P, Minkkinen, J, Pohjala, L Nov. 30 2010, *Betuliiniperäiset yhdisteet antimikrobisina aineina*, 121468.



INTERNATIONAL EVALUATION OF RESEARCH AND DOCTORAL TRAINING AT THE
UNIVERSITY OF HELSINKI

RC-SPECIFIC TUHAT COMPILATIONS OF OTHER SCIENTIFIC ACTIVITIES 2005-2010

DePoNa/Urtti

1 Analysis of activities 2005-2010

- Associated person is one of Arto Urtti , Maxim Antopolsky , Marika Häkli , Päivi Tammela
, Lasse Murtomäki , Kim Bergström , Antti Petteri Laukkanen, Heidi Kidron ,
Mari Raki , Sanjay Sarkhel , Margit Hornof, Julia Lehtinen , Astrid
Elena Subrizi , Kati-Sisko Vellonen , Leena Kontturi , Mechthild Schmitt ,
Johanna Linnankoski , Melina Malinen , Lauri Joonas Paasonen ,
Aseyev , Sreevani Kotha , Tatu Lajunen , Heikki Tenhu , Vladimir
Pekka Hirvonen , Sami Hietala , Anna Viktorovna Zarembo, Susanna Helmi Elisabet Holappa, Markus Nuopponen, Sami-
Anu Alhoranta ,
Mikko Karesoja , Erno Johannes Karjalainen ,
Szymon Jan Wiktorowicz , Jukka Niskanen , Petri Pulkkinen , Lauri Antero Valtola ,
Kortejärvi , Marjo Yliperttula , Tapani Viitala , Hanna-Sisko
Yan-Ru Lou , Paraskivi Kallinteri , Jonna Wikström ,
Martina Hanzlikova , Niko Granqvist , Emilia Marie Claudia Galli ,
Huamin Liang , Unni Kaarina Tengvall , Janne Marvola ,

Activity type	Count
Supervisor or co-supervisor of doctoral thesis	23
Prizes and awards	7
Editor of research journal	11
Peer review of manuscripts	48
Assessment of candidates for academic posts	13
Membership or other role in review committee	21
Membership or other role in research network	3
Membership or other role in national/international committee, council, board	20
Membership or other role in public Finnish or international organization	5
Membership or other role of body in private company/organisation	1
Other tasks of an expert in private sector	5
Participation in interview for written media	14
Participation in radio programme	1
Participation in TV programme	3



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2 Listing of activities 2005-2010

Supervisor or co-supervisor of doctoral thesis

Arto Urtti ,

Supervision of doctoral thesis, Arto Urtti, 01.01.2005 → 31.12.2005, Switzerland
Supervision of doctoral thesis, Arto Urtti, 01.01.2005 → 31.12.2005, Switzerland
Supervision of doctoral thesis, Arto Urtti, 01.01.2006 → 30.12.2006, Finland
Supervision of doctoral thesis, Arto Urtti, 01.01.2006 → 30.12.2006, Finland
Supervision of doctoral thesis, Arto Urtti, 01.01.2006 → 30.12.2006, Finland
Supervision of doctoral thesis, Arto Urtti, 01.01.2006 → 30.12.2006, Finland
Supervision of doctoral thesis, Arto Urtti, 01.01.2006 → 30.12.2006, Finland
Supervision of doctoral thesis, Arto Urtti, 01.01.2006 → 30.12.2006, Finland
Supervision of doctoral thesis, Arto Urtti, 01.01.2006 → 30.09.2006, Finland

Marika Häkli ,

PhD study supervision, Marika Häkli, 2006 → 27.08.2010

Päivi Tammela ,

Supervision of doctoral thesis of Kari Kreander, Päivi Tammela, 2004 → 2006, Finland
Supervision of PhD thesis of Leena Pohjala, Päivi Tammela, 2006 → 2010, Finland
Supervision of doctoral thesis of Susanna Nybond (on-going), Päivi Tammela, 2010 → ..., Finland

Lasse Murtomäki ,

Supervision, Lasse Murtomäki, 2005 → 2007, Finland
Supervision, Lasse Murtomäki, 2007 → 2010, Finland

Kim Bergström ,

Supervisor of PhD thesis in progress, Mirikka Sarparanta, Kim Bergström, 2007 → ...
Supervisor of PhD thesis in progress, Teija Koivula, Kim Bergström, 2007 → ...

