

Umeå Plant Science Centre

Biennial Report 2024-2025

A collaboration between



UMEÅ
UNIVERSITY



SWEDISH UNIVERSITY OF
AGRICULTURAL SCIENCES

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UPSC 25th Anniversary Symposium (photo: Mattias Pettersson, UMU)

1. Introduction

Introduction

Words from the Director

When I look back at the past two years at UPSC, one highlight stands out: the celebration of our 25-year anniversary in June 2024, a milestone that clearly reflected the strength and shared vision of our community. We marked this milestone together with university leadership and many of those who were central in shaping the vision of a strong, shared research environment by joining the forces of two departments from two universities: the Department of Plant Physiology at Umeå University and the Department of Forest Genetics and Plant Physiology at the Swedish University of Agricultural Sciences (SLU).

In 2026, we also celebrate 25 years since the co-location of these departments in a shared building at Umeå University, an important step that transformed UPSC from an agreement on paper into a fully realised, integrated research centre. Over this period, UPSC has developed into one of Europe's leading research centres in experimental plant biology and forest biotechnology and is recognised as one of the top research environments at both universities. This position is built on strong collaborations in large strategic projects, coordinated recruitment, and a shared approach to engagement with society and stakeholders. Close links with industry have further developed into a strong innovation environment, translating fundamental research into solutions for sustainable forestry and agriculture while training the next generation of researchers.

Today, more than 210 people of 49 different nationalities work at UPSC in 31 research groups covering the full breadth of plant science from biochemistry and developmental biology to ecophysiology, genetics, and breeding. In 2024 and 2025, we welcomed two new research group leaders, Susan McEvoy and Johannes Messinger, and in 2026 a further five were recruited. These groups will play a key role in shaping the future of UPSC.

We also welcomed a new Scientific Advisory Board, comprising Professors Malcolm Bennet, Alisdair Fernie, Sally Aitkin, Dirk Inzé and Julia Bailey-Serres, who visited UPSC for the first time in November 2024 and provide valuable strategic advice.

Another important development is the expansion of the UPSC bioinformatics environment. It has grown from an internal support platform into a broader collaborative environment involving around 25 staff working across UPSC and national infrastructures, serving both both universities in Umeå but also researchers across Sweden.

At the same time, UPSC researchers have continued to secure prestigious funding, including ERC Synergy Grants awarded to Stéphanie Robert and Stephan Wenkel, a Novo Nordisk Interdisciplinary Grant to Totte Niittylä and

major support from the Swedish Research Council (VR). Rishikesh Bhalerao was also appointed as a Wallenberg Scholar, one of Sweden's most prestigious research programmes.

The launch of the large strategic research programme WIFORCE (Wallenberg Initiatives in Forest Research), funded by the Knut and Alice Wallenberg Foundation, represents a significant step forward. This programme originated from a large grant to UPSC but has now expanded to cover all relevant forest-related research at the Swedish University of Agricultural Sciences in collaboration with Umeå University. UPSC is still a central part of this programme, which will provide a strong long-term foundation for future research.

Our researchers have also received numerous recognitions and contributed important scientific advances across a wide range of fields, including photosynthesis, plant stress responses, and tree biology. During this period, 15 PhD students successfully defended their theses.

Finally, after many years of discussion, we launched the UPSC newsletter – an important step in strengthening communication and engagement with our wider community. If you would like to follow the UPSC journey, we invite you to subscribe to our newsletter.

In summary, the past two years have been highly successful for UPSC, and we look ahead to the coming years with great confidence and enthusiasm.

Ove Nilsson
Director of Umeå Plant Science Centre



Photo: Fredrik Larsson

Introduction

Perspectives from SLU and Umeå University

UPSC is a perfect example of how coordinated planning, collaboration and recruitment strategies can lead to the establishment of a research centre that is among the best in its field. It was a great pleasure for me to take part in the UPSC 25th anniversary celebration in June 2024, where many of the centre's achievements were highlighted. The benefits of this collaboration for SLU and Umeå University cannot be overstated.

In 2024, the Wallenberg Initiatives in Forest Research (WIFORCE) was launched. It is based at the Faculty of Forest Sciences at SLU and involves several departments within the Faculty as well as UPSC. This basic science research programme aims to deepen our understanding of the processes behind forest growth, survival and biodiversity. Ultimately, this research could contribute to sustainable forestry, new management practices, and climate-adapted trees. WIFORCE has now become firmly embedded within both departments of UPSC through new strategic recruitments, research infrastructure support, and the education of PhD students within the WIFORCE Research School.

UPSC has played a key role in establishing SLU's world-leading role in agricultural and forestry research, education and outreach. A key feature has been our successful collaboration with other leading international and national partners. We are now establishing a WIFORCE Data Support Centre that will work closely with the Bioinformatics Environment at UPSC. I therefore look forward to continue working with Umeå University as we advance UPSC into the future.

Göran Ericsson
Dean for the Faculty of Forest Sciences
Swedish University of Agricultural Sciences



Photo: Susanna Bergström, SLU

UPSC is an integrated part of the Faculty of Science and Technology. In my roles as Dean and Professor in Physics, I have interacted with many of the centre's researchers. UPSC is seen as an excellent example of how joint efforts and competences can lead to scientific breakthroughs. The centre's success has been built on a strong focus on curiosity-driven basic research with great potential for forestry applications.

Our long-standing and consistent support for UPSC has benefited not only plant science but the entire faculty, for example through shared scientific infrastructure such as the Swedish Metabolomics Centre, the C-Trap Facility that allows the study of molecular interactions, and the Plant Growth Facility. In recent years, UPSC has taken responsibility for hosting bioinformatics support, strengthening both our faculty and the Faculty of Medicine. We are also looking forward to the new master's programme in bioinformatics, hosted by UPSC.

One of the prioritized research areas of Umeå University is "Northfood: Plant Science for Change", in which UPSC researchers play an active role. Here, researchers across several faculties collaborate in a transdisciplinary effort to drive the much-needed transformation of our region, counteract the effects of climate change and secure local food production.

Over the past decades, UPSC has been one of the most attractive places in Europe for plant researchers. We look forward to a future in which basic plant science research continues to make an impact on our faculty, our university, and our region.

Thomas Wägberg
Dean for the Faculty of Science and Technology
Umeå University



Photo: Mattias Pettersson, UMU



The UPSC building in summer (photo: Anne Hönzel)

2. UPSC Organisation

UPSC Organisation

About UPSC

UPSC is a centre for experimental plant biology established in 1999 through a collaboration between the Department of Forest Genetics and Plant Physiology at the Swedish University of Agricultural Sciences and the Department of Plant Physiology at Umeå University. Together, these partners provide a strong and integrated research environment that enables excellent plant science.

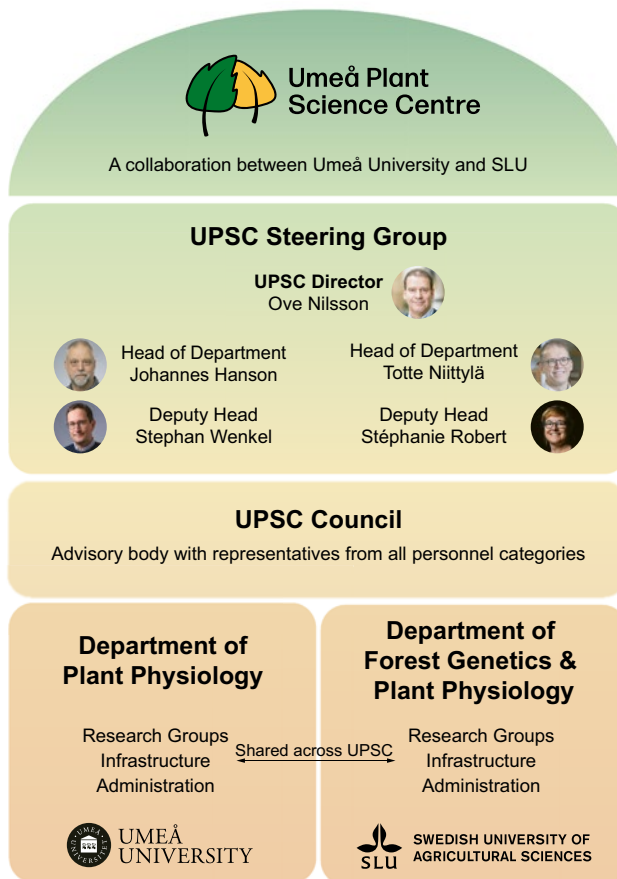
The two departments retain their own leadership and administration while coordinating their activities closely within UPSC, a model that has proven both efficient and effective. The success of UPSC directly strengthens both departments, reflecting a strong mutual commitment to the collaboration.

At the core of UPSC are its research groups, led by Principal Investigators (PIs), and its research infrastructures, led by Facility Managers or Facility Directors. These units operate with a high degree of independence in scientific decision-making and are responsible for their own funding and long-term development.

In 2025, the organisation of UPSC was revised through a new agreement between the two universities, including updated governance structures. UPSC is now led by a director, who is responsible for the overall coordination and development of the centre. Strategic direction and formal decisions on UPSC-wide matters are taken by a Steering Group, comprising the Director and the leadership of the two departments. A UPSC Council, with representatives from across the organisation, provides advice and supports coordination and communication within the centre.

Over its 27 years, UPSC has developed into a highly successful and sustainable model for collaborative research. This success is built on the contributions of its scientists, teachers, students, technicians, postdoctoral researchers, staff scientists and administrative staff. Together, they have created a dynamic and collaborative research environment where shared expertise strengthens scientific excellence.

Today, Umeå Plant Science Centre provides an environment in which high-quality experimental plant science can thrive, and where new students and staff are welcomed into a supportive and creative community. UPSC continues to benefit both universities and contributes to the development of the surrounding society.



Organisational structure of Umeå Plant Science Centre (UPSC), a joint centre of Umeå University and the Swedish University of Agricultural Sciences (SLU). The Steering Group, including the UPSC Director and department leadership, is responsible for strategic direction and decision-making, while the UPSC Council serves as an advisory body with representatives from all personnel categories. Research activities are organised within the two departments, which host staff, administration, and resources, while research infrastructure is shared across UPSC.

Leadership and Structure

UPSC is organised as a joint centre between Umeå University (UMU) and the Swedish University of Agricultural Sciences (SLU). Its structure is designed to ensure shared responsibility, efficient decision-making, and strong integration between the two universities.

Management Structure

The management structure of UPSC is based on three main components: the Director, the Steering Group, and the UPSC Council.

The Director has overall responsibility for planning, coordination, and development of UPSC and ensures that the centre operates in line with its mission, strategic goals, and the regulations of both universities. The role is time-limited and jointly appointed by the universities.

The Steering Group serves as the executive decision-making body of UPSC. It consists of the Director and the heads and deputy heads of the two departments. The Steering Group is responsible for the overall direction and development of the centre, including strategic priorities, joint initiatives, and the coordination of shared resources. Decisions are made in consensus between the Director and the department heads, reflecting the joint ownership of UPSC by the two universities.

The UPSC Council acts as an advisory body to the Steering Group and the Director. It includes representatives from all major personnel categories across both universities, ensuring broad participation in the management of the centre. The Council plays an important role in facilitating communication, strengthening integration, and providing input on strategic and organisational matters.

Roles and Responsibilities

The Steering Group is responsible for guiding the overall development of UPSC and promoting its scientific environment. This includes initiating and prioritising joint research and education initiatives, supporting shared infrastructure and platforms, and strengthening collaboration within the centre and with external partners, including industry, funding bodies, and other research environments.

The UPSC Council contributes by promoting communication and information flow within the organisation, bringing forward perspectives from different personnel categories, and supporting the development of a collaborative, inclusive, and well-integrated research environment.

Organisational Framework

UPSC does not employ its own staff and has no independent economy. All personnel are employed by either UMU or SLU and participate in UPSC activities through their respective departments. Administrative support and financial management are handled by the host departments at the two universities.

The centre operates within defined four-year periods, with its continuation and development subject to evaluation by the universities. These evaluations are based on a self-assessment and, when required, external review by UPSC's Scientific Advisory Board.

UPSC Council composition

Category	Representatives
UPSC Director	1
Heads of Department	2
Teachers/PIs	2
PhD student	1
Postdoc	1
Staff Scientist	1
Technical/Admin staff	1

Composition of the UPSC Council, showing representation from leadership and all major personnel categories. The Council meets four times per year.

Our Mission

UPSC is mandated by Umeå University (UMU) and the Swedish University of Agricultural Sciences (SLU) to maintain and further develop its position as an internationally leading research environment in experimental plant biology.

Our core missions are:

- **To maintain and strengthen an internationally leading research environment in experimental plant biology, with a particular focus on forest biotechnology, through close collaboration between UMU and SLU.**
- **To contribute to the development and maintenance of effective and sustainable technology platforms and research infrastructure in collaboration with other departments and research initiatives.**
- **To provide high-quality education in the field and to actively communicate our research and activities to the wider society.**

At UPSC, we believe that achieving these missions depends on an open, inclusive, and stimulating research environment. We foster a culture in which ideas can be freely developed and tested, and where collaboration is encouraged across disciplines, research groups, and

institutions. Our aim is to provide efficient administrative and technical support, as well as shared infrastructure, that enables individuals and research groups to develop scientifically and reach their full potential.

To support our missions, we:

- Promote and develop the scientific environment at UPSC and encourage open academic discussion.
- Make strategic recruitments to further strengthen our research environment.
- Support education through joint programmes at advanced and doctoral levels and foster early-career researchers.
- Encourage collaborative research projects.
- Develop and maintain shared facilities and research infrastructure.
- Promote interaction and knowledge exchange with industry and society.
- Strengthen engagement with external funders and partners.
- Maintain strong links with university leadership, faculties, and other research environments.



Networking at UPSC's 25th Anniversary Symposium in June 2024 (photo: Mattias Pettersson, UMU)

Scientific Advisory Board



Credit: Jack Woods

Sally Aitken

Professor at the University of British Columbia, Canada

Expertise: **Tree population genetics and climate adaptation**



Credit: UC, Riverside

Julia Bailey-Serres

Professor at the University of California, Riverside, USA

Director of the Center for Plant Cell Biology UC Riverside

Expertise: **Genetic mechanisms controlling abiotic stress resilience**



Credit: University of Nottingham

Malcolm Bennett

Professor at the University of Nottingham, UK

Expertise: **Systems biology of root growth and development**



Credit: Max-Planck Institute of Molecular Plant Physiology

Alisdair R. Fernie

Professor at Max-Planck Institute of Molecular Plant Physiology, Germany

Expertise: **Plant Metabolism**



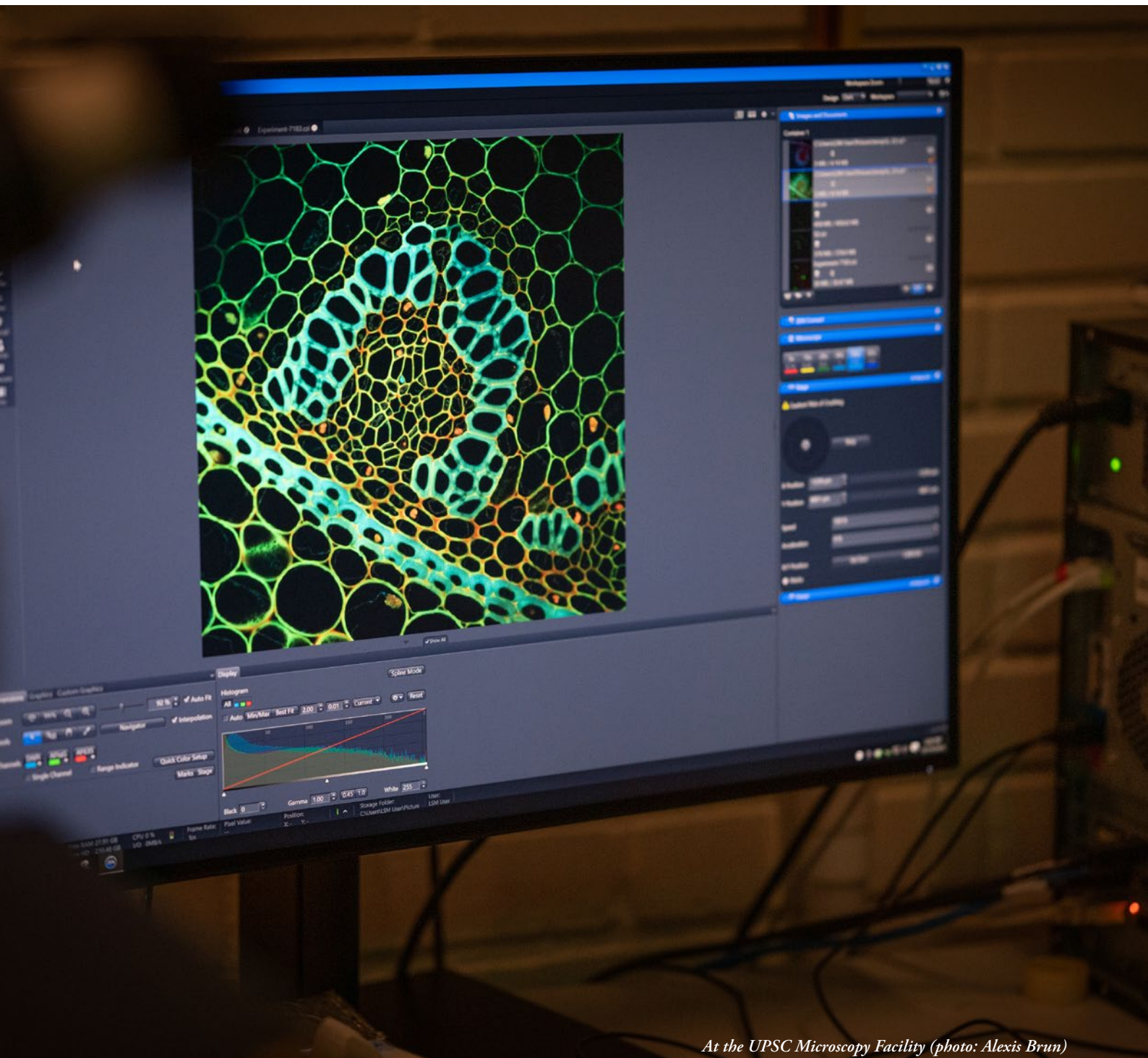
Credit: VIB-UGent

Dirk Inze

Professor at Ghent University, Belgium

Emeritus Science Director of VIB-UGent Center for Plant Systems Biology

Expertise: **Plant organ growth and development**



At the UPSC Microscopy Facility (photo: Alexis Brun)

3. Research at UPSC

Research Areas

At UPSC, we research across a wide range of disciplines in plant science reaching from basic science to industrial applications. The work at UPSC is carried out at all organisation levels of the plant spanning from molecular to ecosystem level. Our common goal is to understand the plants' ability to adapt and acclimate to a changing world.

Research at UPSC focuses mainly on the following three research areas that were defined in 2023:

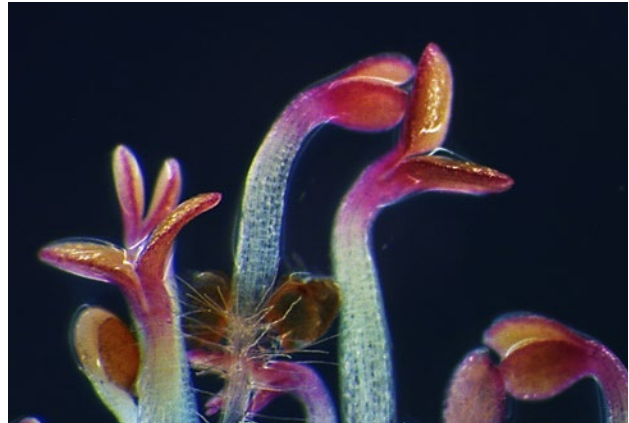
- Cell- and Developmental Biology
- Growth and Adaptation
- Genetics, Genomics and Breeding

We host about 30 principal investigators with different areas of expertise researching on questions mainly related to one or several of the three research areas. The research groups at UPSC collaborate closely with eleven associated research groups who are based in other departments at Umeå University or SLU or at other universities.

To provide an excellent research infrastructure for our research groups, we host ten research facilities at UPSC offering state-of-the-art instrumentation, resources and trainings.



Åsa Gavelin waters aspen plants in the Wallenberg greenhouse (photo: Samuel Pettersson)



Germinating Arabidopsis seedlings (photo: Laxmi Mishra)

Cell- and Developmental Biology

Our research aims to elucidate the mechanisms underlying plant adaptation to environmental variables including light, temperature, day length, drought, and physical damage. We concentrate our investigations at UPSC at various levels, ranging from subcellular mechanism to cellular dynamics and organ responses.

We aim to unravel the roles of major plant signalling molecules, such as phytohormones, in orchestrating plant morphogenesis. Moreover, we place significant emphasis on understanding the cell wall, an extracellular matrix pivotal in shaping plant development, facilitating cell adhesion, and fortifying the cell against both biotic and abiotic stresses. We are working on the plant genetic models *Arabidopsis thaliana* and aspen but also Norway spruce. We employ a wide range of approaches including traditional biological methods but also biophysics, microfluidics, advanced cell biology and computer simulations. A key focus is the advancement of methodologies in tree biology, particularly in the domain of somatic embryogenesis for Norway spruce.

We investigate multiple processes, ranging from gene expression and protein synthesis to organelle communication, to understand how plants integrate developmental and environmental signals. Our goal is to contribute to developing plants that are resilient to the environmental consequences of the climate change.

Research Areas



Arabidopsis wild-type plant exposed to cold temperatures (photo: Vaughan Hurry)

Growth and Adaptation

Plants are sessile organisms that need to continuously adjust their growth and development in response to changes in their environment, and these adjustments can come at the expense of growth. At UPSC, we study how plants balance growth and adaptation in coordination with photosynthesis, which is central for plant growth.

In our research, we investigate different factors that affect the photosynthetic and adaptive capacity of plants. We study how plants react to environmental changes like different light quality and intensities, temperature, water and nutrient availability. One important research question for us is to understand how the carbon that is assimilated during photosynthesis is used for growth and storage. We examine how the assimilated carbon is used for wood formation in trees, how cellulose, hemicelluloses and lignin synthesis is regulated, and how this shapes wood properties and tree performance. Regulation of seasonal growth is another important question, as is understanding how microbes like fungi and bacteria interact with plants, how this affects carbon storage in the forest, and how the environment influences this interaction. To do this research, we mainly use model plants such as the annual plant *Arabidopsis thaliana* and the model tree species such as aspen, birch, spruce and pine.

Our aim is to generate knowledge that can lead to the development of new tools and the identification of tree varieties that can cope with the changing climate, and that can lead to practical applications, such as enhancing growth conditions for spruce and pine seedlings in nurseries.



Swedish forest (photo: Laura Morales)

Genetics, Genomics and Breeding

Plants inherit and express traits based on their genes. Researchers at UPSC played a key role in sequencing the genomes of Populus, Scots pine and Norway spruce, and now use these resources to develop new tools for tree research and modern tree breeding.

With the help of bioinformatics, we are studying and improving the tree genome resources available. We use genome assembly, transcriptomics and co-expression network analyses to understand the genetic basis of complex traits such as leaf shape, wood formation and tree responses to abiotic and biotic stressors. To better understand the biology and evolution of different traits such as wood development, we compare the genomes of individuals within a species as well as comparing genomes across species. We are studying the function of repetitive DNA elements and non-coding RNA in different plant tissues and under stress conditions to discover how they influence genome three-dimensional structure and how this contributes to regulating which genes are activated under specific conditions. We also use metagenomics and metatranscriptomics to analyse the composition, diversity, activity and function of the microbes in and around tree roots. Along with our strong genomic and genetic research, we develop methods for genomic selection, genome wide association studies, seed orchard genetics and genome-wide population studies that are used for modern tree breeding.

Our goal is to gain comprehensive knowledge about genes, their regulation and genomic structures, and to use this knowledge for sustainable forestry.



Spruce seedlings in the Wallenberg Greenhouse (photo: Samuel Pettersson)

3.2 Research Groups

Benedicte Riber Albrectsen

UPSC group leader since 2005, Umeå University



Plant Physio-Ecology Group

Research focus: Plant chemical defence and plant–microbe interactions, and the metabolomic and genomic basis of ecological interactions in trees and crops.

Research goal

Our research investigates how plants defend themselves against biological stress and how chemical traits shape resistance and ecological interactions. Using field studies, controlled bioassays, metabolite profiling, gene expression analyses, microscopy, and growth measurements, we study resilience mechanisms in salicaceous trees and potato.



Andromachi Sortikou is inspecting potato plants in the greenhouse after controlled infestation with peach aphids (*Myzus persicae*) (photo: Arti Mishra)

Highlights of 2024-2025

- Plant Sensing Laboratory established, enabling controlled studies of plant responses to environmental cues. Using several potato cultivars, we analyse metabolomic and genomic responses to beneficial microbes and herbivore attack.
- Novel four-guild potato interaction platform developed in the greenhouse, combining plant growth–promoting bacteria, root-feeding nematodes, and aphid herbivores. The first full-scale experiment using this integrated system was completed.
- Integrative metabolomic and genomic analyses of salicaceous trees revealed new insights into the biosynthesis and ecological functions of salicinoid phenolic glycosides and the role of condensed tannins in plant–mycorrhizal interactions.

- Long-term *Populus tremula* field experiments continue to reveal links between condensed tannin chemistry, plant resistance, and growth.
- Regional *Salix* diversity survey launched across Västerbotten County to investigate natural variation in salicinoid phenolic glycosides and their ecological significance.



Salix safari with Professor Lars Ericson and Hans Gardfjell, collecting *Salix* taxa across Västerbotten County for screening of salicinoid phenolic glycosides (photo: Benedicte Riber Albrectsen)

Future plans

Future work will link phenolic chemistry of salicaceous trees to ecological interactions, resilience traits, and biogeographical distribution. In the potato system, locally isolated bacteria will be screened for plant growth–promoting traits and tested in potato bioassays. Promising strains will be characterised genomically to uncover mechanisms supporting plant growth, defence, and sustainable crop production.

Group members (2024-2025)

Postdocs: Arti Mishra, Lovely Mahawar
Students: Konstantinos Thomos, Diego Tazueco del Rio, ACC Krishani, Rollo Tristan, John Mathew, Antonin Chessé, Diana Castro Pinto
Guest researchers: Nina Zhang, Monika Koul, Marta Potrykus, Kristiina Mäkinen, Andromachi Sortikou

Photo on top: Mattias Pettersson

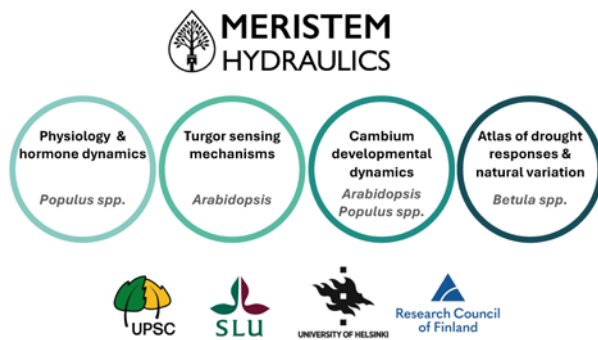


Juan Alonso-Serra

UPSC group leader since 2026, SLU

Meristem Hydraulics

Our group investigates how fluctuating environmental water conditions affect meristem activity. We integrate plant hydraulics with molecular and cellular regulation to understand how stem cells and transit-amplifying cells perceive water status fluctuations, such as turgor pressure and water fluxes, and how these signals converge to drive adaptive growth regulation. Our primary model is the vascular cambium, the largest plant meristem, which produces xylem (wood) and phloem (bark) and drives radial stem growth. By linking whole-plant water relations with tissue-specific cellular and molecular analyses, we aim to uncover the mechanisms connecting water dynamics to growth regulation.



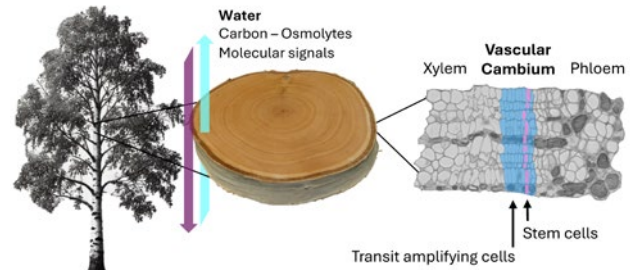
Overview of key research lines in the Meristem Hydraulics Group and the plant species used in each project (illustration: Juan Alonso-Serra)

Research goal

Our goal is to understand how water becomes a signal for plant development. This fundamental question is motivated by numerous studies worldwide indicating that water availability is the primary determinant of annual tree growth and wood formation. Thus, we aim at uncovering causally linking mechanisms between plant hydraulic fluctuations and molecular regulation

Highlights of 2024-2025

- Was recruited as a new group leader to UPSC in 2025 starting in 2026.
- Established the Meristem Hydraulics Group also at the University of Helsinki, supported by an Academy Research Fellowship from the Research Council of Finland (2025-2029).



Conceptual illustration of water and hormonal fluxes via vascular tissues that originate from the vascular cambium, highlighting stem cells and transit-amplifying cells (illustration: Juan Alonso-Serra)

Future plans

Our future research will dissect how water dynamics regulate cambium activity and secondary growth across scales. We will investigate the link between water fluxes and hormonal dynamics in poplar, uncover cambium developmental plasticity through lineage tracing in poplar and Arabidopsis, and test turgor-sensing mechanisms in Arabidopsis for later translation to tree species. In parallel, we will generate a cross-species atlas of hydraulic and molecular responses to water fluctuations in poplar, birch, and Arabidopsis to reveal conserved and species-specific regulatory principles

Group members (2024-2025)

Postdocs: Mariano Lang (UPSC), Jennifer Lopez-Ortiz & Sampo Muranen (University of Helsinki)

Staff scientist: Ema Marmara (University of Helsinki)

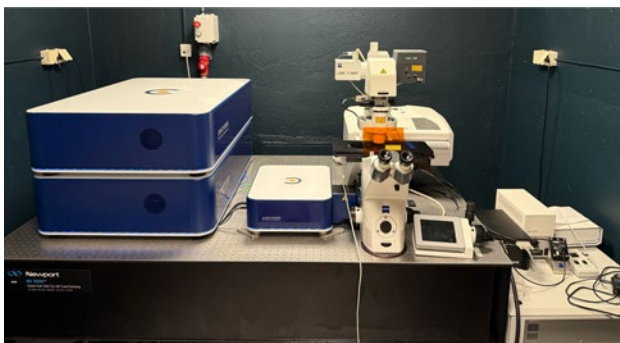
Laura Bacete

UPSC group leader since 2023, Umeå University



Plant Cell Wall Dynamics Research Group

Plant cells must keep their walls strong enough to resist turgor pressure, yet flexible enough to expand and remodel during development and stress. We study the dynamics of plant cell walls that enable cell wall homeostasis, with a focus on cell wall integrity monitoring: how cells sense mechanical and chemical wall cues and adjust growth, defence, and development. We combine genetics, quantitative biophysics, and advanced microscopy to connect wall composition and mechanics with signalling outputs. We work mainly in *Arabidopsis thaliana*, and extend to algae for evolutionary comparisons, to cotton for crop-relevant traits, and to woody plants for secondary growth and biomass properties.



Brillouin microscopy system (photo: Laura Bacete)

Research goal

We aim to define how specific mechanical and chemical wall cues are converted into cellular decisions. We will identify early cell wall integrity (CWI) sensors and transcriptional regulators, test how wall-derived signals gate growth and cell-cycle progression, and establish causal links between defined wall perturbations and downstream molecular responses from the wall to the tissue.

Highlights of 2024-2025

- Three postdocs joined: Demetrio Marcianò (Kempestiftelserna KBC stipend), Bastien Dauphin (Lowski stipend), Nasrin Sabooni (Kempestiftelserna stipend) and Manju Maharjan joined as PhD student.
- Funding (selected): Kempestiftelserna equipment grant for Brillouin microscopy, VR Starting Grant for Watchers on the Wall, Bio4Energy for project on wood mechanics.
- Brillouin module installed on the Zeiss LSM 780 confocal microscope in April 2025, enabling non-destructive mechanical mapping in living tissues and supporting group projects and collaborations.

- PI Laura Bacete was selected to join the Swedish Young Academy for 2025–2030.
- Training: one bachelor thesis completed; 10+ project/bachelor/Erasmus+ students supervised; two master students started in 2025.
- Publications/collaborations: Marcianò et al. 2026; Fernández-Calvo et al. 2024.

Future plans

Overall, our direction is to build an experimental pipeline that enables causal tests of CWI signalling. We are developing controlled perturbation tools, including chemo-optogenetic control of wall-active enzymes, together with minimal systems based on artificial walls and encapsulated protoplasts. In parallel, we will extend these approaches to cotton and woody tissues; and strengthen comparative work across the green lineage, including algae, to test how CWI perception is conserved and how it diversified. We will also build collaborations with groups applying Brillouin microscopy to additional *Arabidopsis* tissues and to other experimental systems.



Laura Bacete with Cell Wall Dynamics lab members in Summer 2025

Group members (2024-2025)

Postdocs: Demetrio Marcianò, Bastien Dauphin, Nasrin Sabooni

PhD students: Klaudia Ordyniak, Manju Maharjan

Students: Hsuan-Han Lu, Maria Goulsouziadou, Nisanur Okuş, Gaia Lucrezia Dalla Pria, Jaime Gazol, Fabian Basso, Jurgi Irurieta Echeveste, Irene Sant, Simina Mihaela Bratu, Sehyeon Kim, Patrik Appelblad, Gianni Claes

Research guest: Nancy Soni

Photo on top: Jan Karlsson

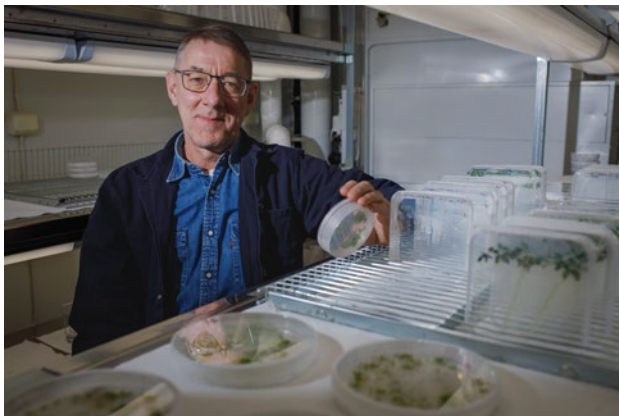


László Bakó

UPSC group leader since 2003, Umeå University

Control of Plant Cell Division and Differentiation

Understanding regeneration at the tissue, organ and whole organism level has long been one of the major interests in the plant field. Regeneration initiates with cellular reprogramming during which cell division is reactivated in differentiated cells. Repeated rounds of cell division give rise to a mass of pluripotent cells that can differentiate into distinct cell types thereby supporting morphogenesis. The liverwort *Marchantia polymorpha* is an emerging model plant regarded not only for its simple life form and non-redundant genome but also for its outstanding regenerative capacity. The cold shock domain protein MpCSP is a single *M. polymorpha* homologue of the Lin28A protein known to have crucial roles in cellular reprogramming and differentiation in animal systems. This project aims to investigate whether the MpCSP protein plays a role in the regeneration of *M. polymorpha* and if so whether manipulation of the expression level, domain and timing of the *MpCSP* gene would enhance or compromise the regeneration capacity of the plant.



László Bakó in the UPSC growth facility (photo: Mattias Pettersson, UMU)

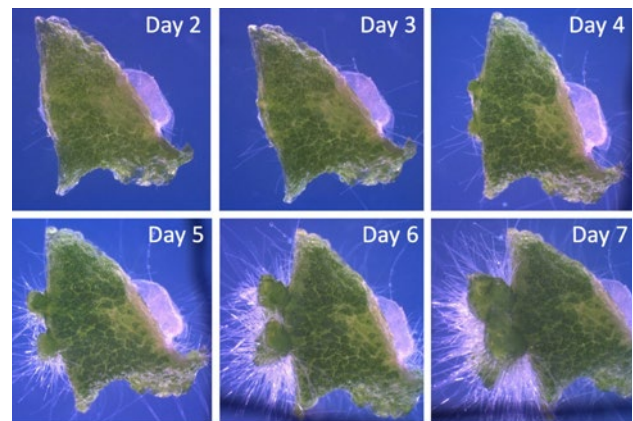
Research goal

Genetic modification of crops and trees as well as clonal propagation of elite lines require efficient regeneration systems. We want to better understand the molecular mechanism underlying regeneration in plants to develop regeneration protocols suitable for recalcitrant plant species.

Highlights of 2024-2025

- We've created transgenic plants for the conditional downregulation of *MpCSP* gene activity as well as lines for constitutive overexpression in distinct cellular domains of *Marchantia* thallus.

- Established a protocol in *M. polymorpha* for Bioorthogonal Noncanonical Amino Acid Tagging (BONCAT) and subsequent CLICK-chemistry based labeling of newly synthesized proteins to study temporal changes of the proteome in regenerating tissues.



Regenerating *Marchantia polymorpha* thallus cuttings (photo: László Bakó)

Future plans

We continue with the proteomics approach aiming to identify MpCSP interactors and assess their role in regeneration. Analysis of knock-down and OEx lines are also planned to test for changes in regeneration capacity. Finally, the BONCAT-CLICK labeling workflow will be pursued to investigate proteome-level changes during regeneration.

Group members (2024-2025)

MSc students: Johan Samuelsson, Victor Engström
Project students: Alina Meiworm, Damien Guignon

Photo on top: Mattias Pettersson, UMU

Catherine Bellini

UPSC group leader since 2002, Umeå University



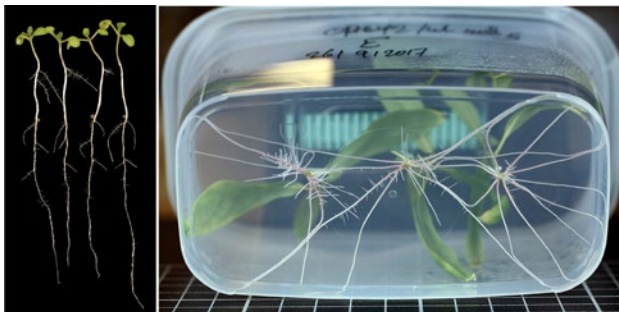
Control of Adventitious Root Initiation

Vegetative propagation through rooting of stem cuttings is economically important for forest trees as it is a cost-effective way to multiply plants from elite clones. Nevertheless, recalcitrance to rooting can result in important economic losses. The development of adventitious roots (AR) is a quantitative genetic trait with high phenotypic plasticity due to multiple endogenous and environmental regulatory factors.

My group made significant progress in identifying molecular networks that control AR development in the model plant *Arabidopsis thaliana*, *Populus*, and conifers.

Research goal

We have identified regulatory genes acting at several levels, including subunits of the COP9 signalosome (CSN) required for protein degradation and genes acting at the crosstalk of auxin, jasmonate and cytokinin signalling pathways. We now plan to further understand the role of these genes in controlling adventitious root development.



Left: *Arabidopsis* etiolated seedlings showing adventitious roots on the hypocotyl (adapted from Gutierrez et al 2009, *Plant Cell*); right: Adventitious roots on in vitro poplar cuttings (photo: Sanaria Alallaq)

Highlights of 2024-2025

- Zeng Y, Verstraeten I, Trinh HK, Lardon R, Schotte S, Olatunji D, Heugebaert T, Stevens C, Quareshy M, Napier R, Nastasi SP, Costa A, De Rybel B, Bellini C, Beeckman T, Vanneste S, Geelen D. Chemical induction of hypocotyl rooting reveals extensive conservation of auxin signalling controlling lateral and adventitious root formation. *New Phytologist* 240 (5) 1883-1899
- Grant from Kempestiftelserna (2024)
- Grant from Carl Trygger Foundation (2024)
- Rosén's Linnaeus Prize in Botany (2025)

Future plans

We have identified two Type B ARR (Arabidopsis Response Regulators) involved in the cytokinin signaling pathway and two WUSCHEL-RELATED HOMEODOMAIN (WOX) genes that play a major role in controlling AR initiation. We are currently characterizing their function.

The COP9 signalosome (CSN) is a highly conserved eight-subunit protein complex required for protein degradation. In several plant species, subunits 5 and 6 are duplicated, leading to 4 distinct CSN complexes, the functions of some of which are unknown. In collaboration with Karina Persson's group (Chemistry Department), we are comparing the structures of the different complexes to determine their functions. We have identified additional proteins that interact with CSN5B outside the hollow complex, which we are currently characterizing.



Catherine Bellini with group members (photo: Stéphanie Robert)

Group members (2024-2025)

Postdocs: Dhruv Agrawal, Samrat Banerjee, Subash Reddy Gaddam, Hiteshwari Sinha
Students: Zahra Rezaeighaleh, Razieh Yazdanpanah

Photo on top: Mattias Pettersson, UMU



Rishikesh Bhalerao

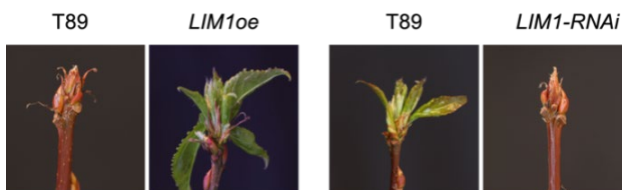
UPSC group leader since 2000, SLU

Environmental Information Processing and Seasonal Adaptation

Trees can live for thousands of years. Consequently trees in boreal regions are faced with extreme changes in their environment with temperatures between +25 in summer to -30°C in the winter and a day length that varies between a few hours in winter to nearly continuous light in the summer.

Research goal

My group is interested in identifying molecular mechanisms that enable trees to robustly time their developmental transitions such as dormancy release and budbreak in response to noisy environmental information such as temperature. Understanding these mechanisms is crucial for devising strategies for breeding trees that are better adapted to future climates.



LIM1 mediates dormancy release and promotes bud break in hybrid aspen trees. Early and late bud-break phenotypes of LIM1^{oe} and LIM1-RNAi plants compared with wild-type (T89) controls (photos: Shashank Pandey)

Highlights of 2024-2025

- Dr. Bhalerao appointed as Wallenberg Scholar.
- Aswin Nair from Bhalerao group published a paper identifying the first temperature sensor ELF3 in trees, crucial for seasonal adaptation, in *Current Biology*.
- Shashank Pandey from Bhalerao group published a paper in *EMBO J*, identifying LIM1, a transcription factor, as a novel mediator of temperature control of cell-cell communication in bud dormancy release.
- Bhalerao group published 12 papers several of which in high impact journals such as *Nature Plants*, *Current Biology*, *Science Advances*, *PNAS*, *Plant Cell*, *EMBO J*.

Future plans

Temperature and photoperiod are two main environmental cues regulating seasonal growth in trees. We have recently discovered a novel role of photoperiod as a gatekeeper in robustly controlling bud break and identified the molecular components mediating this response. This novel control mechanism reveals how buds avoid premature bud break due to the transient, unseasonal warm temperature in

the spring. Uncovering the molecular components that sense photoperiodic signal during bud break is one of the goals of the future work. Additionally, we have uncovered how tree buds robustly time their dormancy release when faced with “noisy” or variable cold signal. This involves previously unrecognized role of warm temperature spikes in dormancy release. Our results indicate that the response to warm spikes is mediated by tree ortholog of florigen component FLOWERING LOCUS T (FT) and its control of plasmodesmatal dynamics. We will focus our future work on identifying the components that mediate temperature control of plasmodesmata in bud dormancy regulation.



Rishikesh Bhalerao in the UPSC greenhouse (photo: Andreas Palmén)

Group members (2024-2025)

Postdocs: Bibek Aryal, Shashank Pandey, Aswin Nair, Abhideep Pal
Guest researcher: Qinsong Yang

Photo on top: Andreas Palmén

Leonard Blaschek

UPSC group leader since 2026, SLU

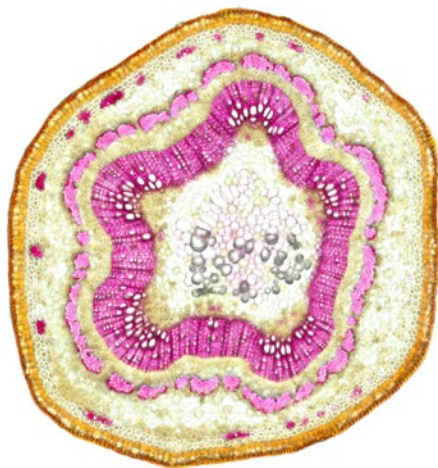


Wood Cell Wall Architecture

Woody cell walls make up roughly half of the biomass on earth. The polymers contained within – cellulose, hemicellulose, lignin – are valuable, renewable resources, while wood itself is a flexible building material. Perhaps most importantly, wood is fundamental to the evolutionary success and physiological robustness of vascular plants. All three of these perspectives are reliant on the mechanisms that control wood formation, in which polymer biochemistry, mechanical properties and physiological roles are inextricably linked. The Wood Cell Wall Architecture group integrates cell wall biochemistry, proteomics, population genomics and cell biology to gain a meaningful, systems-level understanding of these processes that, in the long term, might allow us to breed and engineer forests that are both economically useful and ecologically robust.

Research goal

Wood cell wall formation revolves around the interactions of several chemically distinct polymers. The Wood Cell Wall Architecture group aims to determine how the deposition of these polymers is dynamically coordinated with each other, with a focus on the prerequisites and consequences of spatiotemporally controlled lignification.

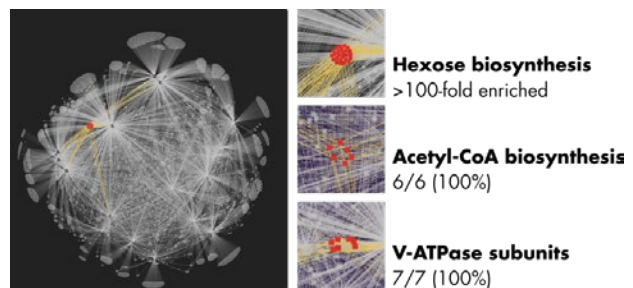


A cross section of a young poplar stem, with lignin stained in purple (photo: Leonard Blaschek)

Highlights of 2024-2025

- The Wood Cell Wall Architecture group opened at UPSC in January 2026, with start-up funding for two postdocs.
- With colleagues in Copenhagen, we published a fully endogenous proximity labeling method to map protein–protein interactions in buried tissues, like wood.

- A collaboration with NTU Singapore showed how a Zinc-finger transcription factor tightly delineates lignification in *Arabidopsis* fruits.
- An *in silico* screen for genetic redundancy, spanning 88 woody and herbaceous proteomes, identified gene families associated with woodiness, which will be experimentally validated in *Populus*.



Protein–protein interaction networks can provide functional information for unknown proteins. (illustration: Leonard Blaschek)

Future plans

We will generate a population of several hundred distinct higher-order populus mutants to identify functions of poorly characterised gene families that are over-represented in woody species. Characterising these will involve the use of fully endogenous proximity-labeling (PUP-IT) in poplar trees, as well as establishing and improving quantitative techniques for *in situ* wood biochemistry (vibrational spectroscopy, MS-imaging and histochemistry). In the medium term, we will extend the use of these techniques to natural populations, aiming to disentangle cell-type-specific polymer deposition in angiosperm and gymnosperm wood.

Group members

Postdocs Aleksandra Liszka and Zawar Hussain will join the lab in the summer of 2026

Photo on top: Don Johnels



Ulrika Egertsdotter

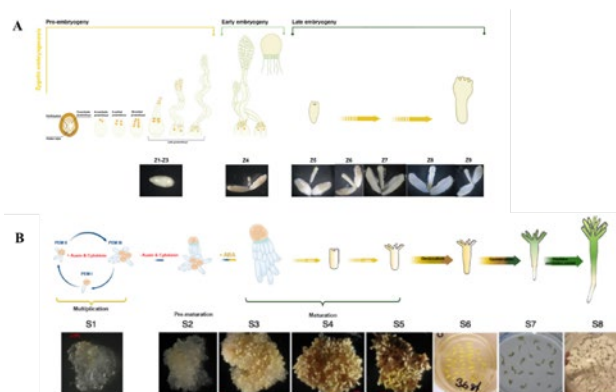
UPSC group leader since 2009, SLU

Conifer Seed Development and Somatic Embryogenesis

Some conifers, such as Norway spruce (*Picea abies*), do not produce seeds annually. The resulting seed shortages for forest regeneration are driving research into the mechanisms controlling seed development and motivates the use of alternative propagation techniques like somatic embryogenesis (SE). SE is an in vitro method to clonally propagate immature zygotic embryos to produce large numbers of identical plants. This technique offers significant advantages for breeding programs: it allows for the early selection by molecular markers and enables automated production of improved plants for affordable, large-scale deployment. We utilize Norway spruce SE as a model system to study embryo development with the goal to understand conifer embryo development and improve SE plant production techniques.

Research goal

My research aims to elucidate the regulatory mechanisms of embryo development in gymnosperms, which exhibit distinct developmental pathways compared to angiosperms. By analyzing the transcriptomic and metabolomic profiles of Norway spruce somatic embryos, we seek to identify the critical regulatory checkpoints essential for successful embryogenesis and further to test our hypothesis by a reverse genetics approach.



Overview of the samples of the embryogenesis developmental series used for transcriptomics and short RNA sequencing from (A) zygotic embryogenesis and (B) somatic embryogenesis. (schematic: Kim Cuong Le; photo ZE: Iftikar Ahmad; photo SE: Sofie Johansson)

Highlights of 2024-2025

- The analysis of the most comprehensive comparison of gene expression during the SE and zygotic embryogenesis (ZE) to date in any conifer was completed. Our findings offer hypotheses for regulatory pathways and suggest

improvements for SE protocols. The results were published in *The Plant Journal* as a Resource paper and presented in an invited keynote at the IUFRO WP 2.09.02

- Short RNAs were also analysed from the same sample set resulting in the most comprehensive view of lincRNAs in Norway spruce and the first study on global identification of lincRNAs during somatic embryogenesis in conifers.
- We are currently wrapping up the interpretation of the results from analyzing the miRNA data associated with the samples from the developmental series above.



The upgraded SE fluidsics system is now in place at UPSC. (photo: Sofie Johansson)

Future plans

The integration of mRNA and miRNA expression data provides compelling insights into the regulatory networks governing conifer embryogenesis. These findings establish a framework for future research; specifically, we intend to validate these miRNA-mediated pathways by utilizing the UPSC spruce transformation platform and conducting bioassays. Additionally, the recently upgraded SE fluidsics system offers a unique possibility to phenotype large numbers of embryos. We will also seek funding to further expand on the system's hyperspectral analytical properties. Opportunities are also emerging to continue the research on the SE initiation process by applying single cell and spatial transcriptomics that would build upon our previous studies where we established laser capture microdissection and gene expression analysis from samples of 100s of cells.

Group members (2024-2025)

Staff scientists: Sofie Johansson, Iftikhar Ahmad, Thomas Dobrenel
Postdoc: Ahsan Ritzvi
Student: Josefine Lind Björs (MSc)

Photo on top: Ulrika Egertsdotter

Maria E. Eriksson

UPSC group leader since 2003, Umeå University



Circadian Clock Function Controlling Growth and Drought Stress Adaptation

The circa 24-h or 'circadian' clock, is a master regulator that coordinates daily and seasonal growth. Light cues perceived by red/far-red and blue light photoreceptors regulate daily and seasonal growth by acting via a set of plant hormones e.g. auxins, cytokinins and gibberellins (GAs). For instance my work has shown that GAs are instrumental for height and diameter growth of hybrid aspen, as well as length of xylem fibres. The circadian clock affects such daily rhythms of hormonally controlled growth. As trees receive short days below a certain threshold they stop growth in a way coordinated by the circadian clock, with decreased levels of GAs allowing buds to form as a preparation for achieving hardy, frost-tolerant buds and trees. We expanded our work to Norway spruce, and their seasonal growth showing the circadian clock may play a prominent role in spring growth.

Recent work has shown that trees having changes in the circadian clock system are able to modulate growth also in the field (figure 1), in a way corresponding to changes obtained in the critical daylength sensing. This makes this system a very important target for obtaining climate adapted trees by future breeding approaches.

Moreover, we were also able to show that salt stress responses in hybrid aspen roots are dependent on regulation by circadian clock components, affecting cell cycle gene expression. Together with the role of the circadian system previously characterized in drought stress of leaves it shows the pivotal role of this system in mitigating various stressors in trees and further underlines the potential of circadian clock components as breeding targets for stress-proofing of trees and securing growth.



View of the field site in Halland where our tree trials were conducted (photo: Maria E. Eriksson).

Research goal

Our work aims to better understand the molecular mechanism, metabolism and physiology of tree growth. We incorporate field trials with trees having altered

photoreception, clock and hormone metabolism to understand tree growth in daily and yearly events. Such knowledge is crucial to find better ways of monitoring, reading and catering for trees using circadian clock knowledge or 'chronosilviculture'. Our work will ease decoding and modelling of responses of trees, forests and global systems under changing climates.



Maria E. Eriksson with group members

Highlights of 2024-2025

- Publications: Ibáñez et al. 2025, Mariën et al. 2025, Donev et al. 2025 and Lázaro-Gimeno et al. 2024.
- My longstanding collaboration in Chile at the Universidad de Concepción led me to plan a workshop on plant resilience research at the Chile-Sweden. ACCESS Forum, that I then co-hosted in January 2026.
- I have engaged in several outreach activities, for instance at P4 Västerbotten, TV4, and Umeå University 'Vetenskapslunch'.
- Johan Sjölander successfully defended his PhD thesis.

Future plans

Organisms adapted to conditions such as those in the Arctic are predicted to face large, abrupt climate changes in future climate scenarios. We will further explore the mechanisms of circadian clock regulation of stomata under different stressors, as well as hormonal coordination of growth under controlled and natural conditions.

Group members (2024-2025)

Postdocs: Bertold Mariën, Haris Ali Khan

PhD student: Johan Sjölander

Student: Selma Skoglund

Photo on top: Happy Wilder

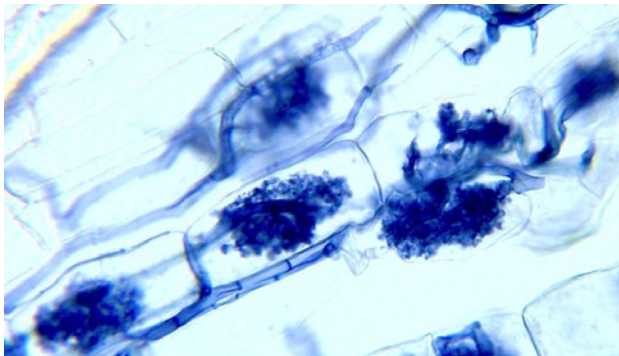


Adam Frew

UPSC group leader since 2026, Umeå University

Mycorrhizal Ecology and Plant Performance

The first terrestrial plants relied on mycorrhizal fungi, and most plants still do today. Mycorrhizal fungi are plant symbionts that play a central role in plant nutrition, stress tolerance, and ecosystem functioning. My research has focused particularly on arbuscular mycorrhizal (AM) fungi, which associate with the majority plant species worldwide. Using DNA metabarcoding, field-based biogeographic surveys, and manipulative experiments, I study how fungal communities assemble across environments, how plants select among potential fungal partners, and when these interactions translate into meaningful benefits for plant growth, nutrient acquisition, and defence.



Microscopy image showing structures of mycorrhizal fungi inside the cells of a plant root (image: Manjeet)

Research goal

My goal is to understand when, where, and how mycorrhizal fungi affect plant performance. I aim to identify how mycorrhizal fungal communities assemble across environments and within plant roots, how plants select among potential partners, and how these interactions influence plant nutrition, defence, and resilience. This work seeks to understand what determines the diversity, distribution, and function of mycorrhizal fungi, enabling prediction and informed ecosystem management.