Sanjay Sarkhel ,

Structural studies of KCC2 C-terminal domain, Sanjay Sarkhel, 2008, Finland
Structural studies of the KCC2 C-terminal domain, Sanjay Sarkhel, 2009 → 2010, Finland

Heikki Tenhu ,

Complexation of poly(ethyleneoxide)-block-poly(methacrylic acid) in aqueous medium, Heikki Tenhu, 2005
Thermally responsive polymers based on poly(N-vinylcaprolactam) and an amphiphilic macromonomer, Heikki Tenhu, 2005
Polymer protected gold nanoparticles, Heikki Tenhu, 2006
Organized nanostructures of thermoresponsive poly(N-isopropylacrylamide) block copolymers obtained through controlled RAFT polymerization, Heikki Tenhu, 2008
Syntheses and self-assembling characteristics of amphiphilic star diblock copolymers, Heikki Tenhu, 2008

Prizes and awards

Arto Urtti ,

Millennium Distinction Award, Arto Urtti, 15.12.2009
EUREKA success story nomination, Arto Urtti, 01.01.2010 → 31.12.2010

Päivi Tammela ,

Albert Wuokko Award to Young Scientist, Päivi Tammela, 17.11.2006, Finland



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RC-SPECIFIC TUHAT COMPILATIONS OF OTHER SCIENTIFIC ACTIVITIES 2005-2010

DePoNa/Urtti

Jack L. Beal Award, Päivi Tammela, 14.07.2010, United States

Lasse Murtomäki ,

Textbook award, Lasse Murtomäki, 28.06.2008, Finland

Textbook award, Lasse Murtomäki, 15.09.2009, Finland

Astrid Elena Subrizi ,

6th Tissue Engineering Symposium, Astrid Elena Subrizi, 04.06.2009, Finland

Editor of research journal

Arto Urtti ,

AAPS Journal, Arto Urtti, 01.01.2005 → 31.12.2005, United States

EUROPEAN JOURNAL OF PHARMACEUTICAL SCIENCES, Arto Urtti, 01.01.2005 → 31.12.2010, Netherlands

International Journal of Pharmaceutics, Arto Urtti, 01.01.2005 → 31.12.2010, Netherlands

Journal of Controlled Release, Arto Urtti, 01.01.2005 → 31.12.2010

Journal of Gene Medicine, Arto Urtti, 01.01.2005 → 31.12.2010, United Kingdom

Pharmaceutical Research, Arto Urtti, 01.01.2005 → 31.12.2005, United States

Advanced Drug Delivery Reviews, Arto Urtti, 01.01.2006 → 31.12.2006, Netherlands

J Gene Medicine, Arto Urtti, 01.01.2006 → 31.12.2010, Netherlands

Journal of Ocular Cell Biology, Diseases and Bioinformatics, Arto Urtti, 01.11.2007 → 31.12.2010, United States

PlosONE, Arto Urtti, 01.01.2007 → 31.12.2010, United States

Maxim Antopolsky ,

Academic editor, Maxim Antopolsky, 03.2008 → 01.2011

Peer review of manuscripts

Arto Urtti ,

AAPS Journal, Arto Urtti, 01.01.2005 → 31.12.2005, United States

European Journal of Pharmaceutical Sciences, Arto Urtti, 01.01.2005 → 31.12.2010, Netherlands

International Journal of Pharmaceutics, Arto Urtti, 01.01.2005 → 31.12.2007, Netherlands

Journal of Controlled Release, Arto Urtti, 01.01.2005 → 31.12.2010, Netherlands

Molecular Therapy, Arto Urtti, 01.01.2005 → 31.12.2010, United States

AAPS Journal, Arto Urtti, 01.01.2006 → 31.12.2006, United States

Biomacromolecules, Arto Urtti, 01.01.2006 → 31.12.2010, United States

Biotechnology and Bioengineering, Arto Urtti, 01.01.2006 → 31.12.2006, Netherlands

Investigative Ophthalmology and Visual Sciences, Arto Urtti, 01.01.2006 → 31.12.2010, United States

J Colloid and Surface Chemistry, Arto Urtti, 01.01.2006 → 31.12.2006, United States

Journal of Fish Biology, Arto Urtti, 01.01.2006 → 31.12.2006, United States

Journal of Gene Medicine, Arto Urtti, 01.01.2006 → 31.12.2006, United Kingdom

Pharmaceutical Research, Arto Urtti, 01.01.2006 → 31.12.2010, United States

AAPS Journal, Arto Urtti, 01.01.2007 → 31.12.2007, United States

Central European Journal of Chemistry, Arto Urtti, 01.01.2007 → 31.12.2007, Germany

Gastroenterology, Arto Urtti, 01.01.2007 → 31.12.2007, United States

Journal of Gene Medicine, Arto Urtti, 01.01.2007 → 31.12.2007, United Kingdom

Nature Biotechnology, Arto Urtti, 01.01.2008 → 31.12.2009



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RC-SPECIFIC TUHAT COMPILATIONS OF OTHER SCIENTIFIC ACTIVITIES 2005-2010

DePoNa/Urtti

Proc Natl Acad Sci USA, Arto Urtti, 01.01.2008 → 31.12.2008
Acta Biomaterialia, Arto Urtti, 01.01.2009 → 31.12.2009
Bioanalysis, Arto Urtti, 01.01.2009 → 31.12.2009
Cornea, Arto Urtti, 01.01.2009 → 31.12.2009
Journal of Pharmaceutical Sciences, Arto Urtti, 01.01.2009 → 31.12.2009
Mini-reviews in Medicinal Chemistry, Arto Urtti, 01.01.2009 → 31.12.2009
Molecular Pharmaceutics, Arto Urtti, 01.01.2009 → 31.12.2009
Oligonucleotides, Arto Urtti, 01.01.2009 → 31.12.2009
Recent Patents in Drug Delivery, Arto Urtti, 01.01.2009 → 31.12.2009
Theoretical Chemical Accounts, Arto Urtti, 01.01.2009 → 31.12.2009
Toxicology, Arto Urtti, 01.01.2009 → 31.12.2010
Trends in Biotechnology, Arto Urtti, 01.01.2009 → 31.12.2009
Expert Opinion in Drug Metabolism and Toxicology, Arto Urtti, 01.01.2010 → 31.12.2010
Molecular Vision, Arto Urtti, 01.01.2010 → 31.12.2010
Progress in Retinal Research, Arto Urtti, 01.01.2010 → 31.12.2010

Päivi Tammela ,

Peer review for Biochemical Systematics and Ecology, Päivi Tammela, 2005
Peer review for European Journal of Pharmaceutical Sciences, Päivi Tammela, 2005
Peer review for European Journal of Pharmacology, Päivi Tammela, 2009
Peer review for Bioorganic & Medicinal Chemistry, Päivi Tammela, 11.02.2010
Peer review for Current Topics in Medicinal Chemistry, Päivi Tammela, 27.05.2010, Netherlands

Lasse Murtomäki ,

Electrochimica Acta, Lasse Murtomäki, 1992 → ...
Journal of Electroanalytical Chemistry, Lasse Murtomäki, 1992 → ...
Langmuir, Lasse Murtomäki, 1992 → ...
Journal of Controlled Release, Lasse Murtomäki, 1995 → ...
Journal of Pharmaceutical Sciences, Lasse Murtomäki, 1995 → ...
European Journal of Pharmaceutical Sciences, Lasse Murtomäki, 1998 → ...

Kim Bergström ,

Referee in 8 peer reviewed Journals, Kim Bergström, 1998 → ...