Highlights of 2024-2025

- I was recruited as a group leader at UPSC in 2025, starting in 2026.
- We launched the national database of arbuscular mycorrhizal fungal diversity data in Australia (AusAMF), an updatable resource with online interface (www.ausamf.com) currently including data from an initial 610 sites (Frew et al. in *Global Ecology and Biogeography*, 2025).
- We showed the importance of plant identity in determining the assembly of mycorrhizal fungal

communities in roots, and how this can influence the fungal effects on their host plants (Frew et al. in *Microbial Ecology*, 2024).

- We developed a hypothetical framework with two alternate mechanistic hypotheses behind fungal community assembly in roots, proposing a potential role for plant defence signalling in plant selection of fungal symbionts (Frew et al. in the *ISME Journal*, 2024).



Image showing collaborators during field work in remote Western Australia (photo: Adam Frew)

Future plans

We will expand large-scale sampling and DNA sequencing of mycorrhizal fungi across forest ecosystems to better resolve their diversity and biogeography. At the same time, we aim to optimise molecular and analytical approaches to improve how this diversity is captured and interpreted. Another focus is to quantify how the effects of AM fungi on host plants vary among taxa, and to test if this variation shows consistent phylogenetic patterns.

Group members (2024-2025)

I joined UPSC in the beginning of 2026 and I am still in the process of recruiting my co-workers. Below I list those I worked with at the Hakwesbury Institute for the Environment, Western Sydney University, Australia.

Postdoc: Emi Stuart (co-supervision)

PhD students: Meike Katharina Heuck, Bhavesh and co-supervision of Jiahao Wen, Solomon Maerowitz-McMahan, Jay Delves, Ramalka Kasige, Anoban Karunanathan

Student: Manjeet

Guest researchers: Yuxiong Zheng, Zhenyu Wang, Yanrong Fu

Photo on top: David Martinelli

M. Rosario García Gil

UPSC group leader since 2004, SLU



Forest Tree Landscape Genetics

My main research interests are forest adaptation, phyllosphere biodiversity, and nature-based forest management practices, which I address by leveraging synergies between quantitative and population genetics, physiology, wood biology, genomics, transcriptomics, molecular biology, mathematics, and, more recently, metabolomics and remote sensing (digital forest). My research has made significant contributions to understanding the genetic basis of local adaptation in conifer species.

Research goal

To investigate the genetic foundations of boreal conifer trees' local adaptation as a means to develop nature-based forest management practices. These practices aim to preserve the forest's ability to adapt and evolve, while also safeguarding the biodiversity it supports.

Highlights of 2024-2025

- Grant: Kempestiftelserna "Assessment of Breeding Impact on Endophytic Fungal Diversity"
- Grant: WIFORCE PhD "Genetic Modeling to Accelerate Drought Adaptation in Conifers"
- Grant: SLU Forest Damage Center "Genetics of Adaptive Responses to Drought in Conifers"
- Grant: SNS Network "Minor Trees, Major Gains: A Collaborative Breeding Network"
- Vice chair of the SLU breeding network since 2022
- Board member of Evoltree (evolutionary genetics) since 2023
- Reviewer of SSF industrial PhD programme
- Eight peer reviewed articles

Future plans

To develop a digitalized model for landscape genetics to improve seed orchard efficiency, accelerate superior tree selection and guide deployment. To advance our understanding on boreal tree local adaptation and the implications on ecosystem resilience. To support with knowledge and tools the development of nature-based forest management practices that protect forest adaptability and associated phyllosphere biodiversity.



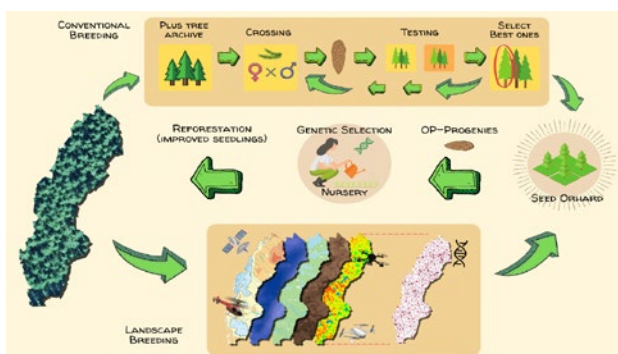
SSF Landscape breeding team with M. Rosario García Gil to the right

Group members (2024-2025)

Staff scientist: Sonali Sachin Ranade

Postdocs: Haleh Hayatgheibi, Edgar Sánchez

PhD students: Annica Nordström, Clara Cuesta Turull



Overview of SSF project in landscape breeding (illustration: Juha Niemi)

Photo on top: Juha Niemi

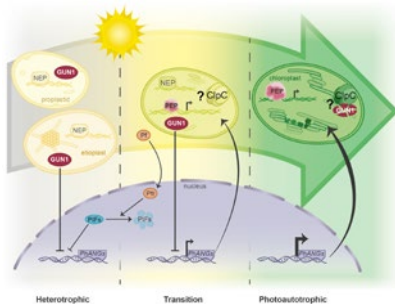


Johannes Hanson

UPSC group leader since 2011, Umeå University

Translational Control of Gene Expression in Response to Environmental Cues

When the environment of the plant changes, the physiology of plant cells changes to better fit the new conditions. Gene expression changes are central to this process. Traditionally, the focus has been on transcriptional control and mRNA levels in the cell. However, recent data have made it clear that mRNA translational efficiency varies between transcripts and can be altered in response to changes in conditions. We therefore focus our work on the regulation of translation. We have been developing the tools to study translational efficiency of all mRNAs, we can now show that thousands of mRNAs are translationally regulated in response to various environmental or developmental changes.



The location of each translating ribosome in the sample can be determined by digesting all parts of the mRNA not protected by ribosomes and sequencing the protected fragments. Translational efficiency (TE) is determined by comparing the sequencing result from isolation of ribosome protected fragments (Ribo-Seq) with that of total cellular RNA (illustration: Sara Häggström).

Research goal

We want to characterize and understand how the plant dynamically regulate its translation of individual mRNAs. We currently think that the more than six-hundred yet uncharacterised mRNA binding proteins of the Arabidopsis genome are playing a huge role. We use model transcript with clear and defined regulatory patterns and dissect their regulatory mechanism using biochemical, molecular, and genetic tools.

Highlights of 2024-2025

- Our sustained efforts to establish molecular techniques for studying translation globally have been successful. Amir and Sara have established the lab as a centre for Ribo-Seq and ribosomal profiling, and we have now

performed Ribo-Seq from Arabidopsis, spruce, poplar, lupin, tobacco, and *E. coli*.

- Sara, Amir and Dhriti have identified mRNAs translationally regulated by the TOR signaling pathway. In addition, they have characterized a regulatory element in the 5' end of the mRNA, crucial for the regulatory mechanism.
- We have identified translationally regulated mRNA throughout different phases of seed and bud development. Some mRNAs are very stable and are kept intact during seed dormancy to be translated immediately after dormancy release, often even before transcriptional activation, in contrast to the general belief of mRNAs as being labile intermediates.

Future plans

By using Ribo-Seq and other techniques, we have identified several mRNAs that are translationally regulated in response to environmental or developmental cellular changes. Most of our current projects focus on characterizing the molecular mechanisms underlying the translational regulation of individual mRNAs. We also continue to optimize Ribo-Seq methodology, on the bioinformatic analytical level as well as in the laboratory.



Johannes Hanson with group members

Group members (2024-2025)

Staff scientist: Amir Mahboubi

Postdocs: Dhriti Singh, Dhruva Khakurel and Manvi Sharma

PhD student: Sara Häggström

Students: Vanja Zoric and Hanna Wickström

Guest researchers: Reyes Benlloch-Ortiz, Irene Moreno, Ruben Casatejada Anchel, Atefeh Farvardin, Anders Hafrén, Aimer Gutierrez Diaz and Ganeshwari Dhurve.

Photo on top: Mattias Pettersson, UMU

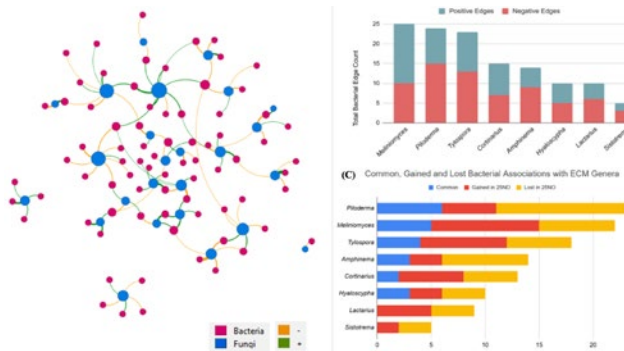
Vaughan Hurry

UPSC group leader since 1999, SLU



Plant Adaptation to Sub-Optimal Environments

In the boreal and nemoboreal zones that make up Sweden's forest estate, ongoing climate change is increasing the exposure of plant communities to biotic and abiotic stresses. Key climate drivers include: 1) increasing atmospheric temperatures are altering the timing of spring growth initiation and autumn growth cessation, leading to increased growth opportunities for plants but also exposing them to increased risk of mis-timing acclimation and deacclimation for winter freezing; 2) increasing temperatures increases the risk to plant communities from changing rainfall patterns and drought. An additional and poorly understood factor in these plant-environment responses is the role of the plant-associated microbiomes. How the different components of these complex plant communities respond to these stressors will determine the long-term stability of these ecosystems.



Root Ectomycorrhizal (ECM)-Bacterial Association Networks. (A) Cross-domain network representing associations between ECM fungi and bacteria in Flakaliden root samples. (B) Bar chart illustrating the distribution of positive (cooperative) and negative (competitive) edges across key ECM genera with bacterial partners. (C) Comparison of network dynamics under fertilization, highlighting ECM-bacterial associations that are retained (common), newly formed (gained) or severed (lost) as compared to control. The results demonstrate a significant restructuring of microbial partnerships in response to nutrient enrichment. (Credit: Kanchan Vishwakarma)

Research goal

Our goals are to understand how Scots pine and Norway spruce respond to changes in their thermal environment and to changes in water availability; and determine whether there is genetic variability in these responses within these species that can be captured into breeding programs. We also want to understand the complex relationship between forest trees and their associated microbiome, especially in the soil, to determine the role these relationships have in increasing the resilience of the forest to environmental change.

Highlights of 2024-2025

- As a compliment to earlier studies on drought and cold responses of Norway spruce needles and roots, we have established complimentary experiments in Scots pine to determine whether there are common regulatory hubs both between species and between stresses.
- Using a breeding population of Norway spruce, we have established that there is genetic variation in basal (non-acclimated) tolerance to freeze injury in developing spring buds and that this is a heritable trait, opening possibilities to select for early season tolerance to compensate for advancing spring phenology.
- Using our established protocols for studying coordinated gene expression of Norway spruce roots and the linked ectomycorrhizal fungal species – we have taken advantage of the new Scots pine genome to compliment the Spruce data set with a comprehensive seasonal transcriptome response from a matching Scots pine forest to establish whether there are common, robust host-microbiome relationships supporting forest function.
- Utilizing the accumulated microbiome datasets we have generated, we have initiated studies into mycorrhiza-bacteria interactions to see whether we can identify conserved, and possibly beneficial, interactions within these complex communities that hold up across soil types and host tree species.

Future plans

We will continue this two-pronged approach of studying how forests respond to climate challenges. First identifying the responses of individual trees and the responses of tree populations to key abiotic stressors with the aim of aiding ongoing tree breeding programs; and second, to understand the consequences of plant stress responses not only for tree growth, but also the consequences of altered tree vitality for the link microbiomes, and effects this interplay has on biodiversity and forest resilience.

Group members (2024-2025)

Staff Scientist: Kanchan Vishwakarma
Postdocs: David Castro, Huibin Wang
PhD student: Tuuli Aro

Photo on top: Mattias Pettersson, UMU



Stefan Jansson

UPSC group leader since 1999, Umeå University

Regulation of the photosynthetic light reaction in trees

Almost everything we know about regulation of the photosynthetic light reaction comes from studies of *Arabidopsis* lines where key proteins – for example PsbS, violaxanthin de-epoxidase (VDE), zeaxanthin epoxidase (ZE), chlorophyll a oxidase (CAO), Stn7, Stn8, Pgr5 or different LHC subunits – have been knocked out or upregulated. Moreover, almost all these studies have been performed on plants grown under controlled and constant conditions, typically at light intensities less than 10 % of natural sunlight. With very few exceptions, mutants for these key proteins have not been generated in other species than *Arabidopsis*, let alone been analysed under conditions that has any resemblance to natural conditions, where evolution/selection has acted. Another question that so far never have been address is how these processes are regulated in trees with lifecycle and canopy very different from *Arabidopsis*. To fill this knowledge gap we systematically use CRISPR to generate aspen mutants lacking the key proteins mentioned above (for some proteins also overexpression lines) and analyse them, grown in growth chambers, in the phenotyping platform or in field experiments, using advanced equipment. We also analyse the thylakoid grana structure and perform structural studies of photosynthetic complexes. The same setup is also used to analyse natural aspen ecotypes (the SwAsp collection), grown in the field or in the phenotyping platform, to understand the natural variation of these traits,



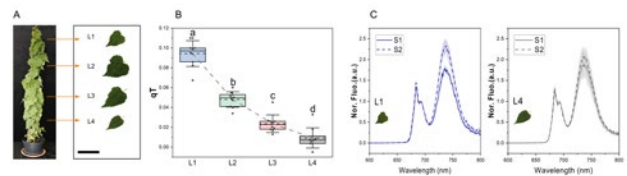
Photosynthetic measurements on aspen mutants in the field (photo: Maximiliano Canizos)

Research goal

Our goals are to understand the general mechanisms regulating photosynthesis traits in trees. But in addition, we are also trying to improve photosynthesis and plant growth using biotechnology.

Highlights of 2024-2025

- We have summarized the studies in our – and other – labs on how the photosynthetic apparatus of evergreen conifers is designed to be able to withstand the harsh boreal winter conditions (Bag et al., 2025).
- We have exploited the possibilities of a novel advanced instrument (Chlorospec) for studies of photosynthetic regulation. (Nanda et al., 2024).



Vertical variation in state transitions capacity is greenhouse-grown aspen. (A) Representative image tree of a T89 tree and leaves from different vertical layers (L1–L4) (B) State transitions levels across layers, (C) 77 K chlorophyll fluorescence emission spectra from thylakoids of L1 and L4. From Hu et al (submitted)

Future Plans

We want to complete the analysis of all our aspen photosynthesis mutants lines. We also hope to use knowledge on photosynthesis to create trees that grow better, for example for bioenergy plantations.

Group members (2024-2025)

Staff scientists: Kathryn Robinson, Tatyana Shutova, Jenna Lihavainen

Postdocs: Nazeer Fataftah, Maximiliano Canizos, Chen Hu, Dolores Pissolato

PhD student: Sanchali Nanda

Olivier Keech

UPSC group leader since 2014, Umeå University

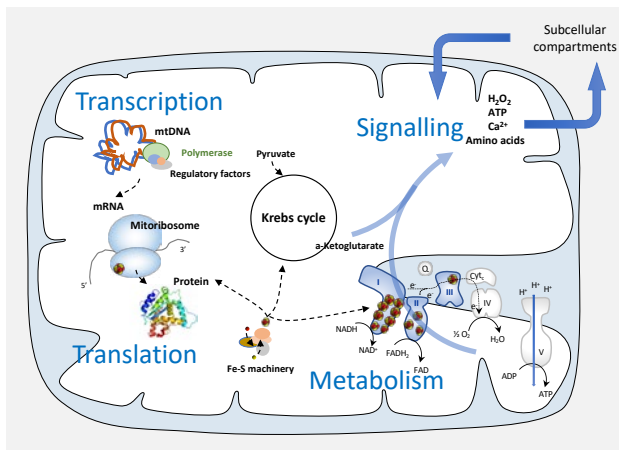


Metabolic Regulations in Response to Stress

Plants are constantly subject to multiple stresses, and years of evolution have tailored them to adapt to many environmental cues such as drought, salinity or low nutrient availability. Yet, many molecular aspects of this adaptation remain unclear. For instance, when a stress is applied, a plant has the possibility to sacrifice certain organs to support the survival of the entire organism. How is this choice made? And can it be used for breeding and biotechnological improvements with the aim to prolong life span of crops and trees in response to severe stress episodes as we will likely face with a fast changing climate? These are the questions we are addressing in my lab by using a multi-disciplinary approach combining genetics, biochemistry, molecular biology, bioinformatics and physiology.

Research goal

Our research explores several aspects of the regulation of plant metabolism in response to stress, with a particular emphasis on mitochondrial metabolism. We have identified key regulators controlling cell death in response to stress, and we are now investigating the different molecular regulations conferring this incredible ability for survival.



Mitochondrial metabolic functions essential for growth and stress response (illustration: Olivier Keech)

Highlights of 2024-2025

- We have successfully isolated mitochondria from mature pollen grains and discovered that the transcription and translation machineries were absent (Boussardon et al, 2025).
- We (with SweTree Technologies) filed a patent for improved drought tolerance and recovery in plants: SE 2450567-9 WO2025244573A1.

- Recipient of several large grants to carry out R&D on land-based multi-trophic farming.

Future plans

We will follow our investigations on several unknown mitochondrial proteins, involved in stress resistance or Fe-S clusters assembly. In addition, we will try to decipher the molecular mechanisms behind a novel regulatory loop pacing the progression of leaf senescence. Several field experiments are also scheduled to test the benefit of such biotechnological improvements.

We will continue to develop our R&D project for sustainable food farming, notably by researching better feed production from organic wastes.



In an applied research project, Olivier Keech aims to develop sustainable methods of producing shrimp and fish in circular aquaculture systems (photo: Sergio Zimmermann)

Group members (2024-2025)

Staff scientist: Clément Boussardon
Postdocs: Marta Juvany, Shah Hussain
Student: Joaquin Fernandez



Peter Kindgren

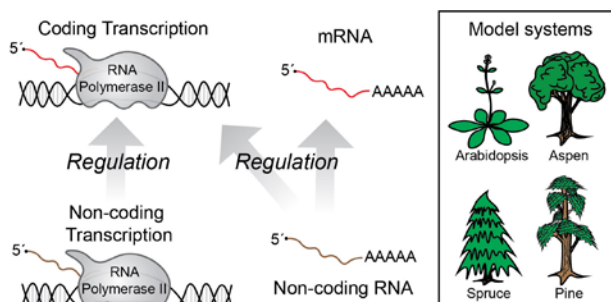
UPSC group leader since 2020, SLU

Coding versus Non-Coding Transcription in Plants

The DNA is the blue-print for how a living organism should develop and respond to different environmental cues. It does so by activating and repressing coding regions of the genome. Surprisingly, most of the DNA in genomes do not encode for proteins but is non-coding. With the development of new sequencing technologies, it is apparent that much of this non-coding DNA is transcribed into RNA. A key question in modern biology is therefore why organisms spend so much energy to transcribe something that is not used as template for protein synthesis. We use Arabidopsis, aspen, pine, and spruce to bridge the knowledge gap we have today of how non-coding transcription regulate coding transcription.

Research goal

My research group tries to find and characterise the functions for transcription of long non-coding RNAs, especially those that occur on the complementary strand of coding genes. We have a special interest in how plant responds to cold temperatures and how the coding transcriptional output is determined by the crosstalk of non-coding transcription and the transcription machinery itself.



In the research group, we are working on four model systems: Arabidopsis, aspen, spruce, and pine. Our interest concerns transcription, how RNA is synthesized from genomic DNA. Our primary aim is to understand of non-coding transcription and its role of regulating the level coding messenger RNA during stress conditions for the plant (illustration: Peter Kindgren).

Highlights of 2024-2025

- Publications in Plant Cell (Kumar Meena et al., 2024), Molecular Plant (Zackaraki et al., 2025) and EMBO Reports (Rosenkranz et al., 2025) that establish the role of antisense transcription in the stress response of plants.
- Grant from Novo Nordisk Foundation.
- Grant from Swedish Research Council.

Future plans

The group is now established in the field of Transcription. The coming years, we will focus on how Transcription is regulated in Norway spruce and Scots pine (a WIFORCE PhD student will start in the group during 2026). In Arabidopsis, we will gain mechanistic insight of the direct effect of non-coding transcription and how that influences transcription dynamics, the chromatin environment and the overall stress response in plants. In addition, we will do more applied research and try to manipulate the levels of non-coding transcripts in crops to make them produce more biomass.



Peter Kindgren with group members and son (photo: Jeky Chanwala)

Group members (2024-2025)

Postdocs: Mishaneh Asgari, Sarah Mermet, Kim Lühmann, Jeky Chanwala, Samantha The
The PhD student: Isabell Rosenkranz
Student: Mattias Svensson





In vitro room at the UPSC Poplar Transgenics Facility (photo: Samuel Pettersson)

Karin Ljung

UPSC group leader since 2005, SLU

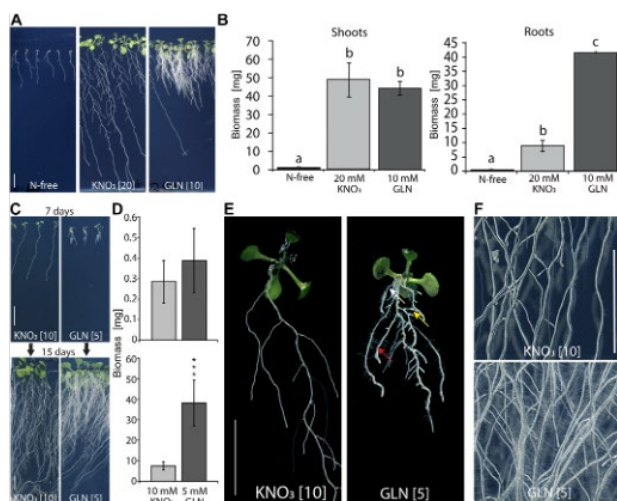


Root Development and Shoot-Root Communication

Plants coordinate growth and development using external and internal signals to cope with different growth conditions and environmental constraints. Plant hormones are essential throughout the whole life cycle of higher plants. They play pivotal roles in key growth and developmental processes, and they are central to coordinate responses to different environmental variables. In my group, we are studying plant hormone metabolism, transport and signaling, how these processes are regulated by internal and external signals, and how they influence primary and secondary root development.

Research goal

My research is focused on mechanisms regulating plant growth and development, especially root development. We are particularly interested in the roles played by the plant hormones auxin and cytokinin in the developmental processes that lead to the formation of the root system, as well as their roles in the integrative coordination of root and shoot growth.



L-Glutamine (GLN) modulates root architecture and hormonal balance in Arabidopsis. Figure adapted from Pařízková et al., 2025. *Physiologia Plantarum* DOI:10.1111/ppl.70723.

Highlights of 2024-2025

- We have continued to develop Fluorescence-Activated Cell and multi-Organelle Sorting (FACS/FAmOS) for transcript and metabolite profiling of root cells and their organelles.
- We have established a method for identification of mutants with perturbations in auxin metabolism. (Casanova-Sáez et al., 2025 in *Physiologia Plantarum*).

- We have, together with researchers in USA and the Czech Republic, shown which metabolic pathways that are indispensable for auxin biosynthesis (Fenech et al., 2025 in *Plant Cell*).
- We have shown that the amino acid glutamine modulates lateral root initiation and development (Pařízková et al., 2025 in *Physiologia Plantarum*), and we are currently investigating the mechanisms behind these changes in root architecture.

Future plans

Our focus during the coming years will be to better understand the processes that regulate lateral root initiation and development. We are especially interested in the roles that different sources of nitrogen play during these processes.



Karin Ljung with group members (photo: Stéphanie Robert)

Group members (2024-2025)

Staff scientist: Ioanna Antoniadis

Postdocs: Barbara Pařízková, Vladimír Skalický

Students: Charikleia Nicolaou, Evangelia Sperantza, Ishil Nihat

Guest researchers: Ondřej Novák, Karel Doležal, Jakub Lemberk

Photo on top: Elisabeth Ohlson Wallin



Jian-Feng Mao

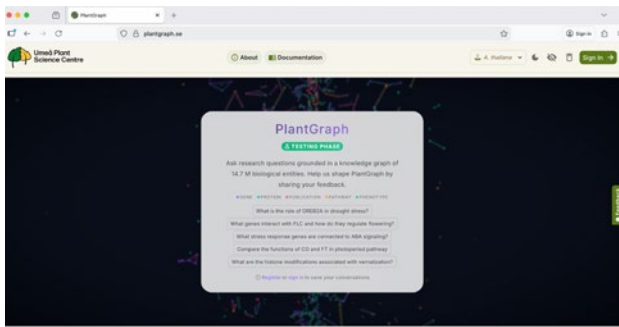
UPSC group leader since 2023, Umeå University

Plant Genomics

The integration of genomics, multi-omics, and computational biology is crucial for contemporary biological breakthroughs. Advanced computation, particularly in artificial intelligence (AI), is transforming the analysis of complex biological datasets, enabling rapid, precise insights that drive research and therapeutic innovations. Our focus is to devise and implement computationally efficient methodologies for dissecting biological intricacies, including data integration, genome annotation, transposon dynamics, gene expression patterns etcetera.

Research goal

Our research aims to pioneer computational approaches for genome and data-intensive analysis by harnessing AI and other efficient computational techniques. We are dedicated to overcoming the complexities of vast genomes, such as those of conifers. Our objectives include generating domain-specific AI agent for plant biology, identifying transposons and long non-coding RNAs (lncRNAs), and advancing genomic prediction. Additionally, we aspire to unravel the genetic underpinnings of heterosis, exemplified in hybrid poplars, through the lens of allele-specific gene expression.

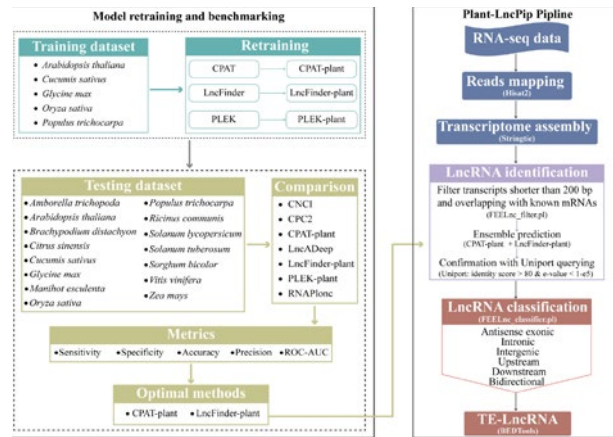


PlantGraph, an AI agent for plant biology (administrator: Estaj Ehsan)

Highlights of 2024-2025

- We are developing an AI agent for plant biology (available at: <https://plantgraph.se/>), by integrating extensive functional datasets, but not solely texts from scientific papers, which thus provides trustworthy multi-hop assistance with reliable deep reasoning in plant biology. Our goal is to evolve PlantGraph from currently Arabidopsis-centric to a pan-plant platform, accelerating discoveries both in sustainable agriculture and forestry and ecosystem resilience.

- We generated a computational pipeline (<https://github.com/xuechantian/Plant-LncRNA-pipeline>; <https://github.com/xuechantian/PlantLncBoost>) in plant lncRNA identification by providing significant improvement (Tian et al., 2024; 2025).
- We generated a computation pipeline (https://github.com/shitianle77/Allele_auto) to identify allele pairs from haplotype-resolved genome assembly and to automate allelic differential gene expression analysis. (Shi et al., 2024).
- We generated a deep-learning driven method (https://github.com/morningsun77/ltr_checker) to identify LTR retrotransposon from genome assembly. This method brings fast speed and high accuracy, runs efficiently for conifer large genomes. (Chen et al., under review).



Workflow of the lncRNA identification pipeline (illustration: Xue-Chan Tian)

Future plans

We aim to harness AI-driven modelling and graph database technologies to develop efficient tools for transposon identification from genome sequence, and to establish a new computational platform for population genomics computation.

Our objective extends to enhancing our just-developed pipelines for broader applicability and disseminating our advancements through publication.

Group members (2024-2025)

PhD students: Shi-Wei Zhao, Zhao-Yang Chen

Postdoc: Ehsan Estaji

Photo on top: Mattias Pettersson

Petra Marhava

UPSC group leader between 2022- 2025, SLU

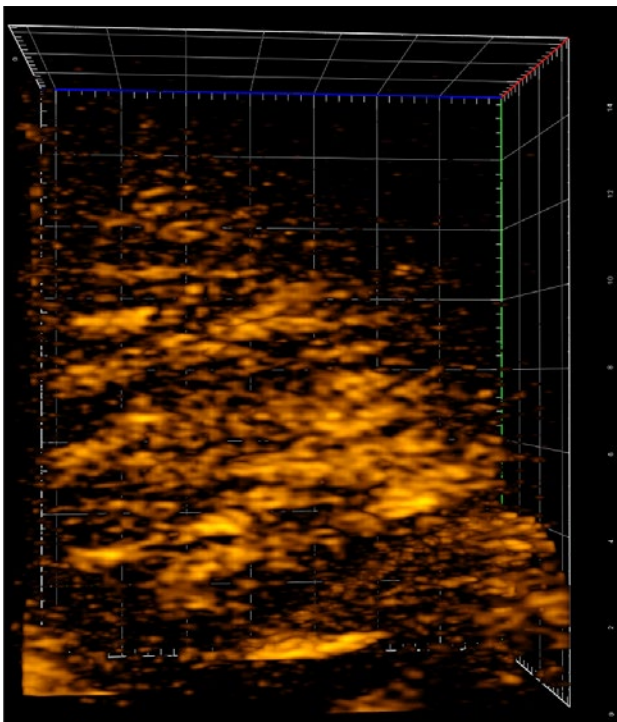


Plant Acclimation to Heat and Cold Stress

Our planet is warming, and extreme-weather events such as sudden heat waves or cold waves will only become more frequent. Unlike animals, plants are sedentary organisms and cannot run away from adverse environmental conditions. Consequently, they have developed sophisticated signaling and protective mechanisms to cope with sub-lethal stress situations. While most studies to date have primarily focused on broader aspects of plant responses to climate change (such as biomass), future research needs to focus on molecular and cellular responses to improve our mechanistic understanding of plant acclimation and adaptation to heat and cold stress.

Research goal

The plasma membrane is a primary target of environmental stress, and maintaining its integrity and fluidity is essential for plant survival. Temperature changes directly affect membrane fluidity and can lead to the reorganization of membrane microdomains, influencing the localization and activity of membrane-associated proteins. Our aim is to uncover the links between phosphorylation events, translational regulation, and temperature-induced changes in membrane fluidity, and to understand how these processes together regulate the dynamics of hormonal transport in response to temperature stress.



The PIN2 protein exhibits a clustered (unequal) localization on the plasma membrane (image: Jasim Basheer)

Highlights of 2024-2025

- Member of the organizing team - international Auxentric (auxin) Symposium, Umeå, Sweden; and UPSC Early Career Researcher Symposium (international), Umeå, Sweden.
- We established the collaboration with Johannes Hanson (UMU, Sweden) and Jenny Russinova (PSB-VIB, Belgium).
- Invited speaker: The 25th International Plant Growth Substances Association (IPGSA), Colorado, USA; Symposium, Conference, The 30th SPPS Congress, Copenhagen, Denmark; Mendel Early Career Symposium, GMI, Vienna, Austria; as well as departmental seminar at CEITEC, Masaryk University, Czechia.
- Guest Editor the Special issue of *Physiologia Plantarum* "A to Z of Auxin".
- Award: SPPS Early Career Prize – award to an early career scientist based in Nordic country.

Future plans

We aim to further investigate plant responses to temperature stress, with a particular focus on how changes in plasma membrane fluidity influence active auxin transport mediated by its transporters. In addition, we seek to characterize the root cell-type-specific transcriptome to identify regulatory mechanisms that control protein synthesis during temperature stress. To complement this approach, we are conducting a chemical genomic screen to uncover novel molecular players involved in temperature stress signaling pathways. Furthermore, we plan to explore how the combination of heat and drought stress influences plasma membrane properties. Investigating how plants integrate these contrasting physical constraints will provide new insights into the mechanisms that coordinate membrane remodeling and stress adaptation.

Group members (2024-2025)

Postdocs: Jasim Basheer, Ling Cheng, Manvi Sharma, Dhruva Khakurel

Students: Romane Leclair (France), Elliot From Heikkila (UMU), Viktorie Hromkova (Czech Republic)

Photo on top: Andreas Palmén



Peter Marhavý

UPSC group leader between 2020-2025, SLU

Short Distance Communication in Responses to Wound Stress

Plants possess the remarkable ability to detect various stress factors, whether they be biotic, abiotic, or physical, and to activate specific signalling pathways in response. While much attention has been devoted to understanding the signals that trigger defensive responses in plants, the precise processes through which cells perceive these signals and transmit them to neighbouring cells remain largely elusive.

Research goal

Our investigation aims to shed light on the molecular mechanisms governing intercellular communication, focusing on the initial responses to root damage in plants. Through our research, we aim to enhance our understanding of how plants coordinate their defensive and regenerative strategies at the cellular level. Additionally, we aim to explore how minimal damage in one plant can elicit a response from neighbouring, uninjured plants, unravelling the intricacies of plant-to-plant communication.



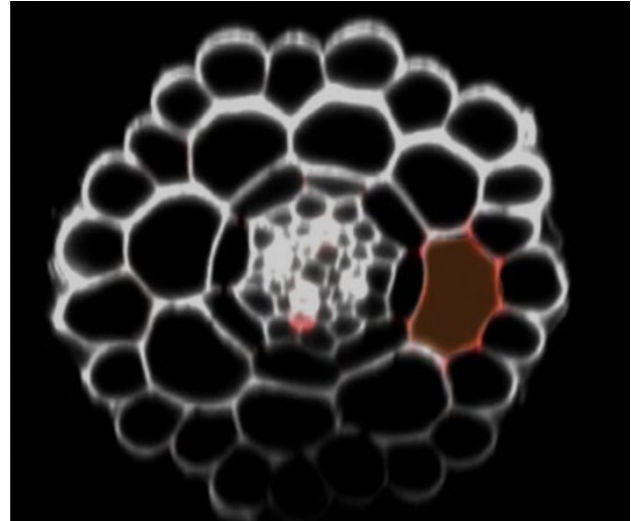
Nematodes in pink (image: Peter Marhavý)

Highlights of 2024-2025

- We published a research article focused on cell wall property that is important during wound induced regeneration. (Di Fino et al., 2025).
- We published a research article with focus hormonal regulations responses to single cell damage. (Ma et al., 2025).

Future plans

We will be expanding our efforts in the field of plant single-cell wound damage research. Our goal is to develop comprehensive mechanistic models that elucidate the intricate responses of plants to wounds. These models have the potential to significantly bolster the capacity of plants to regenerate and defend themselves, especially amidst the ongoing global climate crises. By deepening our understanding of how plants respond to wound at the cellular level, we aim to contribute to the development of strategies that can enhance their resilience and survival in challenging environmental conditions.



Cross section of Arabidopsis root showing single cell damage in red (image: Peter Marhavý)

Group members (2024-2025)

Postdocs: Xuemin Ma, Luciano Martin Di Fino, Nagenna Zhahid, Muhammad Anjam, Andriani Mentzelopoulou
PhD student: Julie Guerreiro

Photo on top: Fredrik Larsson

Susan McEvoy

UPSC group leader since 2025, SLU

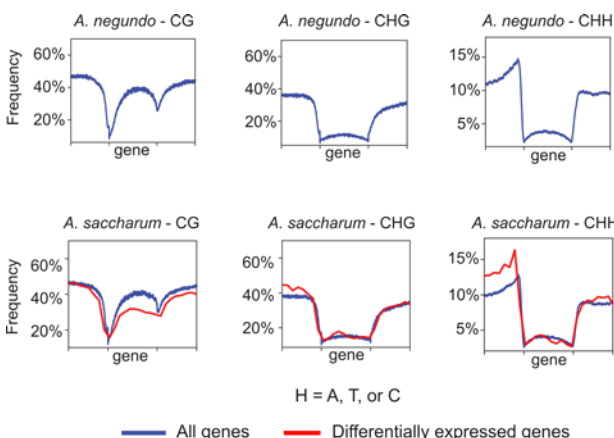


Forest tree genomics: evolution, diversity and adaptation

My research group studies genetic diversity and adaptation within conifer species and other plants. Genetic diversity provides the foundation for adaptation to a changing environment. Compared with many angiosperm trees, gymnosperms such as conifers are relatively slow-growing organisms, resulting in slower rates of adaptation in populations now facing numerous challenges, many of which are expected to increase as climate change progresses. These challenges are often complex; for example, the increasing prevalence of drought stress has led to greater susceptibility to other stressors such as pests and pathogens, and this trend has been reported in many plant species world-wide. Given the uncertain timing, magnitude, and nature of future environmental changes, integrating genetics into our understanding and decision-making for forest trees is essential to support resilient forest ecosystems and resources long into the future.

Research goal

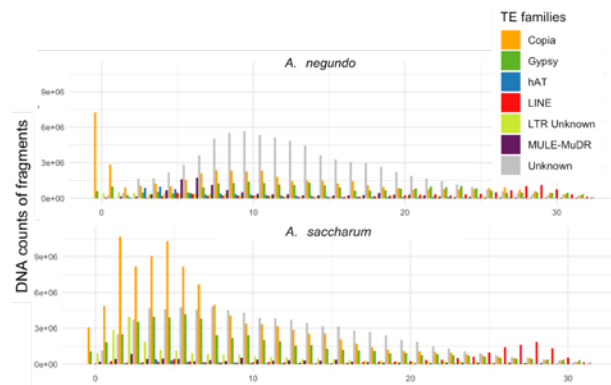
My goal is to improve our understanding of the ways that genetic diversity has evolved and how it contributes to the adaptability and long-term sustainability of forest species. This includes studying the past evolution and adaptation of conifer and other plant genomes, identifying important adaptation related to different lineages, as well as characterising the dynamics of genomic variation and adaptation in populations.



Normalized average methylation levels across all genes in *Acer negundo* (top) versus *Acer saccharum* (bottom). The red line indicates averages for candidate nutrient stress genes only. (modified from McEvoy et al. 2024; doi 10.1111/eva.13669)

Highlights of 2024-2025

- We were among the first groups to detect non-CpG methylation, an important epigenetic modification in plants, from nanopore sequencing. (McEvoy et al., Profiling genome-wide methylation in two maples, 2024, Evolutionary Applications).
- I created a reference genome for an endangered species in the sunflower family, which will serve as a resource for its conservation. (McEvoy et al., The reference genome of an endangered Asteraceae, *Deinandra increscens* subsp. *villosa*, endemic to the Central Coast of California, 2024 in G3).
- I was recruited as a new group leader to UPSC in 2025



Transposable element abundance and relative age of activity by family for *Acer negundo* (top) and *Acer saccharum* (bottom). More recent activity appears to the left of each plot. (modified from McEvoy et al., 2024; doi 10.1111/eva.13669)

Future plans

My current plans involve approaches from both population genomics and comparative genomics. As a new research group, we will continue analysing genetic diversity in multiple tree species across Europe, including detecting of signatures of natural selection, as well as measuring the effect, strength and proportion of recent mutations. We will also compare larger-scale genomic differences across forest tree species, including genes, transposable elements, epigenetics, and other regulatory elements, according to their evolutionary relatedness, to examine strategies of genome evolution and adaptation and how these relate to characteristics of fitness found in different lineages.

Group members

I joined UPSC in November 2025 and will be recruiting a postdoc and a PhD student in 2026.

Photo on top: Samuel Pettersson



Ewa Mellerowicz

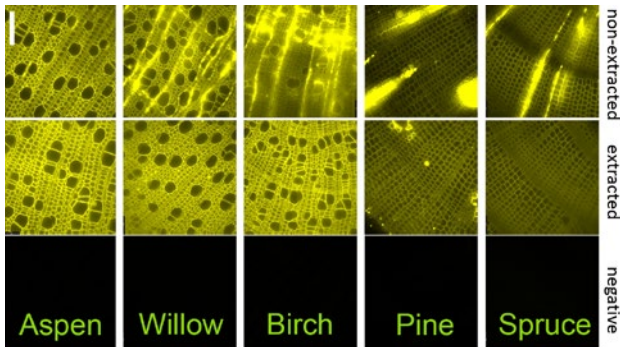
UPSC group leader from 2005 to 2025, SLU

Wood Matrix Polysaccharides

Approximately one quarter of carbon bound in the wood biomass is in the form of non-cellulosic polysaccharides commonly called “matrix polysaccharides”. The matrix polysaccharides play an important role in wood development; they are responsible for regulation of cell wall properties during cell growth, thus mediating wood cell size and shape, and they regulate properties of mature wood cell wall, thus affecting mature wood function as water conducting and crown supporting tissue of trees. Matrix polysaccharides have backbones made of hundreds of sugar units, some of which are decorated with different side chains. Their contents and structures are strictly controlled by plant cells, both during their biosynthesis in cell protoplasts, and during their carriers in the cell wall.

Research goal

Our goal was to understand how matrix polysaccharides mediate cell wall properties in the wood and how they affect tree growth and development, as well as wood traits important for wood utilization. We studied these questions not only in controlled environment but also in natural environment in the field.



Lipids remaining in the wood cell walls after removal of extractives. Negative - autofluorescence. Size bar = 100 μm (photo: Marta Derba-Maceluch)

Highlights of 2024-2025

- We discovered that matrix polysaccharides binds part of lipid-like extractives in the cell wall, methodologies to characterize these lipids and found how they are affected by drought (Mitra et al., in preparation; Pandey and Mitra in preparation).
- We showed that the formation of leaf cuticle, that forms a lipidic surface on the leaves protecting leaves from desiccation, depends on the integrity of a pectic matrix cell wall component - the homogalacturonan (Biswal et al., 2025).

- We found that xylan modification triggers changes in plant physiology, which can lead to severe alternation of xylem growth and cell wall biosynthesis program (Sivan et al., 2025), increased growth (Urbancsok et al., 2026) and drought tolerance (Barbut et al., 2024).
- We demonstrated that xylan is connected to lignin by the γ -ester link, and that reducing this connection leads to superior growth, lignin solubility and saccharification properties (Derba-Maceluch et al., 2025).
- Prize for the best PhD course from the Faculty of Forest Sciences, SLU.
- Félix Barbut obtained his PhD.



Field trial of transgenic aspen (photo: Marta Derba-Maceluch)

Future plans and reflections

As I am now a *professor emerita*, my goal is to write several publications. My time at UPSC was very happy and satisfying. I thank all my colleagues at UPSC for many fruitful collaborations and wish them a continued success in pursuing their scientific questions and in teaching the next generations of foresters and plant physiologists.

Group members (2024-2025)

Postdocs: Evgeniy Donev, Madhusree Mitra, Garima Pandey
PhD student: Félix Barbut

Photo on top: Ewa Mellerowicz

Johannes Messinger

UPSC group leader since 2024, Umeå University

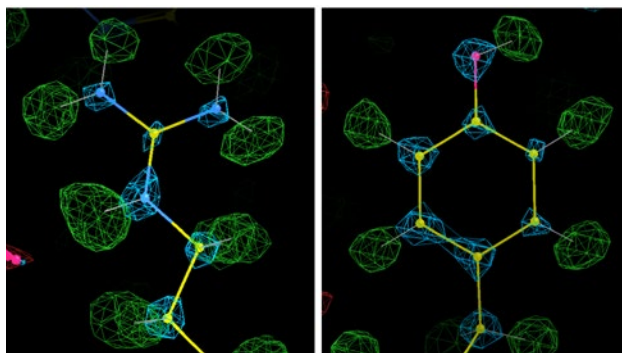


Biophysics of Photosynthesis

We employ a range of biophysical and biochemical techniques for investigating catalytic reactions in photosynthesis. Our main focus is understanding water splitting in photosystem II and CO₂ fixation by rubisco. The biophysical techniques include time-resolved membrane inlet mass spectrometry, cryo-EM, serial crystallography at free electron lasers, x-ray spectroscopy, neutron scattering, electron paramagnetic resonance and fluorescence. We are also interested in the assembly and repair processes of photosystem II and its regulation via cellular processes.

Research goal

My goal is to understand the design principles of biological redox catalysis, such as water oxidation in photosystem II and CO₂ reduction by rubisco. Of specific interest is how protein-water-cofactor interactions and protein dynamics can be utilized to activate base metal ions (e.g. of Mn, Ca, Mg) for complex conversion reactions of small molecules (e.g. H₂O, CO₂).



Cryo-EM image of an arginine and a tyrosine residue of spinach rubisco. Due to the atomic resolution the individual carbon atoms (blue) and H-atoms (green) can be seen. (credit: Nicholas Croy)

Highlights of 2024-2025

- Identification of the substrate water binding sites in the oxygen evolving complex of photosystem II. (de Lichtenberg et al., 2024, PNAS).
- We obtained the highest resolution structure of cyanobacterial photosystem II (Hussein et al., 2024, Science).
- One VR project grant and two grants from the Kempestiftelserna allowed restarting my group at Umeå University by employing one PhD student and one postdoc, and renewing the Isootope Ratio Mass Spectrometry platform.

Future plans

Within national and international collaboration, we will combine cryo-EM, serial crystallography at XFELs, EPR, neutron scattering, membrane inlet mass spectrometry and advanced calculations to unravel the design principles of protein-water-cofactor interactions in photosystem II and rubisco. Another focus will be on the regulation of photosystem II and rubisco by cellular CO₂/HCO₃⁻ levels.



Johannes Messinger with group members and Tatyana Shutova (photo: Jan Karlsson)

Group members (2024-2025)

Staff scientists: Dmitry Shevela, Abuzer Orkun Aydin
Postdocs: Danhong Li, Jack Forsman
PhD students: Nahlah Mohamed Arshed Arain, Nicholas Croy (Uppsala)
Professor emeritus: Wolfgang P. Schröder

Photo on top: Felizitas Messinger

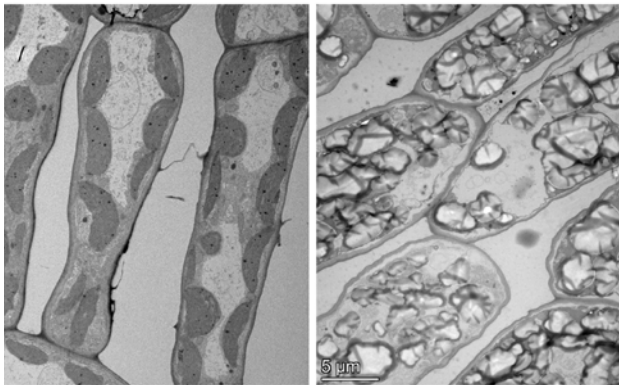


Totte Niittylä

UPSC group leader since 2009, SLU

Carbon Allocation and Metabolism

Our research focuses on understanding plant metabolism, carbon allocation and growth with emphasis on trees and the formation of wood. Carbon allocation is a core physiological process that determines how trees grow and how carbon moves from atmosphere to biomass, scaling from individual cells to forest ecosystems and the global carbon cycle. To uncover the molecular mechanisms that control this flow of carbon we combine genomics, metabolomics and fluxomics approaches. These tools allow us to identify genes, enzymes and metabolic pathways that convert CO₂ to wood. Aspen serves as our primary model system for tree and wood biology, while Arabidopsis is used to dissect cell biological mechanisms that govern plant metabolism and growth.



Electron micrographs illustrating mesophyll cell ultrastructure in CRISPR-Cas9-edited aspen lines engineered to display contrasting starch phenotypes: starchless (left) and starch-excess (right) (photo: Kumar Seerangan)

Research goal

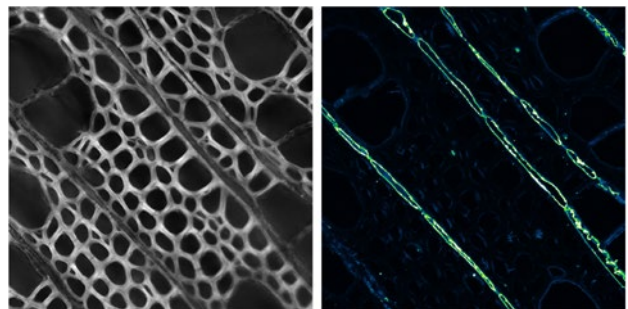
Our goal is to elucidate the metabolic mechanisms that link photosynthetic carbon metabolism with the subsequent partitioning of carbon to wood. Through this work, we aim to identify factors that constrain trees' capacity to assimilate atmospheric carbon and enhance our ability to interpret and predict forest ecosystems responses to climate change. Complementing our work on carbon assimilation and allocation, our second goal focuses on how the molecular architecture of the cell wall influences carbon incorporation into wood. Our current emphasis is on the enzymes responsible for Arabinogalactan protein (AGP) biosynthesis and on the mechanistic links between AGPs and cellulose synthesis.

Highlights of 2024-2025

- We discovered that OPENER - the protein we originally characterized in 2019 - is a key regulator of ribosome

biogenesis in plants, providing fresh insight into the core processes that determine plant growth, yield and performance (Wang et al., 2025).

- By adopting new isotope-based approaches, we are now better equipped to uncover how carbon is partitioned and utilized during tree growth and development.
- New funding from NovoNordisk Foundation gave us the opportunity to enrich the team with new expertise.



Fluorescent *in situ* antibody labelling in wood ray cells responsible for radial carbon transport and storage shows abundant arabinogalactan proteins (AGPs) (photo: Romain Castilleux)

Future plans

We plan to further expand our research activities in plant metabolism, with an ambition to build mechanistic models that capture how trees assimilate and process carbon. These models will support improved predictions of tree carbon sequestration and their role in global carbon cycle dynamics and climate change mitigation.

Group members (2024-2025)

Staff scientist: Pieter Nibbering

Postdocs: Kumar Seerangan, Pratibha Kumar, Thomas Wieloch, Oleksandr Ilchenko, Jingjing Zhou

PhD students: Franziska Brunozzi and Jarl Kjellström

Student: Magdalini Koroxenidou

Photo on top: Johan Günséus

Ove Nilsson

UPSC group leader since 1999, SLU

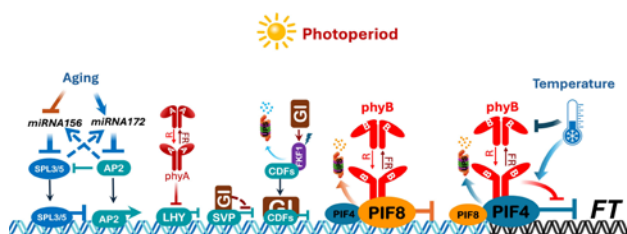


Regulation of Tree Flowering and Phenology

For trees, especially for those growing at higher latitudes, it is important to adapt life cycles and growth to the varying day lengths and temperatures that occur over the year. In autumn they need to set bud well in time to be able to develop frost hardiness before winter arrives and in spring they have to ensure that they do not break their buds too early in the season to avoid frost damage. Because of the importance of this correctly tuned annual growth cycle, climate change can severely affect the fitness of forest trees. Trees are also the latest flowering plants that we know of since they typically want to delay their flowering for many years until they are firmly established in the forest. We still know very little about the mechanisms controlling the timing of first flowering in trees.

Research goal

We want to understand the mechanism behind the regulation of flowering time and phenology in trees as well as the mechanism underlying latitudinal adaptation. My group is mainly focusing on the role of *FT/TFL1*-like genes. After our initial finding that *FT*-like genes in *Populus* are not only potent inducers of flowering, as they are in most plants studied so far, but are also controlling the length of the growing season, we have focused on the regulation of these genes, as well as their role in local latitudinal adaptation. We have found many similarities, but also differences, between the genetic pathways controlling photoperiodic regulation of flowering in annual plants and phenology in trees. We want to understand how the same type of genes can be involved in controlling both phenology and tree flowering during the juvenility-to-maturity transition.



Model of the proteins involved in the regulation of the *Populus* *FT2* genes (model by Bo Zhang)

Highlights of 2024-2025

- We generated a transcriptional roadmap of the yearly growth cycle in *Populus* trees comparing trees grown outside with those grown in indoor controlled conditions (Marcon et al., 2025).

- We showed how daylength and light signals interact with temperature signals in controlling seasonal growth in cold environments (Zhang et al., 2025).
- In collaboration with a previous post-doc, Jihua Ding, we described the mechanism underlying the genetic control of seasonal meristem arrest in trees, showing conserved aspects with the regulation of meristem arrest after flowering in annual plants and identifying new potent activators of *FT* transcription in *Populus* trees (Wang et al., 2025).
- Ove Nilsson was elected as member of the Royal Skytteanska Society, the scientific academy for northern Sweden.



Ove Nilsson with group members (photo by Anne Honsel)

Future plans

We want to continue to study the sub-functionalization of the *FT*-like genes and their roles in the regulation of flowering and phenology. What is the mechanism underlying their regulation? How do they interact with other important regulators such as *TFL1*-like genes and *SPL* genes? We also want to understand the mechanistic basis for the central role of the *FT2* gene in latitudinal adaptation in *Populus* trees. What is causing the difference between northern and southern trees? We also plan to continue our research on the role of *FT/TFL1*-like genes and *SPL*-like genes in the control of flowering in Norway spruce and *Populus* trees.

Group members (2024-2025)

Staff scientists: Bo Zhang, Keh Chien Lee

PhD students: Alice Marcon, Laura Garcia Romañach

Photo on top: Fredrik Larsson



Stéphanie Robert

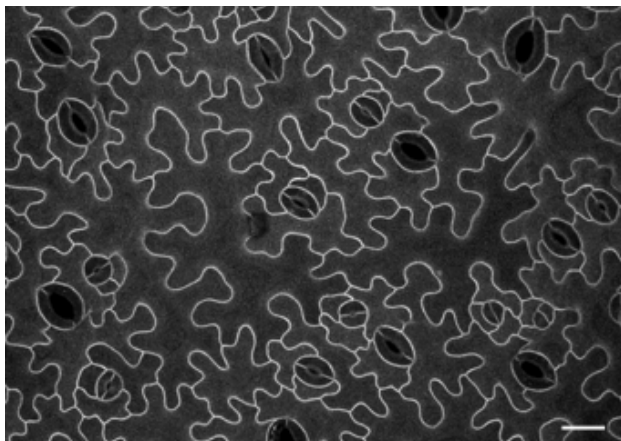
UPSC group leader since 2010, SLU

Regulation of Plant Morphogenesis Coordination

Understanding how various cell types precisely emerge in optimal forms at the right time and location is one of the most important questions in developmental biology. This process serves as the foundation of morphogenesis in multicellular organisms. Plants, in particular, exhibit remarkable adaptability, enabling them to adjust their developmental patterns to swiftly changing environments. This adaptability is facilitated by a series of morphological modifications governing the growth of organs like leaves, roots, and stems. Achieving proper morphogenesis is based on the synchronised orchestration of cell expansion, shape acquisition, and fate determination within individual cells.

Research goal

The aim of our research is to elucidate the molecular mechanisms underlying the regulation of plant morphogenesis via understanding the process of cell shape acquisition and its associated signalling pathways. We are particularly focusing our studies on auxin transport and signalling, endomembrane trafficking and cell wall/cuticle function in cell shape acquisition. Most of our work is established on the model plant *Arabidopsis thaliana* but we also work on poplar.



Confocal microscopy image of plasma membrane marker PIP2:GFP in 3rd true leaf of 12-day-old *Arabidopsis thaliana* seedling. Scale bar: 20 μm (image: Sandeep Yadav).

Highlights of 2024-2025

- We published “RACK1A positively regulates opening of the apical hook in *Arabidopsis thaliana* via suppression of its auxin response gradient” in PNAS (Ma et al., 2025).
- We received and coordinate an ERC-SYG grant STARMORPH shared with Ondrej Novak, Alexander Jones and Juergen Kleine-Vhen.

- Stéphanie became Deputy Head of the Department of Forest Genetics and Plant Physiology, SLU.
- We received funding from the European Research council (ERC), the Swedish Research Council, Vetenskapsrådet- “Coordination of cell shape acquisition in plants, Marie-Sklodowska-Curie Actions Postdoctoral fellowship-Vinod Kumar, Kempestiftelserna and Carl Trygger Foundation.
- We organised the Auxentric 2024, together with Stéphane Verger, Petra Marhava, and Karin Ljung.



Stéphanie Robert with group members

Future plans

We aim to now focus on the understanding of the developmental processes regulated by extracellular layers (such as cell wall or cuticle) or by the cell sublayer, which govern plant growth and development.