Heikki Tenhu ,

Referee of hundreds of manuscripts for various scientific journals, Heikki Tenhu, 01.01.2005 → 31.12.2010

Yan-Ru Lou ,

American Journal of Physiology - Endocrinology and Metabolism, Yan-Ru Lou, 2010
Journal of Steroid Biochemistry and Molecular Biology, Yan-Ru Lou, 2010

Assessment of candidates for academic posts

Arto Urtti ,

Professor of Pharmaceutical Technology, University of Basel, Switzerland, 2005, Arto Urtti, 01.01.2005 → 31.12.2005
Professor of Drug Delivery, University of Basel, 2006, Arto Urtti, 01.01.2006 → 31.12.2006
Professor of Polymer Chemistry, University of Gent, Dept of Organic Chemistry, 2006, Arto Urtti, 01.01.2006 → 31.12.2006
Professor of Biopharmaceutics, University of Copenhagen, 2007, Arto Urtti, 01.01.2007 → 31.12.2007



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Professor of Molecular Medicine, AIV Institute, University of Kuopio, 2007, Arto Urtti, 01.01.2007 → 31.12.2007
Professor of Drug Delivery, University of Basel, 2008, Arto Urtti, 01.01.2008 → 31.12.2008
Professor of Gene Transfer Technologies, AIV Institute, University of Kuopio, 2008, Arto Urtti, 01.01.2008 → 31.12.2008
Professor of Pharmaceutical Technology, University of Southern Denmark, 2008, Arto Urtti, 01.01.2008 → 31.12.2008
Pirjo Laitala-Leinonen, Department of Cell Biology, University of Turku, 2009, Arto Urtti, 01.01.2009 → 31.12.2009
Professor in Pharmaceutical Technology, University of KwaZulu Natal, South Africa, 2009, Arto Urtti, 01.01.2009 → 31.12.2009
Adjunct Associate Professor, Dept. of Medical Pharmacology, Ohio State University, USA, 2010, Arto Urtti, 01.01.2010 → 31.12.2010
Tenure track position Biopharmacy, University of Basel, Switzerland, 2010, Arto Urtti, 01.01.2010 → 31.12.2010

Marjo Yliperttula ,

Member of the professor evaluation board, Marjo Yliperttula, 01.01.2008 → 31.12.2008

Membership or other role in review committee

Arto Urtti ,

Award Committee Member, Arto Urtti, 01.01.2006 → 31.12.2007
Reviewer for Government of Ireland, Embark Initiative (post doctoral fellowships), Arto Urtti, 01.01.2006 → 31.12.2006
Reviewer for Luxembourg Ministry of Education, Arto Urtti, 01.01.2006 → 31.12.2006
Reviewer for Research Council of Catholic University of Leuven, Belgium, Arto Urtti, 01.01.2006 → 31.12.2006
Reviewer for Research Council of Norway, Nanotechnology and Materials Program, Arto Urtti, 01.01.2006 → 31.12.2006
Reviewer for Austrian Science Academy (2007), Arto Urtti, 01.01.2007 → 31.12.2007
Reviewer for Finnish Cultural Foundation Grant Applications 2007, Arto Urtti, 01.01.2007 → 31.12.2007
Reviewer for Millennium Award, Arto Urtti, 01.01.2007 → 31.12.2007
Reviewer for the Hong Kong Research Council (2007), Arto Urtti, 01.01.2007 → 31.12.2007
Reviewer of Infrastructure Grants (FWF Vienna, Austria), 2008, Arto Urtti, 01.01.2008 → 12.12.2008
European Union (FP-7, HEALTH program, Arto Urtti, 01.01.2009 → 31.12.2009
Grant reviewer for BBSRS Council, UK, 2009, Arto Urtti, 01.01.2009 → 12.12.2009
Reviewer for Danish Agency for Science, Technology and Innovation, Arto Urtti, 01.01.2009 → 12.12.2009
Reviewer for FWO, Belgium, 2009, Arto Urtti, 01.01.2009 → 31.12.2009
Reviewer for Irish Research Council for Science, Engineering and Technology (IRCSET), Arto Urtti, 01.01.2009 → 12.12.2009
Reviewer for The Danish Council for Independent Research, Arto Urtti, 01.01.2009 → 31.12.2009
NWO Nano STW, The Netherlands, 2010, Arto Urtti, 01.01.2010 → 01.12.2010
Reviewer for Innovation and Technology Commission, Hong Kong, 2010, Arto Urtti, 01.01.2010 → 01.12.2010
Reviewer for Sigma Delta Epsilon, Graduate Women in Science, National Fellowships, USA., Arto Urtti, 01.01.2010 → 01.12.2010