Group members (2024-2025)

Staff scientists: Siamsa Doyle, Sara Raggi
Postdocs: Sandeep Yadav, Vinod Kumar, Grégoire Loupfit, Lorinda Devi Loitongbam, Rahul Puthan Valappil, Adrien Heymans
PhD students: Hemamshu Ratnakaram, Markéta Buderová, Lin Mengzhuo (1 year)
Students: Jule Braha, Mélio Dagnaud-Adam

Photo on top: Erik Abel

Åsa Strand

UPSC group leader since 2003, Umeå University

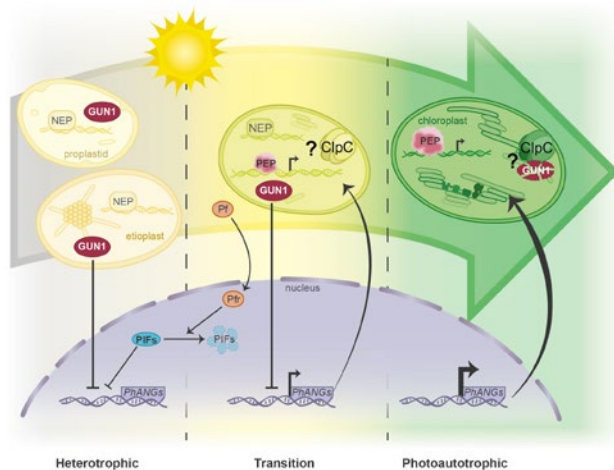


Regulation and Control of Cellular Energy Metabolism

Mitochondria and chloroplasts are the powerhouses of the cell and exposure to stress inhibits metabolic activities leading to severe constraints on cellular energy homeostasis. Failure to restore either respiration or photosynthesis severely affects vigour, and possibly survival, of the organism. Communication between the organelles and the nucleus, so called retrograde signalling networks, are essential for the recovery of energy metabolism following stress but also for the establishment of cellular energy metabolism. To address the regulatory mechanisms that control the dynamic interaction between the different genomes we take an integrative approach using a combination of genetics, molecular biology, biochemistry, cell biology and biological modelling.

Research goal

The overall goal of the research in my group is to understand the regulation and control of cellular energy metabolism. Our projects endeavour to identify the intracellular signalling mechanisms that coordinate the dynamic interaction between the different genomes during major cellular metabolic transitions.



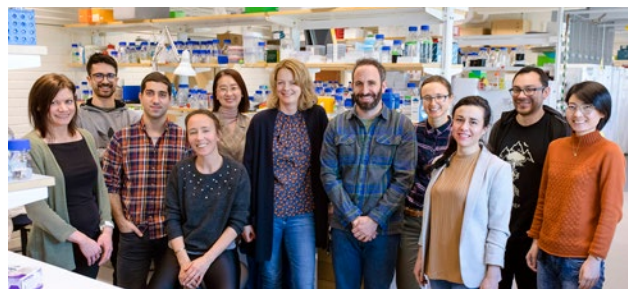
Chloroplast development proceeds in two regulatory phases. Where the first phase is initiated by nuclear events and the second phase is dependent on removal of the suppressive GUN1-mediated retrograde signal. The dependency of PhANGS expression on plastid activity provides a clear checkpoint which enables the plant to synchronize expression from the nuclear and chloroplast genomes during seedling establishment (illustration: Daria Chobrok, DC SciArt).

Highlights of 2024-2025

- My group have identified a novel mechanism controlling how plants integrate different environmental signals,

including changes in CO₂ concentration, to optimize the number of stomata appropriate for the prevailing environment (Hermida-Carrera et al., 2024).

- We have demonstrated that the epigenome is closely connected to organellar activities by retrograde signals and that a plastid signal is required for the specific changes to chromatin compaction that permit full activation of photosynthesis genes (Quevedo et al., 2025).
- Our Agenda 2030 Advanced Research Center from the Swedish Foundation for Strategic Research, SSF, “Redesigning Photosynthesis for Future Food Security” is now entering the proof-of-concept phase in close collaboration with SweTree Technologies AB.
- I was elected a member of the board of Umeå University.



Åsa Strand with group members (photo: Mattias Pettersson, UMU)

Future plans

I will direct my research focus into a new area, the epigenome. I have spent my entire career working on different aspects of energy metabolism and the emphasis on the epigenome is a natural progression from the comprehensive models my research has so far provided. The metabolism-epigenome relationship is fundamental to cellular function. We will determine how a dynamic metabolic state is translated into changes in the histone code, altering chromatin structure and DNA accessibility and giving rise to new cellular activities.

Group members (2024-2025)

Staff scientist: Xu Jin

Postdocs: Luis Cervela, Marti Quevedo, Leonor Ramirez, Alex Vergara, Alexis Brun, Giordano Ponce, Alena Patnaik

Photo on top: Vaughan Hurry



Nathaniel Street

UPSC group leader since 2011, Umeå University

Genomics of Forest Trees

Although all individuals of a species share a common genome sequence, differences in the DNA sequence among individuals can result in differences in characteristics such as biomass, flowering time, stress response and interactions with microbial species. High quality genome sequences are therefore essential to understanding the biology of a species. The genomes of Norway spruce and Scots pine, the most important forestry species in Sweden, are very large and challenging to sequence and assemble. Aspen is an important host of biodiversity in Swedish forests and an important tool for tree genomics research, making access to its genome sequence highly valuable.

Research goal

We are producing genomics resources for Norway spruce, Scots pine and aspen. We use these resources to determine the genetic basis of within and between species variation in wood and leaf development, abiotic stress response and the production of defence compounds. We also use genomics methods to explore the interaction between trees in the forest and their associated microbial communities. We develop the PlantGenIE.org web resource to host the genomics data produced by us and others at UPSC.



An air filter in a Swedish forest stand for collection of environmental DNA for assessment of biodiversity (photo: Amanda Mikko)

Highlights of 2024-2025

- We identified conserved patterns of 3-dimensional chromosome structure in Norway spruce and Scots pine.
- We identified conserved stress and wood formation regulators between Norway spruce and Scots pine.
- We identified genes for the biosynthesis of specialized metabolites in aspen.



Developing new crops for the north of Sweden (illustration: Nathaniel Street)

Future plans

We will continue to explore the role that repetitive DNA elements play in determining evolutionary novelty in conifer genomes. We are developing tools for using eDNA to assess forest biodiversity. We have initiated a new project to *de novo* domesticate crop species in the north of Sweden, for example 'fireweed' (see above).

Group members (2024-2025)

Staff scientists: Vikash Kumar, Jamie McCann

Postdoc: Ashish Sharma

PhD students: Amanda Mikko, Teitur Ahlgren Kalman, Sara Rydman, Eduardo Rodriguez, Elena Van Zalen

Photo on top: Fredrik Larsson

Kelly Swarts

UPSC group leader since 2023, SLU

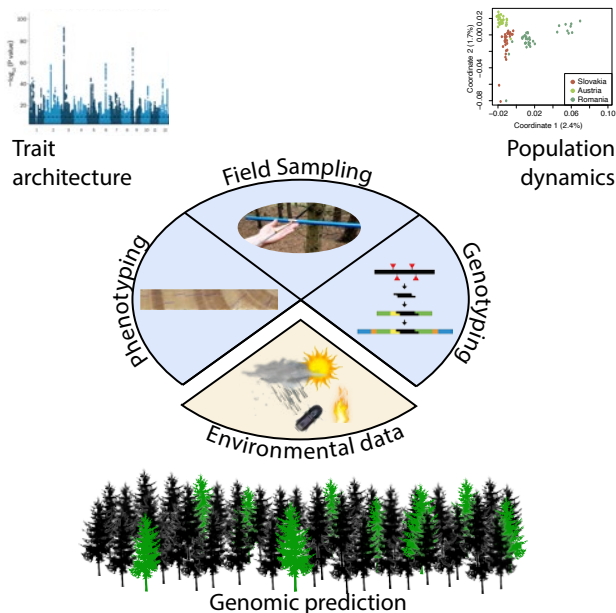


Tree-Ring Genomics

Conifers are ecologically dominant and economically important, but are globally succumbing to drought, disease, early-budding and other challenges due to climate change, as mature trees are no longer adapted to their environment. If we could predict how individual tree genotypes would respond to different environments, we could - given environmental predictions - plant the right tree in the right space.

Research goal

Measuring annual growth from tree increment cores allows us to assess an individual genotype's performance in different environments across its lifespan. Combining annual growth measurements with environmental data from weather stations and other historical records, we can begin to understand the genetics underlying adaptation to environment. As interannual variation is often as great or greater than between location variation across much of Europe, we can also use the associations to make predictions for the best adapted individuals to plant in environments across Europe.



Research overview of Tree-ring Genomics (illustration: Kelly Swarts)

Highlights of 2024-2025

- Move to UPSC early 2024
- Sampled clonal trials west of Stockholm to validate models
- Sampled mixed forest in the Varrjo Strict Nature Reserve, Finland for continental boreal spruce diversity

- KAW WIFORCE PhD Grant 2026-2030, “Heritable Drivers of Plastic Response”, Kelly Swarts (main), Nathaniel Street, Vaughan Hurry, Yanjun Zan
- KAW WIFORCE PhD Grant 2026-2030, “Turning Commercial Forests into Progeny Trials: Linking Genetics and Harvesting Data”, Ola Lindroos (main), Kelly Swarts
- Organizers, TRACE (Tree Rings in Archaeology, Climatology and Ecology), 2025, Umeå, Sweden, June 15-20, 2025



Kelly Swarts and group members

Future plans

The move to UPSC in 2024 has led to exciting new collaborations at UPSC, SLU and with Skogforsk. We were awarded PhD projects in plasticity modeling (with UPSC researchers) to improve predictions for resiliency and another with Ola Lindroos in Forest Biotechnology to prototype approaches for generating DNA at harvest time, allowing for genetic assessment of the traits collected at harvest and in the sawmills – effectively turning all of Sweden into a progeny trial. We have also just recruited a new postdoctoral fellow (Timo Kneuver) to develop physiological response models to improve environmental modeling for prediction. Having settled after the move to Umeå, we have a backlog of projects to publish, including tree-ring based models to understand drought and competition response, maize dynamics across the Americas from ancient DNA, the genetic basis of growth habit in *Pinus mugo* and the genetic basis of virulence and resistance in the *Picea abies*-*Ips typographus* pathosystem.

Group members (2024-2025)

Staff scientists: Anni Nurmisto, Lucyna Slusarz, Kirill Akulov, Nicole Suty

Postdocs: Cristine Tagliapietra-Schons, Daniela Olivera, Yumei Jiang, Miroslav Polacek, Milos Rydval, Miguel Vallebuena

PhD student: Vasilina Akulova

Students: Lisa Wiedlich, Paige Guevarra

Photo on top: Johan Günséus



Hannele Tuominen

UPSC group leader since 2001, SLU

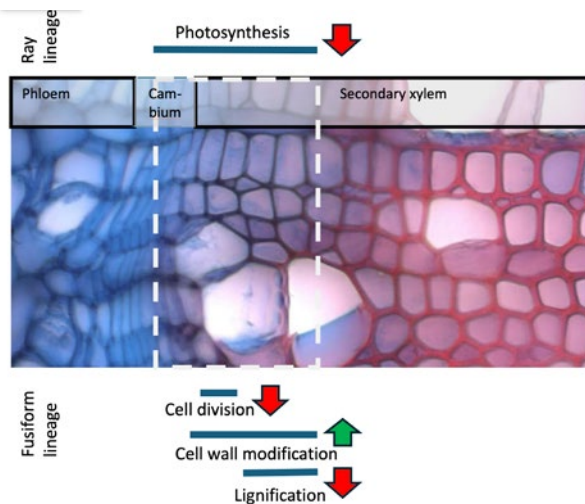
Xylem Differentiation and Wood Properties

Deciduous trees, like aspen, offer a sustainable source of bioenergy and biomaterials. This resource is likely to become even more important in the face of emerging changes in silvicultural practices and the need for increased biodiversity. Understanding of the molecular regulation of traits, such as xylem properties of woody tissues, is needed to provide tools for breeding of deciduous trees for diversified use of the wood in the future.

Xylem properties are largely influenced by deposition of the secondary cell wall constituents of cellulose, hemicelluloses and lignin. The deposition of polysaccharidic cell wall is finalised by death of the xylem elements, while lignification continues even post mortem. These processes are controlled by developmental cues but are also significantly influenced by external cues.

Research goal

The goal is to dissect molecular regulation of xylem differentiation, xylem cell death and post mortem lignification as a part of normal xylem development but also in response to external cues such as light, temperature and nitrogen. Ultimately, we want to understand how xylem differentiation influences properties of wood, xylem functioning in water transport, and the use of aspen wood as a biorefinery feedstock.



Single cell RNAsequencing was used to elucidate the mechanisms underlying the signaling function of nitrate on wood formation. A nitrate pulse that was applied to the xylem sap had diverse effects on the different xylem lineages (photo: Hannele Tuominen)

Highlights of 2024-2025

- We characterised variation in lignin chemistry and composition withing the Swedish aspen population

(SwAsp). Genetic markers were found for both G- and S-type lignin.

- We developed a method for the analysis of the wood chemical and physical properties in microscopic sections of the stem by near-infrared spectroscopy.
- We revealed that certain nitrate and amino acid transporters negatively correlated with stem diameter within the SwAsp population, indicating that excessive nitrogen retrieval from the xylem sap suppresses radial growth of the stem.
- We characterised the effect of different nitrogen sources and levels on wood formation.
- We developed a method for the analysis of gene expression in single wood cells by single cell RNA sequencing.



Anna Renström defended her thesis on the control of wood formation by nitrate signaling. Hybrid aspen trees were grown in the phenotyping platform for the analysis of nitrogen use efficiency (photo: Anne Honsel).

Future plans

We will investigate the molecular and genetic basis of xylem differentiation by reverse genetic and genome wide association approaches in aspen and hybrid aspen in greenhouse conditions and in the field. We will focus on the regulation of secondary cell wall deposition by light, drought, cold temperatures and nitrogen fertilisation.

Group members (2024-2025)

Staff scientist: Pal Miskolczi

Postdocs: Maxime Chantreau, Isura Nagahage, Shruti Choudhary, Manoj Kumar Mandal, Jeny Jose, Yupeng Zhang

PhD students: Mikko Luomaranta, Anna Renström

Student: Elin Nordin

Photo on top: Fredrik Larsson

Stéphane Verger

UPSC group leader since 2019, Umeå University

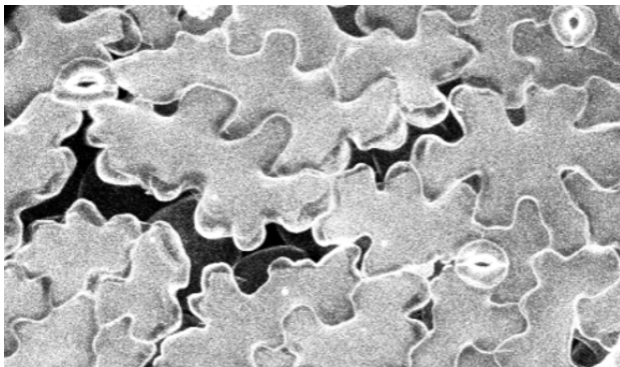


Mechanics and Dynamics of Cell-Cell Adhesion in Plants

Cells are the basic structural units of all known living organisms, coming together in millions or even trillions to form multicellular organisms. Fine-tuned control of cell adhesion is thus critical for the integrity, development, and physiology of such organisms. In contrast to animals, we still know very little about how adhesion is dynamically regulated in plants. Adhesion dynamics also plays an important role during hardwood formation where fibre cells elongate by a mechanism called intrusive tip growth which requires cells to separate and re-adhere during growth. Understanding how wood fibres grow intrusively by modulating their adhesion could ultimately help us make trees with fast-growing high-quality wood.

Research goal

Our main goal is to identify and characterize the molecular regulators and the physical features that contribute to cell adhesion in plants. In turn we aim to apply this knowledge in the context of fibre growth during wood formation to progress toward the establishment of fast growing trees with high-quality wood.



Cell adhesion defect in the cotyledon epidermis of *Arabidopsis quaimodo2-1* mutant. Confocal maximal intensity projection from propidium Iodide stained sample (image: Stéphane Verger).

Highlights of 2024-2025

- Özer Erguvan and Léa Bogdziewicz successfully defended their PhD in 2025.
- Stéphane Verger became head of UPSC microscopy facility in 2024.
- We showed that Rhamnogalacturonan-II dimerization deficiency impairs the coordination between growth and adhesion maintenance in plants (Baba et al., 2024).
- We showed that the outer epidermal cell wall edges mediate cell-cell adhesion for tissue integrity in plants (Erguvan et al., 2025).

- We have developed a new experimental and computational method for protoplast wall regeneration optimization (Bogdziewicz et al., 2025).



Stéphane Verger with group members

Future plans

We will continue to study the regulation of adhesion dynamics with a focus on understanding how mechanical signals are perceived and influence adhesion but also cell fate. We will also keep focus on investigating the physical and structural features of the cell wall, cell shape and tissue organization that allow adhesion maintenance. We will continue to apply this knowledge to wood formation, in particular by exploiting recently generated Crispr mutants, transgenic reporter lines as well as the SwAsp genetic resource for Genome Wide Association Studies on wood fibre length and wood mechanics.

Group members (2024-2025)

Staff scientists: Asal Atakhani, Marta Derba-Maceluch
Postdocs: Abu Imran Baba, Adrien Heymans, Ioannis Theodorou, Johan Sjölander
PhD students: Audrey Rigaud, Léa Bogdziewicz, Lucija Lisica, Özer Erguvan
Students: Alfred Sörnas, Jatin Gupta, Jeanne Juquel
Guest researcher: Barbora Jelinkova

Photo on top: Johan Gunséus

Harry Xiaming Wu

UPSC group leader since 2010, SLU

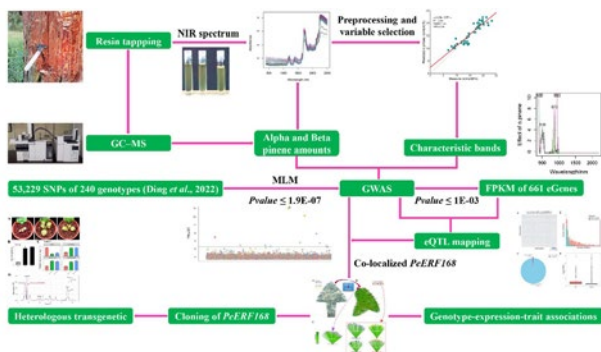


Forest Genetics and Breeding

My group investigates genetic variation of quantitative traits in forest trees and their underlying genetic and genomic base. We use quantitative genetics and genomic tools to dissect the genomic base of phenotypic variation, genotype by environmental interaction and local climate adaptation for wood and fitness related traits. Based on the knowledge of the genetic bases, we design most effective selective breeding methods to produce new germplasm of higher quality and productivity for commercial production and for climate adaptation. Recent advances in genome sequencing, re-sequencing, GWAS and genomic selection made it possible to accelerate breeding process and increase genetic gain.

Research goal

Our goal is to use genomics and quantitative genetics to shorten breeding cycle and to manage inbreeding depression and unfavourable genetic correlation between growth and wood quality traits in advanced breeding generations. We also focus on selective breeding to identify populations for future climate adaptation.



Flowchart for steps undertaken to conduct association genetics research for resin content (from Ding et al, Int. J. Biol. Macromol., 2025, 300, 139728, <https://doi.org/10.1016/j.ijbiomac.2025.139728>)

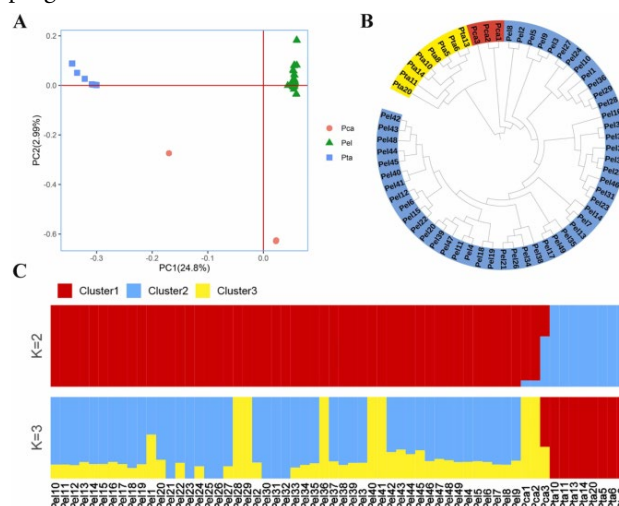
Highlights of 2024-2025

- We integrated high-throughput phenotyping, GWAS, and transgenic to detect terpene biosynthesis gene (Ding et al., 2025).
- Development of 51 K liquid-phased probe array for Loblolly and Slash pines for population genomics and genomic selection studies (Diao et al., 2025).
- Revealed significant differences in the recombination landscape for genic and intergenic regions for pines (Yang et al., 2026).

- Grants from Bo Rydin and Föreningen Skogsträdsförädling Foundations.

Future plans

We will continue to investigate the genomic base of quantitative trait variation and climate adaptation for major Swedish tree species using genomic tools. Advanced genomic selection methods including cross-generation, cross-populations will be developed for Swedish national tree breeding program. We will also focus on development of breeding strategy to overcome inbreeding depression and negative genetic correlations in advanced tree breeding program.



Population structure of 49 Slash pine (Pel), 8 Loblolly pine (Pla) and 3 Caribbean pine (Pca) trees based on 28,670 SNPs (from Diao et al, Ind. Crop. Prod., 2024, 216, 118777, <https://doi.org/10.1016/j.indcrop.2024.118777>)

Group members (2024-2025)

Staff scientists: Tomas Funda, Zhiqiang Chen
Postdocs: Rajiv Chaudhary, Maximiliano Estravis Barcala, Chenjui Yang
PhD students: Adam Klingberg, Edward Carlsson, Lam Minh Nguyen, Jemal Mohammed Abdela
Guest researchers: Xianying Ding, Jiexian Luo, Margaux Delage

Photo on top: Anne Honsel

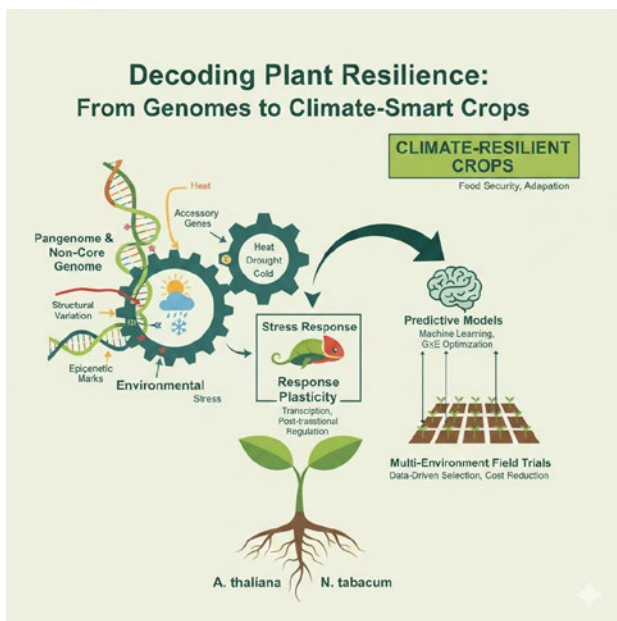


Yanjun Zan

UPSC group leader since 2026, Umeå University

Complex Trait Genetics and Genomics

How do complex, polygenic traits, regulated by thousands of genes, allow a plant to adapt to a shifting climate? My research explores how individual genomic differences translate into a unique ability to respond to environmental stress. By analyzing how genetic variation interacts with heat and drought, I map the mechanisms behind stress response plasticity. These insights reveal how plants reshape their biology to endure extreme weather. Ultimately, I use this knowledge to build smarter predictive models, bridging the gap between genomics and field performance to develop the climate-resilient plants essential for future food security.



Overview of our research focus on complex trait regulation and prediction (illustration: Yanjun Zan)

Research goal

We leverage *A. thaliana* and *N. tabacum* genomics to mine the functional role of the non-core genome. By mapping the regulatory layers of stress response plasticity, we develop predictive models that translate genetic theory into optimized field trials - accelerating the breeding of climate-adapted, resilient plants.

Highlights of 2024-2025

- Was recruited to UPSC in 2025, starting in 2026.
- We developed the first pangenomes for *A. thaliana* and super pangenome of *N. tabacum* genus, capturing the “hidden” genetic variation essential for trait discovery (Zan et al. in *Nature Genetics*, 2025).

- We revealed role of epigenetic modification in cold induced flowering time plasticity (Han et al. in *Molecular Ecology*, 2024).
- We developed a multi-environment trial model that significantly boosts genomic prediction accuracy while optimizing resource allocation to reduce total breeding costs (Han et al., in *Plant Communications*, 2025).

Future plans

We aim to quantify the expression of accessory and lineage-specific genes in *A. thaliana* and *Nicotiana*. By integrating transcriptomic data with pangenome scaffolds, we will determine how this “hidden” genomic variation contributes to adaptive traits. We will investigate the cascading mechanisms, from transcription and translation to post-translational modifications, that govern stress response plasticity. Our goal is to pinpoint how these regulatory layers interact to allow plants to reshape their physiology in real-time under escalating heat and drought stress.



Yanjun Zan with group members (image: Jiayu He)

Group members (2024-2025)

I will join UPSC in April 2026 and I am in the process of recruiting co-workers. Below, I list my present co-workers at the Tobacco Research Institute, Chinese Academy of Agriculture Sciences. Among them, Dr. Lei Liang will join my group at UPSC as a postdoc, and Ran Hao will continue work with me as a visiting PhD student at UPSC.

Staff scientists: Huan Si, Hao Wang, Ruili Hao

Postdocs: Lei Liang, Le Yu

PhD students: Ran Hao, Li Liu

Students: Jiarui Zhao, Ziping Cheng

Photo on top: Hans Karlsson

Associated Research Groups

Associated group leaders are employed by other departments but interact strongly in their research projects with research groups at UPSC. They benefit from the UPSC scientific environment and infrastructure and bring other competences and adjoining research fields to UPSC.



Photo by Malin Grönborg

Sandra Jämtgård

Researcher at the Swedish University of Agricultural Sciences - Associated research group leader

Plant nitrogen availability

“My group’s research revolves around understanding the mechanisms governing plant nitrogen availability at the root-soil interface. Our main aim is to develop the sampling technique microdialysis as a tool for root simulation, investigating key aspects of root physiology and plant-microbial interactions and how that influence plant nitrogen availability at the root surface, in a root growing in undisturbed soil.”



Photo by Fredrik Larsson

Thomas Moritz

Professor at the University of Copenhagen, Denmark - Associated research group leader, previously group leader at UPSC

Metabolomic control of shoot elongation and wood formation

“The aim of my research is to understand how plant hormones and other metabolites are involved in the control of plant development, and how different environmental cues, such as photoperiod, affect the metabolic control of growth and development. We are using both targeted and untargeted metabolomics approaches to study the metabolic control of growth and development.”



Photo by Torgny Näsholm

Torgny Näsholm

Professor at the Swedish University of Agricultural Sciences - Associated research group leader

Ecophysiology and molecular biology of plant organic nutrition

“My research deals with plant nitrogen physiology, particularly nitrogen acquisition and metabolism of forest plants. This research spans from detailed studies of uptake processes to forest fertilization and environmental effects of nitrogen.”

Associated Research Groups



Photo by Fredrik Larsson

Markus Schmid

Professor at the Swedish University of Agricultural Sciences -
Associated research group leader

Regulation of plant growth and development by the environment

“Our goal is to enhance our understanding of how ambient temperature regulates growth and development in the model plant species *Arabidopsis thaliana* through the process of transcription and subsequent alternative mRNA processing..”



Photo by Thor Balkhed

Eleni Stavrinidou

Senior Associate Professor at Linköping University - Associated
research group leader

Plant bioelectronics

“The research in my group focuses on developing bioelectronic technologies for real time monitoring and dynamic modulation of plant physiology to overcome limitations of conventional methods and establish bioelectronics in plant biology. Focus is given on understanding and enhancing plant responses to environmental stress.”