Kim Bergström ,

Reviewer of NorFA:s (Nordic Academy of Advanced Study) guest professor, Kim Bergström, 2003 → ...

Marjo Yliperttula ,

Nanotechnology program applications, 2008-9, CEA, CNRS, Marjo Yliperttula, 01.01.2008 → 31.12.2009

Membership or other role in research network

Päivi Tammela ,

Member of Viikki Research Group Organisation, Päivi Tammela, 2007 → ..., Finland
Administrative co-ordinator of the FP7 project MAREX, Päivi Tammela, 01.08.2010 → 31.07.2014
Member of American Society of Microbiology, Päivi Tammela, 2010 → ..., United States



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Membership or other role in national/international committee, council, board

Arto Urtti ,

Health Science Research Council, Academy of Finland, Arto Urtti, 01.01.2005 → 31.12.2006

Member-at-Large: Executive Council (EC) of the Globalization of Pharmaceuticals Education Network (GPEN), 1.1.2003-31.12.2008, Arto Urtti, 01.01.2005 → 31.12.2008

Suomen Akatemia, Arto Urtti, 01.01.2005 → 31.12.2005, Finland

Nordic Chapter of Controlled Release Society, Arto Urtti, 01.01.2006 → 31.12.2006, Finland

Suomen Akatemia, Arto Urtti, 01.01.2006 → 31.12.2006, Finland

Suomen Geeniterapiaseura, Arto Urtti, 01.01.2006 → 31.12.2006, Finland

University of Gent, Belgium (Dept of Research Affairs), Arto Urtti, 01.01.2006 → 31.12.2006, Belgium

Controlled Release Society / Journal of Controlled Release (best paper award evaluator), Arto Urtti, 01.01.2007 → 31.12.2007, United States

Hong Kong Research Council (arvioija), Arto Urtti, 01.01.2007 → 31.12.2007, Hong Kong

Päivi Tammela ,

Deputy Member of the Committee of Research Affairs, Päivi Tammela, 2004 → 2006, Finland

Member of Admissions Board, Päivi Tammela, 2005 → 2009, Finland

Deputy Member of the Committee of Educational Affairs, Päivi Tammela, 01.01.2006 → 31.12.2006, Finland

Member of the Advisory Committee of the UNDP/DDC Arab States Programme, Päivi Tammela, 2008 → ...

Deputy Member of the Committee of Educational Affairs, Päivi Tammela, 2010 → ...

Kim Bergström ,

National Advisor in Radiopharmacy, European Association of Nuclear Medicine, Kim Bergström, 2006 → ...

Member of Editorial Board of the Current Radiopharmaceuticals –journal, Kim Bergström, 2007 → ...

Supervisor member of Drug Discovery Graduate School (DDGS), Turku, Finland, Kim Bergström, 2007 → ...