Photo by Mattias Pettersson

Xiao-Ru Wang

Professor at Umeå University - Associated research group leader

Ecological genomics of speciation and adaptation

“The ability of a species to sustain environmental change is primarily determined by its genetic reservoir, which is shaped over the course of history through demography and selection. We apply ecological and genomics tools to understand the origin and distribution of genetic diversity across landscapes in Eurasian conifer species.”



In the lab at UPSC (photo: Samuel Pettersson)

3.3 Collaborative Research

Wallenberg Initiatives in Forest Research

WIFORCE Background

The Wallenberg Initiatives in Forest Research (WIFORCE) is a basic science research programme that aims to improve our understanding of the processes behind forest growth, survival, and biodiversity. The programme aims to generate knowledge that can contribute to sustainable forestry, new management practices, and climate-adapted trees.

WIFORCE is based at SLU's Faculty of Forest Sciences with activities across departments in Umeå, Uppsala and Alnarp. Thanks to WIFORCE's collaboration with UPSC, the programme is also run in partnership with Umeå University. The addition of a new Data Support Centre in 2026, located jointly at UPSC and the High Performance Computing Center North (HPC2N), will further strengthen WIFORCE's presence at Umeå University.



The WIFORCE core team in 2024-2025. From left to right, top row: Programme Director Ove Nilsson, Communications Officer Susanna Bergström, Research Coordinator Maria I Nordström; lower row: Research Coordinator Anke Carius and Deputy Programme Director Hjalmar Laudon. Additional roles in the WIFORCE Research School: Director Hjalmar Laudon and Director of Studies Maria I Nordström (photo: Malin Grönborg).

WIFORCE at a glance

In 2024, the Knut and Alice Wallenberg Foundation (KAW) launched WIFORCE as a strategic research programme to investigate the sustainable use and conservation of forests. Central to this effort were new funding for a research school and strategic recruitment packages. The programme also relied on two existing strong research programmes focusing on Future Silviculture at SLU and the other on Forest Biology and Biotechnology at UPSC, which were both incorporated into WIFORCE and received extended funding by KAW. Since then, WIFORCE is expanding to include field-based research arenas and a data support centre to facilitate collaboration and innovation among forest stakeholders in Sweden.

The total value of WIFORCE, including all KAW grants for both current and past WIFORCE projects as well as all

co-funding from SLU and Umeå University, amounts to approximately 900 million SEK up to 2030.

Forest Biology and Biotechnology

WIFORCE supports an ongoing programme in Forest Biology and Biotechnology at UPSC, which has been running since 2016 and is of profound importance to our centre. The overall aim is to translate basic plant biology research into practical applications for forestry and forest stakeholders. This programme supports key research infrastructures at UPSC, including a phenotyping platform for automated greenhouse experiments. It also offers generous starting packages for newly recruited UPSC group leaders. The programme is shared equally between the two UPSC departments. Director of this research programme is Ove Nilsson.



In 2019 the phenotyping platform was officially inaugurated by the SLU Vice Chancellor Maria Knutson Wedel. Since its opening, the platform is used to automatically monitor and record growth parameters of trees (photo: Anne Honsel)

Future Silviculture

This WIFORCE programme connects basic research on trees, soils, and landscapes with applied research in forest management. The goal is to develop silvicultural methods for the future. Future Silviculture is based at SLU's Department of Forest Ecology and Management in Umeå. Director is Sandra Jämtgård who is also an associated research group leader at UPSC.

WIFORCE Research School

The WIFORCE Research School provides PhD students with a solid foundation in natural sciences to enable them to analyze, develop, and contribute to research on the future of sustainable forestry. In total, more than 50 PhD students at SLU and Umeå University will be trained, including 16 PhD students in collaboration with industry and other stakeholders.

Wallenberg Initiatives in Forest Research

In 2024, four WIFORCE PhD students started at UPSC. As industry/collaboration PhD students, they are employed by external partners and undertake their doctoral studies either at the Department of Plant Physiology at Umeå University (**Amanda Mikko**, Stora Enso), or at the Department of Forest Genetics and Plant Physiology at SLU (**Clara Cuesta Turull**, Sveaskog; **Jemal Mohammad Abdela**, SCA; and **Lam Minh Nguyen**, Forestry Research Institute of Sweden). In 2025 three additional PhD project grants were awarded to UPSC group leaders. These PhD students will be employed at SLU and are expected to start in 2026.



WIFORCE PhD student Amanda Mikko at UPSC running a test of different air filters to collect environmental DNA (photo: Susanna Bergström).

WIFORCE Arenas

The most recent addition to WIFORCE is an instrument to stimulate interactions and collaborations among research groups as well as with various stakeholders – so called “Research Arenas”. One such arena will be a novel **Data Support Centre** for storage, curation, analysis and modelling of large-scale forest-related data. It will collect and quality-assure forest-related data from research, industry and public authorities in Sweden. By enabling advanced modelling, artificial intelligence and analyses using modern computing capacity, it will provide a shared data foundation for future decision-support. The Data Support Centre will utilise the HPC2N supercomputer cluster at Umeå University and will rely on dedicated personnel for curation, analysis and modelling support. Close connections will be established with the other KAW-supported strategic research programme WASP (Wallenberg Artificial Intelligence, Autonomous Systems and Software Program) that will give access to AI-modelling support and even more powerful supercomputing resources.

The other part of the Arena concept focusses on **field-based research**, where researchers and stakeholders

collaborate on the analysis of common field trials, addressing different scientific questions with potential future applications in sustainable forestry.

These field-based arenas focus on three overarching themes:

1. Climate, water and biodiversity

Examines how drought, hydrology, temperature variation and management practices affect forest development and ecological processes.

2. Forest management, biodiversity and climate benefits

Investigates the effects of different forest management systems – from conventional practices to continuous-cover forestry and restoration measures – with a focus on biodiversity, production, climate benefits and carbon sequestration.

3. Genetic diversity and resilience

Links genetic variation to various factors affecting tree growth, drought tolerance, wood properties and resistance to pests and diseases, providing a basis for climate-adapted forest breeding.

WIFORCE Strategic Recruitments

KAW is funding five strategic recruitments within the WIFORCE initiative. Two out of these group leaders have been recruited to UPSC. **Susan McEvoy** at SLU will study forest genetic biodiversity and **Adam Frew** at Umeå University will focus on soil biodiversity using environmental DNA.

Social sciences and Humanities for the Forests of the Future

How we manage and conserve forests is not just a question of natural sciences – it also involves people’s values, behaviours, and decisions.

As part of broadening WIFORCE, the Marianne and Marcus Wallenberg Foundation and Marcus and Amalia Wallenberg Foundation awarded grants in December 2025 for research in the humanities and social sciences with relevance to forest issues. Camilla Sandström at Umeå University is coordinating this research with the WIFORCE community.

More information about WIFORCE can be found on the SLU homepage: www.slu.se/en/wiforce.

Collaborative Research

UPSC researchers play a significant role in many large national and international collaboration projects, some of which have been running for over a decade. Below, we have summarised a selection of ongoing collaborations.

Governmental Strategic Research Areas

Two long-standing research programmes involving UPSC researchers including PhD students are TC4F and Bio4Energy, both fostering collaborations between SLU, Umeå University, and other partners.

• Trees and Crops for the Future (TC4F)

Trees and Crops for the Future is a Strategic Research Area (SRA) at SLU with Umeå University and the Forestry Research Institute (SkogForsk) as collaborative partners. TC4F develops knowledge on sustainable plant production and plant-based product development with the main objective to support the development of a new circular bioeconomy in Sweden. TC4F consists of two parts, T4F focusing on trees and C4F focusing on crops.

• Bio4Energy



A newly planted mixed forest experiment with four different species (Larch, pine, birch and spruce) in high density close to Vindeln, Västerbotten. In this T4F project, UPSC researchers Vaughan Hurry, Nathaniel Street and Kelly Swarts collaborate with Michael Gundale (SLU Umeå), Urban Nilsson (SLU Alnarp) and Mari Suontama (*Skogforsk*) (photo: Anke Carius).

The research environment Bio4Energy aims to create highly efficient and environmentally-sound biorefinery processes including methods and tools for making products such as biofuels, “green” chemicals and new bio-based materials which draw on biomass sourced from forests or organic waste as a raw material. Bio4Energy includes researchers from Umeå University, SLU, Luleå University of Technology and RISE.

European Research Council (ERC)

• ERC Synergy Grant

“STARMORPH - Unravelling Spatio-temporal Auxin intracellular Redistribution for Morphogenesis”

This project aims to investigate the interplay between auxin and mechanical forces in plant organ morphogenesis. STARMORPH introduces the innovative concept of an “auxin signature” which reflects auxin levels not only in organs, tissues, or cells but also within specific cellular compartments integrating cellular responses to developmental and external signals.

Project duration: March 2025 – February 2030

Project leader: **Stéphanie Robert**, UPSC, SLU

Co-applicants: Ondřej Novák, Czech Academy of Sciences, Palacký University Olomouc, Czech Republic; Jürgen Kleine-Vehn, University of Freiburg, Germany; Alexander Jones, Sainsbury Laboratory, University of Cambridge, United Kingdom

• ERC Synergy Grant

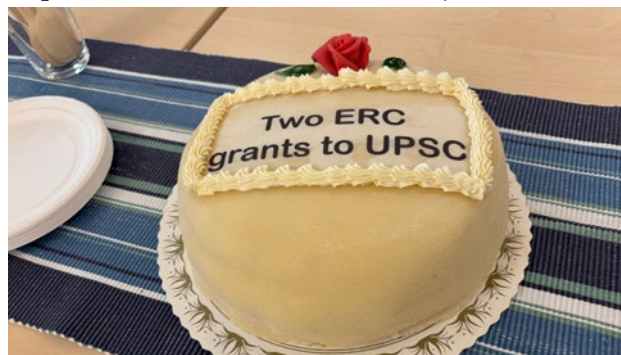
“RESYDE - Re-engineering symmetry breaking in development and evolution”

RESYDE will seek to unravel the complex processes of symmetry breaking in plant development using flowers as a model system. The researchers will combine live imaging, multi-omics, and predictive modelling to decode symmetry-breaking events, thereby laying the groundwork for re-engineering biological development by design.

Project duration: May 2025 - April 2030

Project leader: Kerstin Kaufmann, Humboldt-Universität zu Berlin, Germany

Co-applicants: Marcus Heisler, University of Sydney, Australia; Henrik Jönsson, University of Cambridge, UK; **Stephan Wenkel**, UPSC, Umeå University



In November 2024, UPSC celebrated ERC Synergy Grants to Stéphanie Robert and Stephan Wenkel (photo: Maria Nordström)

Collaborative Research

Kamprad Family Foundation for Entrepreneurship, Research and Charity

Project grant within the call “A better environment and improved quality of life for the elderly 2024”

“Turning organic waste flows to valuable feed with novel climate-smart fermentation and pelleting techniques”

Developing circular solutions for more sustainable and efficient food systems. Can leftovers of organic materials from the forest and food industries become valuable feed for animals?

Project duration: 2025-2027 Project leader: **Olivier Keech**, UPSC, Umeå University

Co-applicants: Anders Kiessling, SLU; Leif Jönsson, Umeå University and Volkmar Passoth, SLU

Knut and Alice Wallenberg Foundation

• KAW Project Grant

“Decoding cell fate with positional information”

The goal of the project is to contribute to the basic understanding of cell identity determination processes by working on root hair cells in the outer cell layer of the root. What are the components of positional information and how may they transform cell identity in epidermal root hair and non-hair cells?

Project duration: 2023-2027

Project leader: **Stéphanie Robert**, UPSC, SLU

Co-applicants: Peter Marhavý, UPSC, SLU; Stéphane Verger, UPSC, Umeå University; Eleni Stavrinidou, Linköping University and Maria Tenje, Uppsala University

• KAW Life Science Initiative

“Norway spruce and Scots pine genome sequencing, re-sequencing and genomic selection”

The Swedish spruce genome was mapped in 2013 by researchers at UPSC and the Science for Life Laboratory. In this project, a detailed update is done, together with mapping the Swedish pine genome for the first time.

Project duration: 2019-2026

Project leaders: **Ove Nilsson**, UPSC, SLU and Ulf Gyllensten, SciLifeLab, Uppsala University

Co-applicants: Nathaniel Street, UPSC, Umeå University; Harry Wu, UPSC, SLU; Pär Ingvarsson, SLU; Björn Nystedt, SciLifeLab, Uppsala University and Ellen Sherwood, SciLifeLab, Stockholm University

Novo Nordisk Foundation

• Novo Nordisk Interdisciplinary Synergy Grant

“CarbonTree: CO₂ assimilation capacity of trees – releasing the sink limitation”

CarbonTree aims to identify the enzymes and metabolic processes that restrict wood formation in trees. The goal is to create a detailed map showing how carbon is transported processed and metabolised within wood.

Project duration: 2025-2028

Project leader: Thomas Moritz, University of Copenhagen, Denmark

Co-applicants: **Totte Niittylä**, UPSC, SLU and Ari-Pekka Mähönen, University of Helsinki, Finland



A collaboration between UPSC and SciLifeLab on the sequencing, re-sequencing and genomic selection of Scots pine and Norway spruce will provide a valuable resource for fundamental and applied research of these tree species. (photo: Sonali Ranade)

Swedish Board of Agriculture

• Project Grant within a call on Sustainable food production

“Bio-Ras Innovation: Sustainable shrimp and fish production”

The project aims to establish and optimize sustainable production of shrimp and fish in a circular aquaculture system.

Project duration: 2024-2027

Project leader: **Olivier Keech**, UPSC, Umeå University

Co-applicants: Sebastian Diehl, Umeå University; Jonas Westin, Umeå University; Anders Kiessling, SLU
In collaboration with the company Cresponix AB

Collaborative Research

Swedish Foundation for Strategic Research

• SSF Agenda 2030 Research Centers (ARC)

“Redesigning photosynthesis for future food security”

Plants are only using a fraction of the light energy that they perceive. We aim to increase crop yields by engineering two key aspects of photosynthesis. Non-photochemical quenching will be optimized through structural engineering and the Calvin-Benson-Bassham cycle will be characterized with systems biology to uncover hidden points of regulation.

Project duration: August 2020 - July 2026

Project leader: **Åsa Strand**, UPSC, Umeå University

Co-applicants: Alexey Amunts, Stockholm University; Paul Hudson; the Royal Institute of Technology (KTH), Sweden; Alizée Malnoë, UPSC, Umeå University

• SSF Biotechnology and plant breeding - food, feed and forest

“Landscape Breeding: A new paradigm in forest tree management”

Can the breeding cycle of Norway spruce be shortened through a novel “landscape breeding” approach? This project will develop a digital tool that integrates remote sensing data on tree health and environmental conditions with modern DNA analyses, enabling faster breeding while preserving biodiversity.

Project duration: 2022-2026

Project leader: **María Rosario García-Gil**, UPSC, SLU

Co-applicants: Eva Lindberg, Johan Holmgren, Kenneth Olofsson, Thomas Lundmark, Malin Elfstrand, Jan Stenlid, SLU; Nicolas Delhomme, UPSC, SLU; Mari Suontama, Skogforsk and Gerhard Scheepers, RISE

• SSF Biotechnology and plant breeding - food, feed and forest

“Trees that grow better”

This project aims to improve growth in deciduous trees by enhancing photosynthetic efficiency and optimizing nitrogen use. By addressing these key limiting factors, it seeks to better understand and improve how trees capture energy and manage nutrients.

Project duration: 2022-2026

Project leader: **Stefan Jansson**, UPSC, Umeå University

Co-applicants: Olivier Keech, UPSC, Umeå University and Henrik Böhlenius, SLU

• SSF Biotechnology and plant breeding - food, feed and forest

“Rapid-Cycling Breeding”

Conventional tree breeding is slow, requiring about 25 years per cycle for pine and spruce. This project aims to accelerate cone production in Norway spruce, enabling faster breeding of trees better adapted to changing climates and emerging diseases.

Project duration: 2022-2026

Project leader: **Ove Nilsson**, UPSC, SLU

Co-applicants: Jens Sundström, SLU; Harry Wu, UPSC, SLU and Mari Suontama from Skogforsk

Swedish Research Council

• VR Grant for Centre of Excellence

“Stress Response Modeling at IceLab”

(Previous title: Centre for Modelling Adaptive Mechanisms in Living Systems under Stress)

A multidisciplinary complexity centre for research questions about how living systems react to stress. Examples of systems are the accelerating loss of biodiversity, the reduction in crop productivity, and the increase in antibiotic resistance.

Project duration: 2024 - 2028

Project leader: Martin Rosvall, IceLab, Umeå University

Co-applicants: Åke Brännström, Umeå University; Sebastian Diehl, Umeå University; Maria Fällman, Umeå University; **Åsa Strand**, UPSC, Umeå University

Umeå University

• Prioritised Research Areas

“Northfood: Plant Science for Change”

(Previous title: Plant science for a sustainable green transformation of the subarctic)

Northfood will be a hub for food production and innovation, fostering collaboration and knowledge exchange. The research will transform plant-based food production and policy. The purpose is to foster a transition towards sustainable forestry and food production and consumption in the European Arctic (subarctic).

Project duration: 2024-2028

Coordinated by **Stefan Jansson**, Umeå Plant Science Centre, Umeå University and Sofia Lundberg, Umeå University



Fireweed, a potential de novo crop in the subarctic Northfood initiative, growing in the Wallenberg Greenhouse (photo: Samuel Pettersson)



WIWAM
Automated systems for plant phenotyping

UPSC
Knut och Alice
Wallenberg
Stiftelsen

The UPSC Phenotyping Platform (Photo: Anne Honsel)

3.4 Research Infrastructures

Bioinformatics Environment at UPSC



Illustration: Fai Kochakarn

Computational Analytics Support Platform (CASP)

The Computational Analytics Support Platform (CASP) is a data analytics service at Umeå University. The platform supports and trains life science researchers in the analysis of experimental data, with a particular focus on downstream omics, including metabolomics. The group have strong expertise in data-driven life science, in addition to wide domain knowledge arising from active engagement in multiple projects across the 'omics' area and beyond.

Our mission is to help researchers convert complex data into meaningful biological and chemical interpretations using advanced data-driven tools and strategies. Support is available throughout the entire project, starting with study design, data preprocessing, quality control of generated data, basic and more in-depth data analysis, through to biological interpretation and publication. CASP also acts as an extended data support to the Swedish Metabolomics Centre at Umeå Plant Science Centre (UPSC).



CASP provides support and training to life science researchers in the analysis of experimental data, using advanced data-driven tools and strategies (AI image: Adobe Stock)

Highlights of 2024-2025

- Formation of the Computational Metabolomics Group (CMG) within SciLifeLab, bringing together data analytics expertise across multiple national platforms.
- Recruitment of data scientist Elena Dracheva to UPSC within CMG.
- Co-organisation of the international *Metabolomics in Life Science* conference together with the Swedish NMR Centre and the Swedish Metabolomics Centre.
- Expanded support to national SciLifeLab platforms and infrastructures.
- Strengthened expertise in advanced data analytics, including implementation of machine learning approaches.



Personnel of the Computational Analytics Support Platform (photo: Mattias Pettersson, UMU)

Future plans

CASP will continue to expand its portfolio of expertise and tools in line with developments in advanced data-driven analytics, further strengthening both local and national support.

Members of CASP/CMG will contribute as teachers and course leader in the new *Introduction to Metabolomics Data Analysis* course at Umeå University (March 2026), strengthening local and national training in computational metabolomics.

In addition, CASP will co-organise the third *Metabolomics in Life Science* conference in 2028, to be held in Umeå, supporting international collaboration and highlighting Umeå in the global metabolomics community.

Personnel (2024-2025)

Director: Johan Trygg

Manager: Kate Bennett

Staff: David Nilsson, Hans Stenlund

Affiliated Staff from SciLifeLab/NBIS: Elena Dracheva

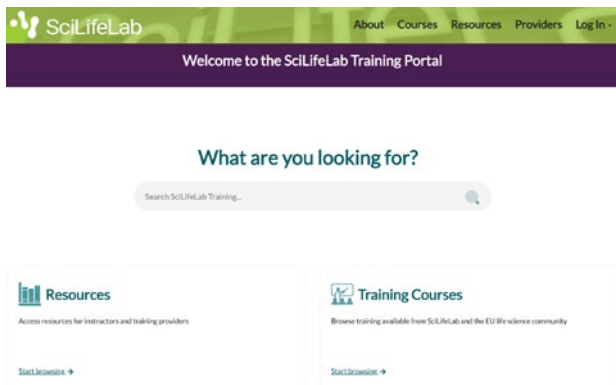


Illustration: Fai Kochakarn

Bioinformatics Environment at UPSC

SciLifeLab Training Hub

SciLifeLab Training Hub supports the SciLifeLab community in developing and delivering high-quality training. We provide pedagogical guidance, technical infrastructure, and hands-on support to trainers across SciLifeLab. We operate at two sites, Umeå and Stockholm, with team members at both locations. The Training Hub manages and develops the SciLifeLab Training Portal and offers consultations and support projects for life science trainers seeking to improve their training and make it FAIR. In addition, we offer courses in pedagogy, FAIR by Design, and organisational learning.



The SciLifeLab Training portal lets you browse the full SciLifeLab Training catalogue and find upcoming courses and materials (screenshot: Training Hub)

Highlights of 2024-2025

- Established ourselves at the Department of Plant Physiology within UPSC.
- Launch of SciLifeLab Training Portal, where trainers can announce their upcoming training and trainers can find useful resources for helping them design and deliver their training.
- Recruited two system developers.
- Started a collaboration with EMBL to build a training administration system.
- Held 13 consultations and worked on five support projects.
- Delivered one Organisational learning course, two Train the Trainer courses, and two FAIR by design courses.

Future plans

In the coming years, SciLifeLab Training Hub will contribute to the development and implementation of the SciLifeLab Training strategy. We will further expand the SciLifeLab Training Portal to provide a comprehensive course catalogue and support the sharing of open and FAIR

training materials that can be reused by trainers across the community. Through the continued development of the Training Portal, we will also begin implementing learning paths for SciLifeLab courses and skills. We also plan to launch a SciLifeLab Canvas instance for SciLifeLab-branded courses, where trainers can host and deliver their training. In parallel, we will continue to strengthen support for the trainer community through pedagogical guidance and by promoting open and FAIR training practices.



Training Hub co-working day with the full team from Stockholm and Umeå (photo: Training Hub)

Personnel (2024-2025)

Manager: Nina Norgren

Staff: Adeel Ahmad, Dimitris Panouris



Bioinformatics Environment at UPSC



Illustration: Fai Kochakarn

National Bioinformatics Infrastructure Sweden (NBIS)

National Bioinformatics Infrastructure Sweden (NBIS, www.nbis.se) is a distributed national research infrastructure, and constitutes the SciLifeLab Bioinformatics Platform. NBIS enables world-class life science research, for example by providing expert knowledge, advanced training, efficient data publication, and access to high-performance data analysis methods. UPSC is an important partner to NBIS, currently hosting 7 staff funded through NBIS, with several being part of the SciLifeLab & Wallenberg National Program for Data-Driven Life Science (DDLS). For efficient knowledge transfer, the NBIS staff at UPSC are part of national support teams, providing expertise in multiple technology and research areas through accessible and transparent national support tracks. All NBIS staff also engage extensively in national bioinformatics training, consultations, and mentorship programs.



NBIS provides bioinformatics and data science support to the Swedish life science research community (photo: Mikael Wallerstedt).

Highlights of 2024-2025

- Re-located NBIS site in Umeå to UPSC, gaining critical mass with the local UPSC Bioinformatics facility, and strengthening the local Umeå bioinformatics community.
- Expanded and strengthened support competences in infection biology and metabolomics by recruiting new staff members at UPSC, partly through the DDLS program.
- Engaged in multiple annual national courses such as Introduction To Bioinformatics Using NGS Data and Python programming with applications to bioinformatics.
- Participated in NBIS national weekly bioinformatics online drop-in sessions. More than 99% of the users

would recommend this service to a colleague (>800 accumulated answers).

- Engaged in the national PhD mentorship program Swedish Bioinformatics Advisory Program.

Future plans

NBIS will remain committed to providing advanced tailored support to large and complex research projects, extensive training programs, and easy access consultations and data management services. Our plans include further expansion at UPSC with two new staff starting early 2026. We aim to strengthen competences in Machine Learning/ AI, in collaboration with staff at the emerging AI Factory Mimer (for example at HPC2N). NBIS will take a co-leading role in improving data integration efforts across the SciLifeLab platforms to provide new and internationally unique service offerings. We will also engage in DDLS initiatives to catalyze the setup of large community data resources across multiple research areas.

Personnel (2024-2025)

Directors: Johannes Hanson (Umeå University), Bengt Persson (Uppsala University)

Managers: Björn Nystedt (Uppsala University), Lucile Soler (Uppsala University)

Staff: Matilda Berkell, Allison Churcher, Elena Dracheva*, Nina Norgren*, Jeanette Tångrot

* Parttime NBIS funded





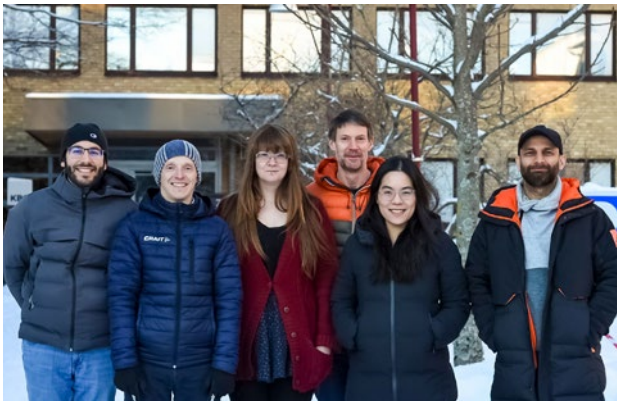
Illustration: Fai Kochakarn

Bioinformatics Environment at UPSC

UPSC Bioinformatics Facility

The department of Plant Physiology at Umeå University hosts both local and national bioinformatics resources, making it a central hub for data-science driven research in Umeå.

The UPSC Bioinformatics Facility (UPSCb) centralises bioinformatic competences, offering a range of bioinformatics services (mainly analysis of High-Throughput Sequencing (HTS) data of many types) as well as participating in wider collaborative projects. The facility also delivers local bioinformatics training and contributes to international workshops and training programs. Furthermore, it offers a storage service at two separate locations, so that groups can follow the ordinance about data archiving.

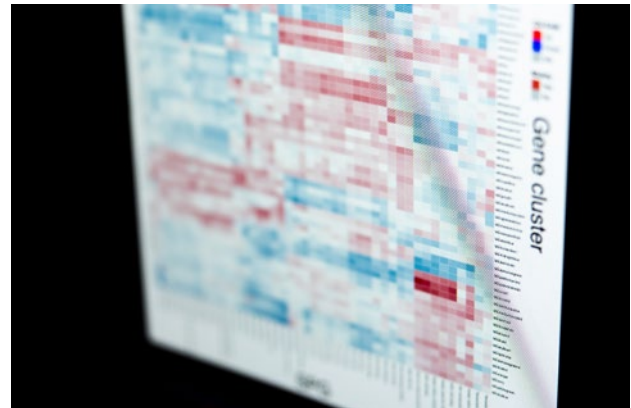


UPSC Bioinformatics Facility members (photo: Vikash Kumar)

Highlights of 2024-2025

- Creation of the bioinformatics environment at UPSC. These are the research groups, initiatives and infrastructures, both local and national, that are now part of it: NBIS, SLUBI, Training Hub, the UPSCb and the research groups of Jian-Feng Mao, Nathaniel Street and Kelly Swarts.
- Recruited a system administrator and a population genetics expert.
- Expanded the storage infrastructure in both active and cold data, with a current capacity of one PB, with a backup stored in the UPPMAX system in Uppsala.
- Extended our collaboration with HPC2N, reducing our own computing hardware. Extended collaboration with NBIS, including shared seminars and co-teaching courses.
- Organised a bioinformatics retreat to facilitate cooperation between bioinformatic infrastructures and groups in Umeå and outside.

- Extensive teaching and organisation activities in two master courses and three PhD ones. Single lectures or assistant teacher roles in two more master courses and a PhD one.
- 64 new projects were started.



The UPSC Bioinformatics Facility contributes to making sense in the huge amounts of biological data generated (photo: Samuel Pettersson)

Future plans

We plan to build a closer link with the Swedish Metabolomics Centre, facilitating communication by hiring an expert in metabolomics data analysis. We will further develop our collaboration with NBIS by running more courses together. We intend to move our compute environment to HPC2N, having them manage servers we own to allow instant access to interactive environment (on-demand sessions), while freeing us from the burden of administering the machines. We will start a collaboration with WIFORCE (Wallenberg Initiatives in Forest Research) to locate and annotate genomics data and enable cross-disciplinary studies. Furthermore, we plan to increase our visibility through a research catalog and improve internal project tracking using the redmine software.

Personnel (2024-2025)

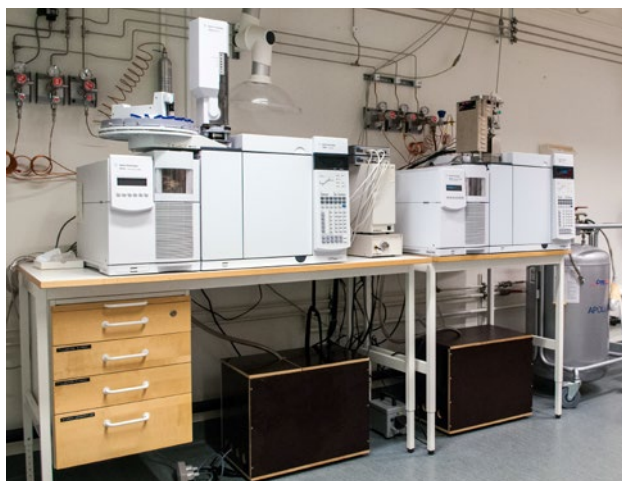
Director: Nathaniel Street
Manager: Nicolas Delhomme
Staff: Sagar Bhat, Edoardo Piombo, Theerarat Fai Kochakarn, Mimmi Eriksson

Biopolymer Analytical Platform (BAP)



Photo: Florian Schmidt

The Biopolymer Analytical Platform (BAP) provides advanced analytical support for research on the cell walls of terrestrial and aquatic plants, biopolymer materials, and soil and sediment. The platform offers state-of-the-art expertise and a broad range of analytical tools for the characterization of major cell wall polymers—including lignin, cellulose, and hemicellulose—and for the detection and quantification of soluble mono and oligo saccharides and other organic compounds. To accommodate these analyses, BAP utilizes conventional wet chemistry methods alongside advanced instrumental techniques such as pyrolysis (Py), gas chromatography–mass spectrometry (GC/MS), and size exclusion chromatography (SEC).



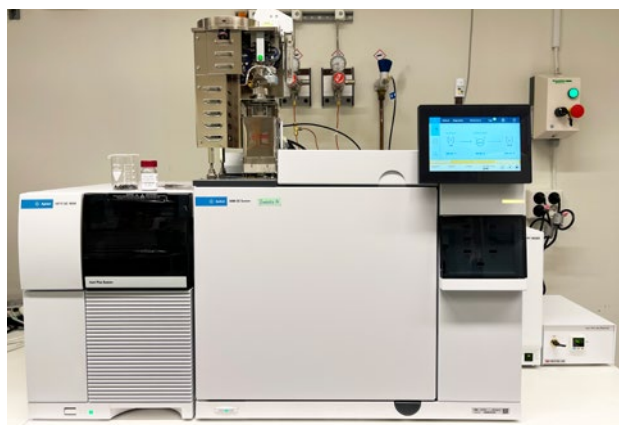
The Agilent GC/MS instruments for composition analysis (photo: Florian Schmidt)

Highlights of 2024-2025

- We supported eleven UPSC research groups by analyzing a wide range of sample materials from algae, Arabidopsis, rice, hybrid aspen, spruce, pine to soil and sediment.
- The new accelerated solvent extractor (ASE) 350 purchased in 2021 has been intensively used for extractive analysis in 2024-2025.
- The new Py-GC/MS system was purchased in 2025.
- The user friendly Py-GC/MS data-processing software, Pyromics, has been programmed by postdoc Oleksandr Ilchenko for automated annotation and classification, and the lignin/carbohydrate library was updated including more detailed sub-classification.
- The carbohydrate linkage analysis with GC/MS was established and the reference library is being constructed.

Future plans

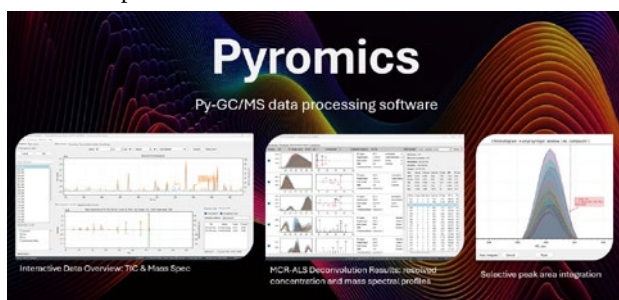
We plan to transition Py data processing and analysis to the Pyromics software environment to increase throughput, reproducibility, and data interpretability.



The new Py-GC/MS system (Frontier Lab EGA/PY-3030D & AS-2020E and Agilent 8890 & 5977C) (photo: Junko Takahashi-Schmidt)

To establish carbohydrate linkage analysis as a routine method additional polymer types—including algal and bacterial cell wall polymers—need to be analysed to build a comprehensive linkage library. Such a resource will support a wider community of researchers working with diverse biopolymer systems.

We also aim to expand interactions between the platform and UPSC groups studying plant cell wall structure and mechanics. Strengthening these connections will facilitate integration of mechanical properties with detailed chemical composition analyses. These developments will be implemented through dedicated postdoctoral and PhD projects, as well as targeted method development efforts within the platform.



The new Py-GC/MS data-processing software, Pyromics (illustration: Oleksandr Ilchenko)

Personnel (2024-2025)

Director: Totte Niittyä
Manager: Junko Takahashi-Schmidt
Staff: Sonja Viljamaa
Postdoc: Oleksandr Ilchenko





Photo: R. Casanova Sáez

C-Trap Facility

The facility provides access to a dual-trap C-Trap Dymo 300 system integrating optical tweezers, multichannel microfluidics, and confocal fluorescence microscopy in a single platform. It enables direct manipulation and visualization of biomolecular processes at the single-molecule resolution and under physiologically relevant conditions. This combination allows real-time investigation of molecular binding events, motor proteins dynamics, structural transitions and mechanical properties of biomolecules, as well as studies of cell mechanobiology and soft nanomaterials.

The facility provides comprehensive support with experimental design and sample preparation. Introductory training on C-Trap operation for data acquisition and support with data analysis are available upon request.

Highlights of 2024–2025

- The C-Trap instrument was installed at UPSC during September 2024.
- Since February 2025, the C-Trap facility is part of the KBC local infrastructures.
- In April 2025, the facility was awarded the status of Umeå University research infrastructure.
- Two projects on single-molecule protein–DNA interaction experiments have been performed.
- A project to measure adhesion forces between individual plant cell wall components and the plasma membrane was run and contributed to Léa Bogdziewicz's PhD thesis, defended in October 2025.
- A project to investigate viral glycoprotein interaction with the extracellular matrix of human cell lines has been launched.
- A project investigating human DNA topoisomerase I variants at the single-molecule level was initiated.

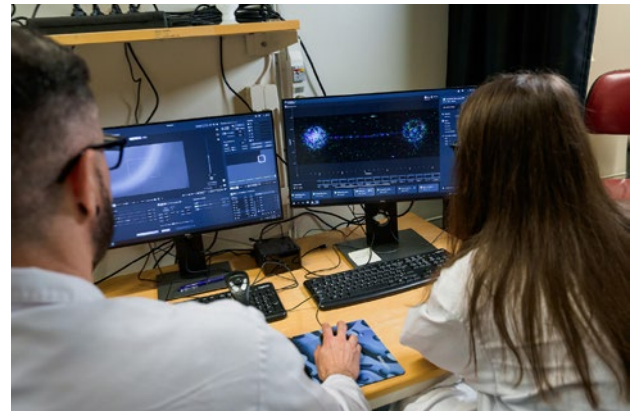


Loading samples to the microfluidics system of the C-Trap (photo: Mattias Pettersson)

- At this time point the facility supports four active projects from different departments, including Plant Physiology, Medical Biochemistry and Biophysics, and Clinical Microbiology.

Future plans

The C-Trap has strong potential to support interdisciplinary research across molecular biology, biophysics, medical research and materials science. In the coming years, we aim to increase the number of users, foster interdepartmental collaborations, and standardize experimental procedures to ensure more efficient and accessible use of the platform. The long-term goal is to develop the C-Trap Facility into a central interdisciplinary hub for single-molecule research at Umeå University.



Setting up the C-Trap with a user. The screen to the right shows a single dsDNA molecule tethered between two optically trapped microspheres (photo: Mattias Pettersson)

Personnel (2024-2025)

Manager: Rubén Casanova Sáez

Steering group: Åsa Strand (Chair), Magnus Andersson, Marta Bally, Stefan Björklund, Stéphane Verger, Rubén Casanova Sáez

Microscopy Facility



Photo: M. Derba-Maceluch

The infrastructure hosts several light microscopes, 5 advanced confocal microscopes with a range of cutting-edge features (e.g. Airyscan, FLIM, Dynamic profiling, multiphoton, spinning disk, etc.), a Brillouin-confocal microscope, an Atomic Force Microscope, 2 FACS instruments, an automated sample preparation system (for immuno-labelling, in situ hybridization, dehydration series, etc.) as well as sectioning equipment. The platform provides access, training for and maintenance of the equipment. Users are trained and primarily use the equipment independently after training. Staff can also provide support for sample preparation, basic image processing and methods development for plant material.



Brillouin microscope at UPSC microscope facility (photo: Marta Derba-Maceluch)

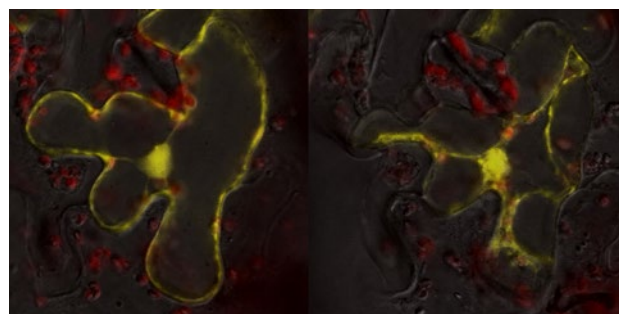
Highlights of 2024-2025

- During 2024, we acquired and installed a Brillouin module which is now connected to our LSM 780 confocal microscope allowing direct correlative mechanical and high-resolution confocal imaging.
- During 2025, we purchased the Zeiss FLAMME LSM 990 which is flipped (vertical imaging microscope) and will provide most of the latest advanced feature available in state-of-the-art Zeiss confocal microscopes (lightfield 4D, AiryScan 2, multiplex mode, with PicoQuant FLIM). This will allow long term live imaging of plant samples growing vertically.
- In 2025, we also acquired a new user-friendly FACS system (BD FACS Melody Cell Sorter) and acquired a Laser capture microdissector (LCM) Zeiss PALM Microbeam.
- We support 25 researcher groups through training, on-demand support as well as paid services including sample preparation, imaging and image processing.

- In 2025, Anna Gustavsson finished working at the platform and was temporarily replaced by Luciano Di Fino and Jasim Basheer for confocal microscopy training and support.

Future plans

Since 2024 Stéphane Verger is the facility director. Léa Bogdziewicz starts her work at the platform in 2026 as confocal and FACS specialist. In the coming years we will aim to increase our links with the UPSC bioinformatics facility and the UPSC high-throughput tree phenotyping platform to increase knowledge exchange regarding bioinformatic approaches for image processing. A potential future development depending on future staff availability, will be to contribute to establish image processing pipelines (as service or user training) for the automated and reproducible analysis of images coming from the microscopy facility and UPSC tree phenotyping platform. We are also planning to increase the involvement of “advanced users” at the platform to provide additional support, training and advice for specific advanced functions of our equipment.



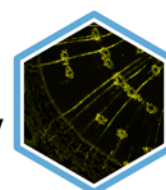
Plasmolysis of poplar epidermal cell (photo: Marta Derba-Maceluch)

Personnel (2024-2025)

Director: Stéphane Verger
Managers: Anna Gustavsson, Marta Derba-Maceluch
Staff: Luciano Di Fino, Jasim Basheer, Ioanna Antoniadis, Siamsa Doyle



UPSC
Microscopy
Facility



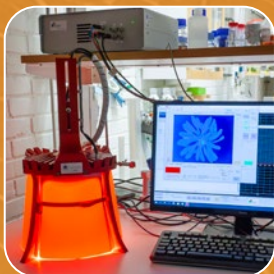


Photo: Anne Honsel

Photosynthesis and Respiration Facility

The facility provides a wide range of approaches and instruments to assay photosynthetic and respiratory activities in different plant materials ranging from intact plants to isolated pigment-protein complexes. All the equipment is available for UPSC members free of charge. We are responsible for the evaluation, purchasing, and maintenance of our photosynthetic instruments. We organize training and introductions and provide all kinds of support required for our users.



The home-built Joliot-type electrode allows measuring flash-induced oxygen evolution patterns (FIOPs) (photo: Anne Honsel)

Highlights of 2024-2025

- Studies on flash-induced oxygen formation became available at Photosynthesis platform. The Joliot type electrode, the classical instrument used in these measurements, capable to follow oxygen evolution pattern and calculate the period-four oscillations and S-state transitions of photosystem II was set up and tested.
- Spectrometer Li180 was purchased and available for research and plant growers.
- Handy chlorophyll content meter Dualex is available for platform users. It allows for quantification of chlorophyll and flavanols in intact leaves and the calculation of nitrogen balanced index.
- The Joliot type spectrometer was fixed and upgraded, including the Minilite II laser. The laser safety procedure was updated as well.



DUALEX – handy chlorophyll content and flavonoid meter (photo: Anne Honsel)

Future plans

Purchase of quadrupole mass spectrometer for gas detection; connecting the quadrupole MS with the LI-COR system; maintenance of instruments, purchasing spare parts, evaluation and ordering of new equipment, updating platform webpage, training and support.

Personnel (2024-2025)

Directors: Johannes Messinger, Olivier Keech
Manager: Tatyana Shutova (50%)

Plant Growth Facilities at UPSC and SLU Umeå



Photo: Johan Gunséus

Researchers at UPSC have access to state-of-the-art plant growth facilities that support the cultivation and analysis of both transgenic and non-transgenic flowering plants under carefully controlled environmental conditions. The infrastructure includes several walk-in climate chambers, controlled growth rooms and growth cabinets, all of which can be programmed to provide a broad range of temperature settings and light regimes.

A dedicated and highly experienced team ensures optimal growth conditions through regular watering, fertilisation and pest management. The facilities are managed through an automated booking system overseen by greenhouse personnel, ensuring efficient use of space and resources. In addition, experienced researchers provide training and guidance to new users to ensure smooth operation and high experimental standards.



A new growth facility at UPSC opened in 2022 (photo: Anne Honsel)



Young Arabidopsis plants grown in the UPSC Growth Facility (photo: Samuel Pettersson)

Highlights of 2024-2025

- A coordinating committee, with representatives from SLU, UMU, Akademiska Hus and growth facility personnel has been formed and has been meeting for the planning of the construction of 16 new walk-in chambers.



Aspen trees in a growth room at the UPSC Growth Facility (photo: Samuel Pettersson)

Future plans

Once the plan for new chambers has been generated and budget is generated, SLU, UMU and other funding sources will be approached for the support of the plan. The greenhouse on floor 5 is scheduled for rebuilding, with exterior work starting in April 2026 and interior work in May 2026. The project is equally co-financed by UMU and SLU and is expected to improve room distribution and contribute to energy savings (savings estimation: 1.5 million SEK in energy costs in the next 5 years).

Personnel (2024-2025)

Director: Rishikesh P. Bhalerao

Staff: Anna Forsgren, Åsa Gavelin, Ann Sehlstedt, Jedidiah Biocati-Brennan



Photo: Verena Fleig

Poplar Transgenics Facility

The *Populus* transformation facility serves all groups at UPSC with *Agrobacterium*-mediated transformations, maintenance, and amplification of our laboratory hybrid aspen clone *Populus tremula x tremuloides*, (T89). The facility also maintains 116 clones of the Swedish Aspen (SweAsp) collection of aspen (*Populus tremula*) in tissue culture, and offers transformations of these clones.

The facility employs 4,5 full-time employees, who during 2024 and 2025, performed 136 and 94 transformations, respectively. Hundreds of transgenic constructs are maintained in tissue-culture and more than two thousand trees are amplified every month for experiments.

CRISPR-Cas9-mediated gene editing is an important tool for *Populus* research and accounted for about 45 percent of the transformations conducted during 2024 and 2025.



Sweasp clone (photo: Veronica Bourquin)

Highlights of 2024-2025

- Finished all the preparation so we can offer the service to also do the transformation into *agrobacterium*.
- We also performed a few *agrobacteria* transformations.
- Rearranged the whole library of constructs older than 3 years to get better control and a more efficient maintenance of them.
- Bought an extra LAF bench which resulted in more flexible work hours for both team members and guests.
- Applied suggestions from team members to improve platform service and work efficiency.
- Moving the platform administration from SLU to UMU.
- In the end of 2024 we had a Kick-off with discussions/ ideas for the future and teambuilding activities.



Poplar biobank: Collection of older constructs (photo: Samuel Pettersson)

Future plans

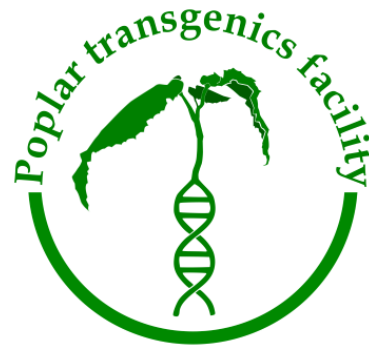
In 2026 the platform will continue to offer extended service with *agrobacterium* transformations. We are also on the way of getting more species included in our collection. In a little longer perspective we will continue working on getting a more efficient and ergonomic handling of the collection of the older constructs.

Personnel (2024-2025)

Director: Ove Nilsson

Manager: Veronica Bourquin

Staff: Iftikhar Ahmad, Sonia Olmedo Diaz, Rubén Casanova Saez, Sarah Lundgren, Kristýna Hladka, Manuela Jurca, Sam Cook, Jingjing Zhou, Barnabás Cseh, Julia Siegel.



Spruce Transformation Facility



Photo: Sofie Johansson

The Spruce Transformation Facility serves as a platform for testing candidate gene function in Norway spruce by primarily using *Agrobacterium* for transformation of early-stage somatic embryos (proembryogenic masses, PEMs). The PEMs are maintained and multiplied in vitro as Somatic Embryogenesis (SE) cultures and can be cryopreserved for long-term storage and induced to form plants for testing.

The facility is equipped to support all steps of the in vitro SE process followed by SE plant growth in the greenhouse. Specialized equipment for SE includes temporary-immersion bioreactors for scale up of embryo production or plant production, a filtration system for large volume sterile filtration of liquid culture medium and an automated system (SE fluidics system) for selection and harvest of mature embryos. A custom-made biolistic transformation instrument is also available.

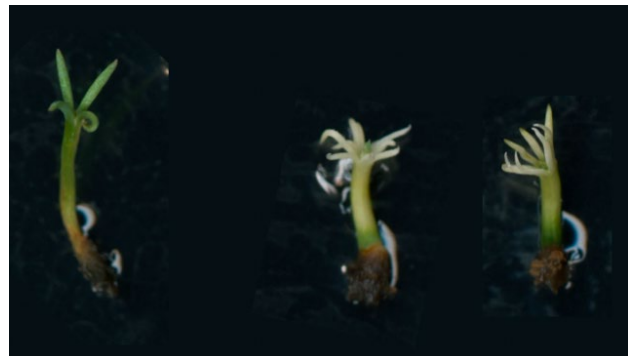


Overexpression of a 35S RUBY resulted in the production of a distinct pink coloration in roots, shoots, and stems (right) compared to wild-type controls (left) in Norway spruce (photo: Sofie Johansson)

Highlights of 2024-2025

- 48 transformations were performed, where 29 were for research projects and the rest for optimizations of our pipeline including further development of CRISPR and RNAi protocols.
- The average number of selected cell lines from each transformation increased from less than 10 to over 30, still with nearly 90% positive transformants, resulting in a tenfold increase in the number of transgenic lines from each transformation event.
- More than 3000 transgenic spruce germinants were produced from 20 over-expression constructs were planted where the transgene had been verified and quantified by qPCR at the PEM stage.
- The potential for early detection of an albino phenotype at the germination stage induced by an RNAi construct targeting DXS1 was confirmed.

- A Filemaker database was implemented to improve tracking and documentation of transformations.
- The visual detection of overexpression of a RUBY construct was used to optimize different steps of the transformation pipeline. Different promoters resulted in pink roots, pink shoots and stems, or a completely pink coloration of roots, shoots, and stems.
- The automated SE fluidics system for embryo selection and harvest was rebuilt and moved to UPSC to enable more frequent use.
- The first official invoice to an external customer was issued.



RNAi-mediated silencing of DXS1 resulted in an albino phenotype at the germinant stage (right) compared to wild-type controls (left) in Norway spruce (photo: Thomas Dobrenel)

Future plans

Improve the rates of establishment of germinants ex vitro in compost and further, plant growth to capture more transformed spruce plants for analyses at later stages of development. Continue to develop the CRISPR transformation system for Norway spruce to become part of the transformation pipeline. Establish routines for frequent use of the automated SE fluidics system for embryo selection and harvest to reduce the manual handling of mature embryos and improve selection of viable embryos for further development.

Personnel (2024-2025)

Director: Ove Nilsson

Senior advisor: Ulrika Egertsdotter

Staff: Sofie Johansson, Thomas Dobrenel, Rubén Casanova-Sáez, Iftikhar Ahmad, Sonja Viljamaa, Josefine Lind Björs



Photo: Mikael Wallerstedt

Swedish Metabolomics Centre

The Swedish Metabolomics Centre (SMC), based in Umeå, is a joint venture between Umeå University and SLU. The centre has operated nationally since 2013 on a fee-for-service basis and has been part of SciLifeLab since 2016. SMC provides untargeted and targeted metabolite and lipid profiling, quantitative metabolite panels, and method development support. Approximately 100 projects per year, representing ~90 PIs from all major Swedish universities, are handled. In addition, an open-access laboratory enables per-day use of mass spectrometers. SMC is acknowledged or co-author on ~35 publications annually, many in high-impact journals.



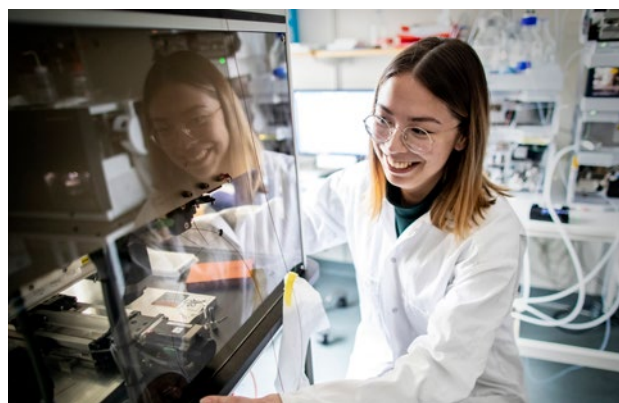
Swedish Metabolomics Centre performs mass spectrometry based metabolite analysis (photo: Rebecca Forsberg)

Highlights of 2024-2025

- Developed sensitive methods to quantify phytohormones in very low-volume tomato phloem sap collected using microsamplers (Roxhed, KTH), expanding plant hormone analysis capabilities.
- Developed a highly sensitive LC-MS/MS method for very low steroidal glycoalkaloids in potato (with SLU Uppsala). Published in *Plant Biotechnology Journal* (2025; doi:10.1111/pbi.70412).
- Established an LC-MS/MS method for simultaneous quantification of ten steroid hormones in 200 µL human plasma, now implemented in SMC's analytical portfolio and applied in human studies.
- Secured SciLifeLab funding for a high-resolution GC-MS, planned for installation in 2026, strengthening fluxomics and metabolite identification capacity.
- Co-organised scientific meetings in Umeå, including conferences on metabolomics and applied mass spectrometry, with hands-on workshops on FAIR data submission to MetaboLights in collaboration with EMBL-EBI and Umeå University Library.

Future plans

SMC will develop a new pre-processing pipeline for high-resolution GC-MS data, including software for isotope tracing, to strengthen fluxomics in collaboration with UPSC and Prof. Thomas Moritz (University of Copenhagen), aiming for service implementation from 2026. A major priority is to initiate spatial metabolomics through planned funding applications for a high-resolution imaging mass spectrometer, complementing existing imaging technologies at UPSC. Targeted panels (gibberellins, kynurenine pathway, neurotransmitters) will be expanded, and a Novo Nordisk Foundation-supported project will develop a curated microbial metabolite database to improve metabolite annotation.



About 100 metabolomics service projects are handled by the skilled staff each year (photo: Mikael Wallerstedt)

Personnel (2024-2025)

Director: Johan Trygg (UMU)
Manager: Annika Johansson (UMU)
Staff: Hans Stenlund (UMU), Elin Näsström (SLU), Maria Ahnlund (SLU), Christine Wegler (UMU), Krister Lundgren (SLU), Cecilia Petterson (SLU), Ondrej Hodek (SLU), Jenna Lihavainen (UMU; 25%)
Affiliated postdoctoral researchers: Mareike Gutensohn (UMU, left June 2025), Nurmeen Adil (SLU, started October 2025)



Swedish Metabolomics Centre

Tree Phenotyping Platform at UPSC



Photo: Ioana Gaboreanu

Tree Phenotyping platform automatically monitors and records the growth parameters of trees. A custom conveyor belt system is used for plant delivery to and from the imaging cabinets and watering stations. Weighing and watering stations deliver the water/fertilizer by volume or weight. Trees are measured and imaged by RGB cameras from side(s) and top and with infrared camera from top. The construction is exclusively lightened by artificial LED lights and allows the adjustments of light as well as the temperature/humidity. The platform is routinely used for growing 364 tall trees up to 2,5 meters high but can accommodate a total of 728 smaller trees.

Highlights of 2024-2025

- Eight runs were performed on the platform including nutrient uptake experiments, drought experiments and growth assessment experiments.
- The platform was used by seven groups from UPSC and collaborators that grew a total of 2478 trees.
- Shoot cuttings collected from an experimental field were tested for the first time as plant material.
- Tree growth was evaluated using different soil mixtures
- A high-density setup was tested in which plants were



Image from "Guataubá... / Rehearsing a lullaby for the herald of woe" by Luis Berríos Negrón et al, Phenotyping platform, UPSC 2024

- grown without spacers.
- Different poplar species were grown on the platform for the first time.
- A new feature was implemented into the WIWAM software allowing more flexibility when programming imaging/fertilization treatments.
- Two research papers have been published where the platform was used.
- We collaborated with Umeå School of Architecture at Umeå University for an art performance which took place at the platform and was focused on tree nurseries.
- We continued to present our platform to numerous groups including pupils, students and researchers from other universities.

Future plans

We will test the capacity of our heating/cooling system at the platform performing a heat and drought experiment.

We are planning to test different light conditions in the beginning and end of the day to simulate the natural light conditions.

Personnel (2024-2025)

Director: Ove Nilsson
Manager: Ioana Gaboreanu
Staff: Jan Karlsson



Left: Side image of a hybrid aspen tree T89 acquired by the WIWAM system; Right Top: Top image of a hybrid aspen tree T89 acquired by the WIWAM system; Right Bottom: Image analysis on the detailed image of the tree stem acquired by the WIWAM system.