Astrid Elena Subrizi ,

Helsinki Drug Research Congress, Astrid Elena Subrizi, 09.06.2008 → 11.06.2008, Finland

Heikki Tenhu ,

The Finnish Society of Sciences and Letters, Heikki Tenhu, 2005

Board of Natural Sciences and Engineering, Heikki Tenhu, 01.01.2010 → 31.12.2012

Membership or other role in public Finnish or international organization

Arto Urtti ,

Polymer Corex, Arto Urtti, 01.01.2005 → 31.12.2005, Finland

Kim Bergström ,

Management Committee Member to COST Action B12, Kim Bergström, 1999 → 2005

National Coordinator for radiopharmacy teaching program, INSTN, France, Kim Bergström, 1999 → 2005

Marjo Yliperttula ,

Akatemian laskennallisen ohjelmatoimikunnan asiantuntijana, Marjo Yliperttula, 01.01.2008 → 31.12.2008, Finland

Yan-Ru Lou ,

Membership, Yan-Ru Lou, 2004 → ..., Finland

Membership or other role of body in private company/organisation

Kim Bergström ,

Board Member, Imanext Ltd, Kim Bergström, 2006 → 2010



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Other tasks of an expert in private sector

Arto Urtti ,

Hallituksen pj, Arto Urtti, 01.01.2005 → 31.12.2010

Scientific Advisory Board Member, Arto Urtti, 01.06.2010 → 31.12.2010

Scientific Advisory Board Member, Arto Urtti, 01.01.2010 → 31.12.2010

Päivi Tammela ,

Deputy Responsible Pharmacist, Päivi Tammela, 29.04.1999 → ..., Finland

Kim Bergström ,

Senior Advisor in life-science sector, Replicon Group, Kim Bergström, 2006 → ...

Participation in interview for written media

Arto Urtti ,

Apteekin hyllyltä, Arto Urtti, 01.01.2006 → 31.12.2006, Finland

KEMIA-KEMI, Arto Urtti, 01.01.2006 → 31.12.2006, Finland

Viikin Kampusseite, Arto Urtti, 01.01.2006 → 31.12.2006, Finland

Yliopisto, Arto Urtti, 01.01.2006 → 31.12.2006, Finland

Kemia-Kemi, Arto Urtti, 01.01.2008 → 31.12.2008

MediUutiset, Arto Urtti, 01.01.2008 → 31.12.2009, Finland

MediUutiset, Arto Urtti, 01.01.2008 → 31.12.2008

Farmasia -lehden haastattelu, Arto Urtti, 01.01.2009 → 31.12.2009

Haastattelu Proviisori -lehteen, Arto Urtti, 01.01.2009 → 31.12.2009

APTEEKIN HYLLYLTÄ, Arto Urtti, 01.01.2010 → 31.12.2010

Haastattely Tiede -lehteen, Arto Urtti, 01.01.2010 → 31.12.2010

Päivi Tammela ,

Pohjatyötä uusien lääkkeiden hyväksi, Päivi Tammela, 2007, Finland

Tonneittain tuolta, Päivi Tammela, 18.06.2009, Finland

Marjo Yliperttula ,

Ylen haastattelu Studia Generalia luentoon liittyen, Marjo Yliperttula, 20.02.2008 → 31.12.2011, Finland

Participation in radio programme

Päivi Tammela ,

Radio interview, Päivi Tammela, 05.04.2006, Finland

Participation in TV programme

Arto Urtti ,

TV1 Uutiset , haastattelu, Arto Urtti, 01.01.2008 → 31.12.2008

Tv-1 Prisma, Arto Urtti, 01.01.2008 → 31.12.2011, Finland

Prisma TV 1 haastattelu, Arto Urtti, 01.01.2009 → 31.12.2009



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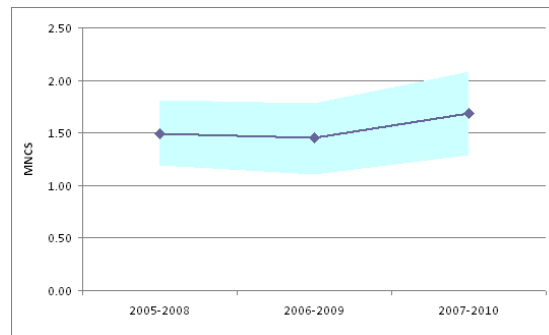
Web of Science(WoS)-based bibliometrics of the RC's publications data 1.1.2005-31.12.2010
by CWTS, Leiden University, the Netherlands

Research Group: Urtti A

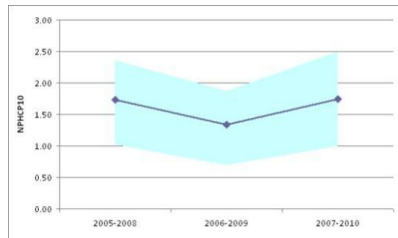
Basic statistics

Number of publications (P)	169
Number of citations (TCS)	1,369
Number of citations per publication (MCS)	8.14
Percentage of uncited publications	15%
Field-normalized number of citations per publication (MNCS)	1.57
Field-normalized average journal impact (MNJS)	1.46
Field-normalized proportion highly cited publications (top 10%)	1.60
Internal coverage	.89

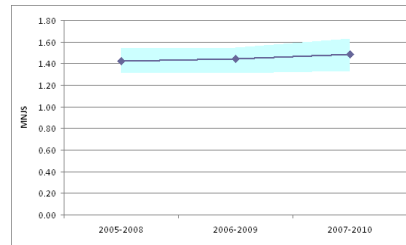
Trend analyses



MNCS

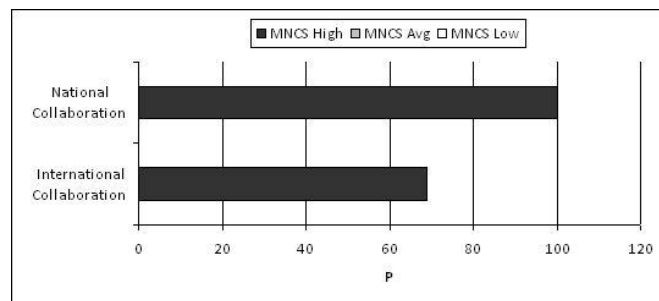


THCP10



MNJS

Collaboration



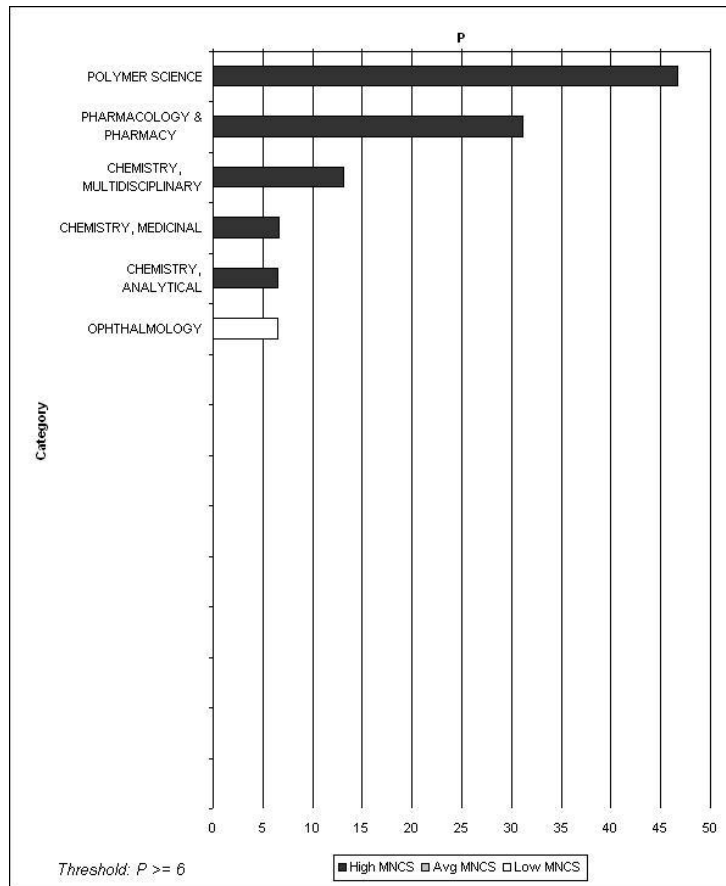
Performance (MNCS) by collaboration type



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