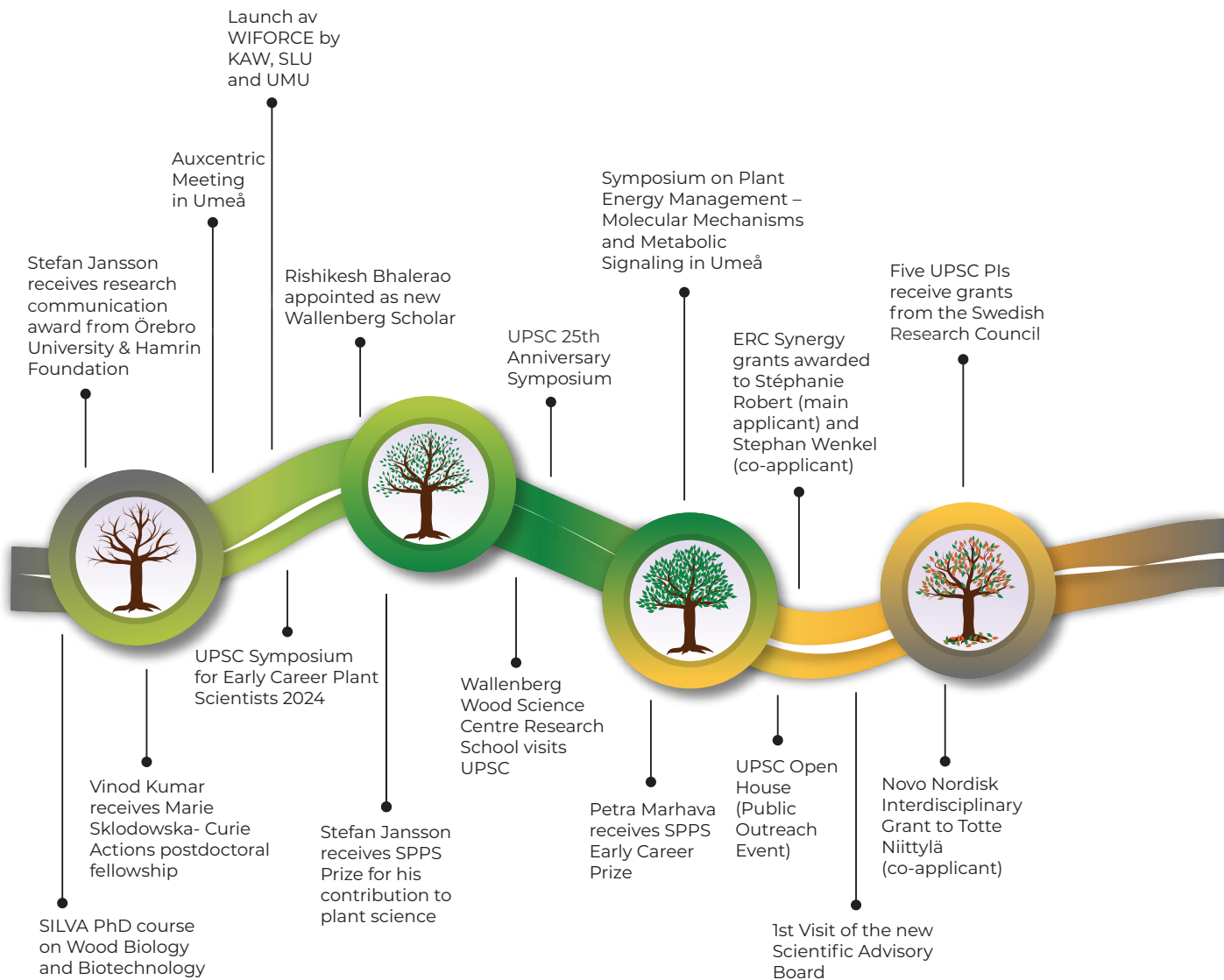
Spruce seedlings grown from seed (photo: Anne Honsel)



Celebrating 25-years of UPSC (photo: Mattias Pettersson, UMU)

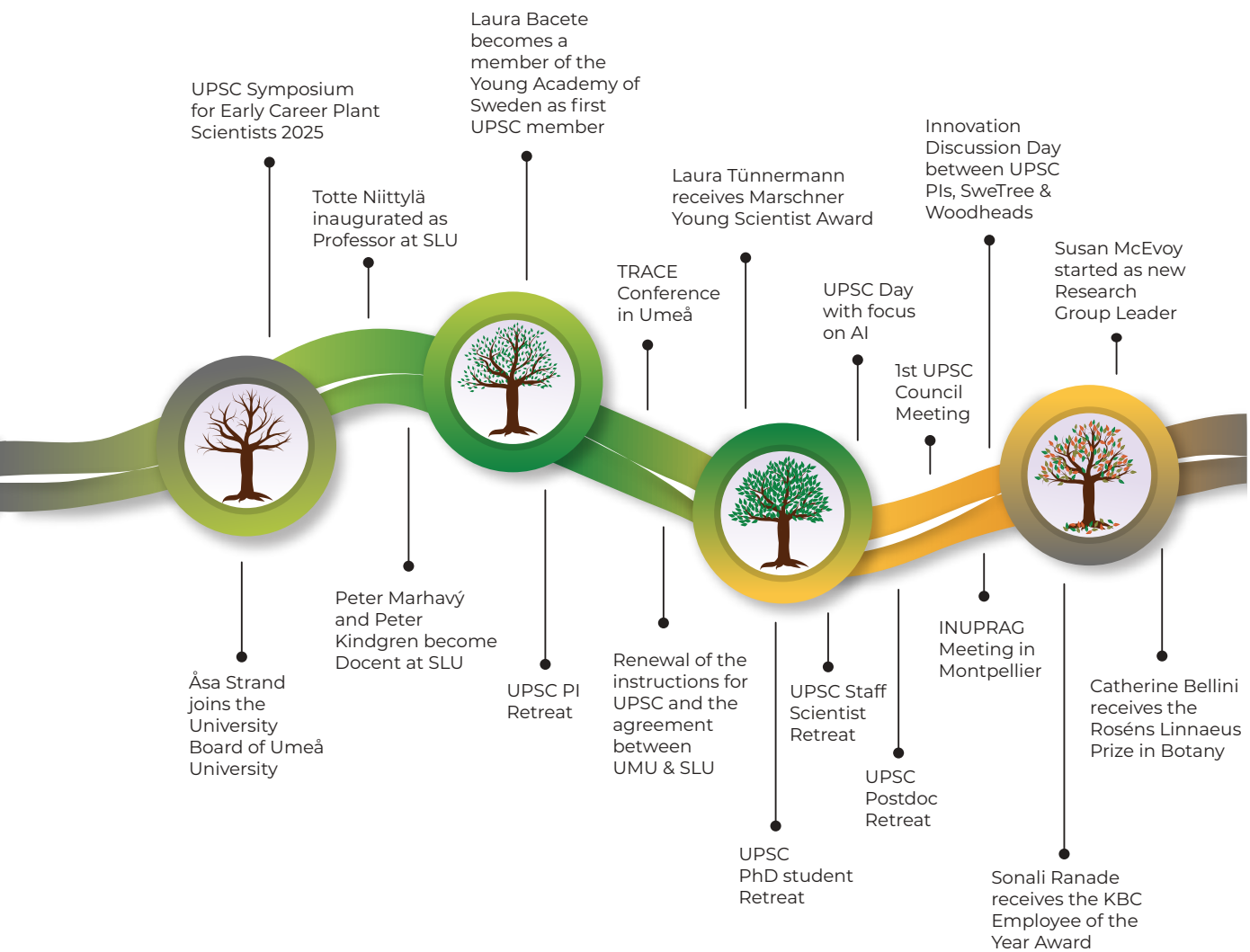
4. Highlights from 2024-2025

Centre Highlights 2024



Highlights from 2024-2025

Centre Highlights 2025



Tree images by Marcin from Pixabay

Research Highlights

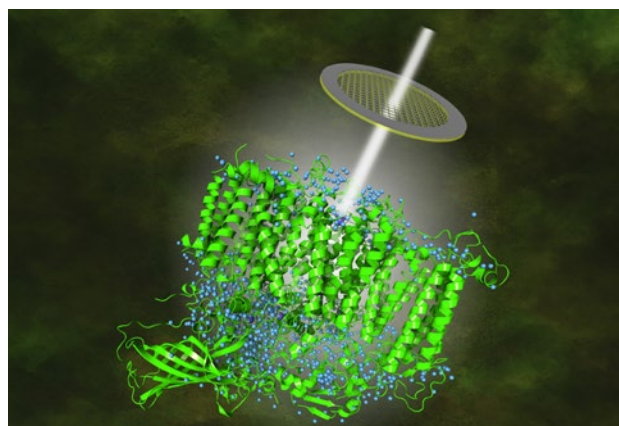
Details of photosynthesis revealed with record-breaking images

By generating extremely high-resolution images in a cryo-electron microscope, at a level never achieved before for comparable complexes, researchers at Umeå University have revealed the positions of hydrogen atoms and water molecules in photosynthesis. This breakthrough provides a new avenue towards uncovering how water is split – a process crucial for life on Earth as well as for scaling up renewable energy systems.

Using cryo-electron microscopy, the researchers produced a 1.7 Å resolution structure of Photosystem II from a cyanobacterium, marking a record for membrane protein complexes and enabling the detection of hydrogen atoms

“This resolution is a new record for a membrane protein complex, regardless of method or species”, says Wolfgang Schröder.

and previously unseen water molecules. These insights reveal how water enters the catalytic site and how protons are transported during photosynthesis, advancing understanding of water oxidation.



Stylistic image of how an electron beam from the cryo-microscope hits frozen PSII particles, whereby a reflection is formed that enables the reconstruction of how the atoms are situated (Image: Wolfgang Schröder)

Rana Hussein (2024) Cryo-electron microscopy reveals hydrogen positions and water networks in photosystem II, *Science* 384:1349-1355

“Junk” DNA helps plants to cope with cold stress



Thale cress in the snow. DNA previously thought to be “junk” has now been shown to help plants to cope better with cold stress (photo: Vaughan Hurry).

A vast amount of DNA contains no genetic information and was long thought to be junk. Recent research has shown that much of this “junk” DNA is in fact activated but it was not known why. Researchers from Umeå Plant Science Centre have now shown that this activation of “junk”-DNA plays a key role in promoting plant survival during stress.

Researchers from UPSC investigated so-called antisense “junk”-DNA, located opposite active genes, and found that its activation enhances the expression of stress-related genes. Using CRISPR-Cas9 to selectively reduce

“We are just beginning to understand why so much of this antisense DNA is activated in plants, but we see great potential to use this knowledge to make plants grow better in more stressful environments,” says Peter Kindgren.

antisense RNA production without affecting the corresponding genes, they showed that plants became less tolerant to cold when antisense activity was lowered.

Meena et al. (2024) Antisense transcription from stress-responsive transcription factors fine-tunes the cold response in *Arabidopsis*. *The Plant Cell* 36, 3467-3482

Research Highlights

Scientists unlock one of the toughest biomaterials and discover clues to pollen's expiration date



The researchers Olivier Keech and Clément Boussardon are studying pollen grains from Arabidopsis plants (photo: Rebecca Forsberg).

Scientists at Umeå University have found a way to break open the protective walls of pollen grains - one of the hardest biomaterials in the world - without damaging the inside cell and its components. This achievement opened the possibility to isolate and study mitochondria, parts of the cell essential for energy production. To their surprise, several proteins that are key for maintaining the energy production of the mitochondria, were nowhere to be found.

Using a newly developed technique, researchers were able to isolate intact mitochondria from pollen grains, which are normally protected by an extremely durable outer wall. After

“This discovery may explain why a pollen grain has a limited lifetime, and why it is fine tuned to survive for the duration of its unique mission - fertilization,” says Olivier Keech.

years of method development, the international collaboration discovered that these mitochondria lack key proteins needed for maintaining and repairing their genetic machinery. This suggests that pollen mitochondria are optimized for short-term energy production rather than long-term maintenance.

Boussardon et al. (2025) The atypical proteome of mitochondria from mature pollen grains. Current Biology (2025), Volume 35, Issue 4, 776-787.e5

A new regulatory link between cell walls and hormones controls differential growth in plants

Plant cell walls give stability to the plant, but they are not just rigid structures. The wall components dynamically interact with each other to influence growth and development. An international research team led by Rishikesh Bhalerao from SLU uncovered a new regulatory link between the plant cell wall and plant hormones.

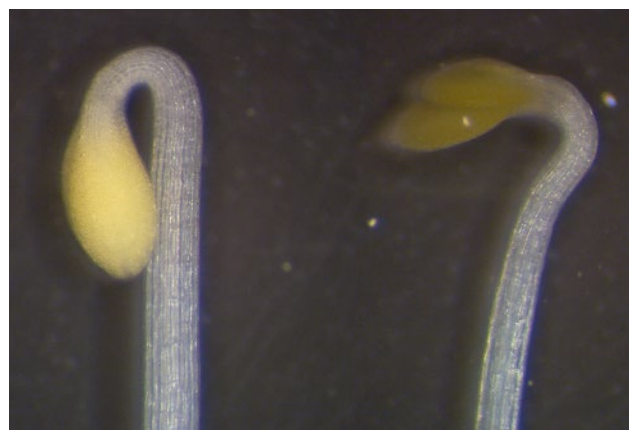
Focusing on a specific cell wall component, RG-II pectin, the researchers showed that its proper dimerization

“Cell wall components and hormones interact with each other in a dynamic manner and thus regulate growth and development”, says Rishikesh Bhalerao.

is essential for maintaining cell wall strength and regulating plant development. Using a mutant with weakened cell walls, they found that disruptions in RG-II pectin affect

the distribution of the growth hormone auxin by altering gene activity involved in its transport. They also uncovered a feedback link with brassinosteroids, another group of hormones, revealing a dynamic interplay between cell wall structure and hormone signalling.

Pawan Kumar Jewaria et al. (2025) Reduced RG-II pectin dimerization disrupts differential growth by attenuating hormonal regulation. Science Advances 11, eads0760



Thale cress seedlings with defective RG-II pectin dimerization (right seedling) cannot establish a full apical hook like non-modified seedlings (left seedling)(collage: Anne Honsel).

Research Highlights

New computational tool helps to identify long non-coding RNAs

An international research team, led by Jian-Feng Mao, have developed PlantLncBoost, a new computational tool that helps to identify long non-coding RNAs in plants. These RNAs are crucial for numerous biological processes but differ a lot between different plant species. PlantLncBoost addresses this challenge with very high accuracy offering new possibilities for genomic studies in plants.

Using machine learning, the researchers analysed over 1,600 features of RNA sequences and identified

“We have developed a tool that achieves both high accuracy and strong generalization capabilities,” explains Jian-Feng Mao.

key characteristics that distinguish long non-coding RNAs from protein-coding ones. By incorporating mathematical approaches, the tool detects underlying

sequence patterns that remain consistent across species despite high variability. Tested on datasets from 20 plant species, PlantLncBoost achieved over 96% accuracy and

outperformed existing methods, including successfully identifying previously validated lncRNAs. The tool is freely available and enables more accurate identification and comparison of these important regulatory molecules across diverse plant species.

Tian et al. (2025) PlantLncBoost: key features for plant lncRNA identification and significant improvement in accuracy and generalization. New Phytologist 247: 1538-1549



Jian-Feng Mao led the international team that developed the new long non-coding RNA analysis tool (photo: Mattias Pettersson, Umeå University).

Unlocking nature’s blueprint – scientists identified the function of a so far uncharacterised protein complex



The main authors of the study, Totte Niittylä (left) and Wei Wang (right), began working with OPENER while searching for unknown genes essential for early seed development in Arabidopsis. Photo: Rebecca Forsberg

Scientists have uncovered the functions of many genes and proteins across different organisms, but much is still unknown. Now, researchers at Umeå Plant Science Centre have identified the function of a protein complex involved in establishing protein production in plants.

Focusing on previously uncharacterised essential genes in Arabidopsis, the researchers identified a gene named OPENER, which is crucial for early seed development.

They discovered that the OPENER protein interacts with others to form a multi-protein complex with a unique structure, revealed using the AI tool AlphaFold. By combining structural predictions with biochemical and cell

“We realised that the proteins combine to form a distinctive three-fingered, claw-like structure. This was the “AlphaFold moment” of the project”, says Wei Wang.

biology approaches, the team showed that this complex plays a key role in assembling ribosomes, the cellular machinery responsible for protein synthesis. The findings reveal an additional layer of regulation in this fundamental process.

Wang et al. (2025), Ribosome biogenesis in plants requires the nuclear envelope and mitochondria localized OPENER complex. Nature Communications 16, 7301

Research Highlights

The protein that helps seedlings straighten



To investigate how the apical hook forms and opens, researchers grow thale cress seedlings in darkness (photo: Qian Ma).

Seedlings bend their tip as they grow through soil, then straighten when they reach light. Scientists from Umeå have, after years of challenging research, identified a protein that promotes this straightening by regulating cell growth through the plant hormone auxin.

Using a chemical screening approach, the researchers identified the protein RACK1A as a key regulator of apical hook opening, a critical step in early plant development. They showed that RACK1A controls the distribution of the hormone auxin, which drives differential cell

“Thanks to these methods we found that RACK1A is involved in apical hook opening. The protein was known before, but this function was completely new”, explains Siamsa Doyle.

growth on opposite sides of the seedling tip. By reducing auxin accumulation, RACK1A allows previously inhibited

cells to resume growth, leading to the straightening of the seedling. This discovery reveals a previously unknown role for RACK1A and provides new insights into how plants regulate growth and respond to their environment.

Ma et al. (2025). RACK1A positively regulates opening of the apical hook in Arabidopsis thaliana via suppression of its auxin response gradient. PNAS 122 (30), e2407224122

Aspen trees integrate light and temperature to time bud set

Even in summer, sudden cold snaps are common in northern regions such as Umeå. To survive, trees must know when to keep growing and when to stop and prepare for winter. Now, researchers at UPSC have discovered how aspen trees sense temperature and combine it with daylight to make that decision.

The researchers identified two key proteins, Phytochrome B and PIF4, that act together as a temperature-sensitive

“Understanding how trees sense and respond to temperature could help us breed trees that are better adapted to a changing climate”, says Ove Nilsson.

system integrating light and temperature signals. By studying modified aspen trees, they found that these proteins respond differently under cooler conditions: Phytochrome B

promotes continued growth during cool summer days, while PIF4 helps trigger growth cessation as temperatures drop in autumn. This mechanism explains how trees fine-tune seasonal timing and reveals that genes can function differently in perennial trees compared to annual plants.



A “temperature sensor” helps trees integrate temperature and day length when deciding to enter dormancy. The four of the six study authors that are still active in the group (from left to right): Keh Chien Lee, Laura García Romañach, Bo Zhang, Ove Nilsson (photo: Anne Honsel).

Bo Zhang, Keh Chien Lee, Laura García Romañach, Jihua Ding, Alice Marcon & Ove Nilsson, Phytochrome B and phytochrome-interacting-factor4 modulate tree seasonal growth in cold environments, Nature Communications (2025) 16:8114

Steps of FeMo-co synthesis

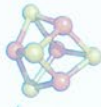


FeMo-co is synthesized in three steps

1. [4Fe-4S]

- NifU

→ Transferred to NifB



■ 2Fe-2S ■ 4Fe-4S ● P-cluster ● NifB-co ● FeMo-co





*UPSC Alumni Stefan Burén presents his research at the *UPSC 25th Anniversary Symposium (photo: Mattias Pettersson, UMU)*



Lab tour at the UPSC Open House (photo: Alexis Brun)

Highlights from Education

Teaching activities UPSC

The **Department of Forest Genetics and Plant Physiology** at SLU is involved in five undergraduate courses in the Bachelor programme in Forestry at SLU Umeå. The courses have around 20-40 students and deal with topics from wood biology and chemistry to genetics and tree breeding. In addition, the department is involved in a Master course in Plant growth and development together with SLU Alnarp, SLU Uppsala, and Umeå University. This course collects around 40 students from several campuses in a hybrid format. In 2025, the department has been actively involved in planning the new engineering programme at SLU and the year of preparational studies in natural science, starting in 2026.

Our collaboration within UPSC enable us to be involved in courses run by Umeå University. Our department offers thesis courses for students during their undergraduate studies. Furthermore, we have a strong international presence of European students on the Erasmus+ programme and other exchange students that function as an important gateway to attract future PhD students.



UPSC arranged a weekly “summer fika” for the visiting students over summer. (photo: Junko Takahashi Schmidt)

The **Department of Plant Physiology** at Umeå University organises and administers the Master’s Programme in Plant and Forest Biotechnology. Plant biotechnology has been established as an increasingly important tool for solving global problems of food, feed, fuel and ecosystem management in an environmentally sound and sustainable manner. To this end, courses within this 2-year programme are designed to provide students with a strong, up-to-date theoretical background and practical skills in plant physiology, molecular biology, biotechnology and molecular breeding. Special sections are dedicated to also raise awareness and understanding of the ethical, ecological and legal aspects of plant biotechnology.

In 2025, Umeå University established a new Master’s Programme in Bioinformatics that is starting in 2026. In this programme, students will study how data science, computational and statistical approaches are applied to enable novel biological insights. The programme will provide a broad insight into the use of bioinformatics, from clinical genetics to plant biotechnology and biodiversity monitoring.

PhD Education

Both UPSC departments educate PhD students and have a similar number of PhD students, rather constantly around 20 PhD students each. On average there are three to four PhD defences per year per department, but during the years 2024 and 2025 there were 15 in total at UPSC.

Although Umeå University and SLU have different formal procedures and requirements concerning PhD education, our ambition is that the UPSC PhD education should be as homogenous and aligned as possible. For example, they all present their progress in the weekly UPSC Monday Seminar series. Since 2023, a UPSC halftime seminar day is organized with several PhD students presenting the progress of their PhD projects. These half-time seminar days are organized 2-3 times a year and involve an evaluation by invited external evaluators.

In 2024, a postgraduate international NOVA course was organised at SLU entitled SILVA Wood Biology and Biotechnology. This five-day course included content reaching from cellular processes, training in wood anatomy and bioinformatics to discussions on computer-based simulations of biomolecules and industrial application possibilities. In 2025, an “Introduction to thesis” writing course, equivalent to 4 ECTS, was established at Umeå University which aims at developing writing skills and gaining insight about the literature early in the PhD education programme.



Participants and teachers of the Wood Biology and Biotechnology course at Umeå Plant Science Centre (photo: Anna Shevtsova)

Highlights from 2024-2025

PhD Graduates

To save plants motivated her to do her PhD in forest regeneration

The choice of the planting position can determine if a tree seedling survives or not. Bodil Häggström always cared about the fate of seedlings which motivated her to investigate in her PhD the effect of different regeneration practices on the survival rate of tree seedlings. Her results reveal that there is no one-size-fits-all solution but recommends diversifying planting recommendations, especially when considering increasing drought periods in spring. She defended her PhD thesis at the Department of Forest Genetics and Plant Physiology, SLU, on the 14th of March 2024.

Title of the thesis: **Improving boreal forest regeneration in a variable climate**



PhD student Bodil Häggström has studied the effect of different regeneration practices on the survival of forest tree seedlings (photo: Anne Honsel).



PhD student Johan Sjölander discovered that modifying the internal clock in hybrid aspen can increase growth (photo: Anne Honsel).

Modulating the internal clock increases growth in hybrid aspen

The internal clock coordinates plant growth and adaptation to daily and seasonal changes. It is among others acting via plant hormones. These small molecules are present in low concentrations in plants and control plant growth. Johan Sjölander focussed his PhD studies on the connection between the clock and plant hormones, particularly gibberellin. He discovered that modifying clock components altered the levels of this plant hormone and increased growth in hybrid aspen. He defended his PhD thesis at the Department of Plant Physiology, Umeå University, on the 14th of June 2024.

Title of the thesis: **Timing is everything: Exploring the role of the circadian clock in plant growth and adaptation**

Plant cell wall research opens up new opportunities for bioengineering

Secondary cell walls provide the plant with stability and protection against damage and pathogens. PhD student Félix Barbut from Ewa Mellerowicz's group has been studying the role of xylan, a long-chain carbohydrate, that is part of the secondary cell wall. He not only identified new molecular players involved in maintaining the integrity of the cell wall, but also interesting target points for bioengineering. Félix Barbut defended his PhD thesis on the 14th of June 2024 at the Department of Forest Genetics and Plant Physiology, SLU.

Title of the thesis: **Unraveling the Role of Xylan in the Integrity of Secondary Cell Walls: Insights from Arabidopsis and Aspen**



PhD student Félix Barbut has studied the function and development of secondary cell walls (photo: Christine Pottier).

Highlights from 2024-2025

PhD Graduates

Identifying putative functions of long non-coding RNAs in trees

Many things were not known when she started her PhD, but Camilla Canovi was not scared by the abyss. She developed a bioinformatics pipeline to identify and assign putative functions to long non-coding RNAs – RNA molecules that do not contain instructions for making proteins. Camilla Canovi applied this pipeline to spruce and aspen and also started to validate her predictions in aspen trees. She defended her PhD thesis at the Department of Plant Physiology, Umeå University, on the 24th of October 2024.

Title of the thesis: **Tackling a genomic abyss: Approaches to link long non-coding RNAs to potential biological function in Norway spruce and aspen**



Camilla Canovi showing the first aspen trees that she modified with the CRISPR-Cas9 technology to remove a putative long non-coding RNA. She successfully defended her PhD thesis last week (photo: Anne Honsel).



PhD student Nabila El Arbi (right) successfully defended her PhD thesis that was supervised by Markus Schmid (left) (photo: Anne Honsel).

Nabila El Arbi sheds light on plant RNA regulation

The central dogma of biology states that DNA is transcribed into RNA, which is then translated into proteins, assuming that one gene contains the information for one protein. However, RNA modifications like alternative splicing can produce multiple proteins from a single gene. Not much is known about this in plants, but PhD student Nabila El Arbi dived into the unknown and started to enlighten it. She defended her PhD thesis at the Department of Plant Physiology, Umeå University, on the 17th of December 2024.

Title of thesis: **Exploring the Role of RNA Metabolism in the Context of Plant Development under Temperature Stress**

Untangling the multifaceted cold response in plants

Plants have developed versatile processes to react to cold temperatures. Varvara Dikaya studied PORCUPINE, a protein that is part of a hub regulating responses to environmental cues like cold. In her PhD thesis, she showed that there is not just a single link between PORCUPINE and cold signalling, but multiple intertwined passes that act simultaneously. She defended her PhD thesis on the 28th of February 2025 at the Department of Plant Physiology, Umeå University.

Title of thesis: **Broken Sm-ring: A quest to the source of the cold sensitivity of the *A.thaliana* SmE1 splicing mutant**



PhD student Varvara Dikaya has studied how plants adjust to cold by focussing on the protein PORCUPINE (photo: Nabila El Arbi).

Highlights from 2024-2025

PhD Graduates

Novel instrument advances research on photoprotection in plants

Light drives photosynthesis, but excessive light can be harmful. Plants protect themselves by converting surplus energy in their chloroplasts into heat for dissipation. PhD student Sanchali Nanda helped validate a novel instrument that monitors the stress levels of plants and used it to gain new insights on their energy dissipation mechanisms. She defended her PhD thesis at the Department of Plant Physiology, Umeå University, on the 6th of March 2025.

Title of the thesis: **New light on photoprotection: Spectral resolution of non-photochemical quenching**



PhD student Sanchali Nanda (front) and her supervisor Stefan Jansson (back) at the ChloroSpec instrument at UPSC (photo: Anne Honsel).



PhD student Mikko Luomaranta

Natural variation study provides new tools for tree breeding

Considerable genetic diversity exists within a single species. PhD student Mikko Luomaranta examined this natural variation in Swedish aspen to reveal the genetic basis of key traits such as growth, biomass accumulation, wood quality, and disease resistance, and their links to lignin biosynthesis. The genetic markers identified in this work support breeding of deciduous trees with improved resilience and higher biorefinery value. Mikko Luomaranta defended his PhD thesis at the Department of Forest Genetics and Plant Physiology, SLU, on 28 March 2025.

Title of the thesis: **Decoding lignin in Swedish aspen: Paths to Better Feedstocks and Resilient Trees**

New genetic insights on seasonal growth in aspen

Deciduous trees have to adjust their growth and development to the respective season, but how is this regulated? PhD student Alice Marcon set out to investigate this and characterised the function of two flowering genes that regulate not only flowering but also seasonal growth in poplar. She also created a seasonal roadmap of gene activities and identified key genes regulating bud dormancy, bud flush and flowering providing valuable information for tree breeding programmes. Alice Marcon defended her PhD thesis on the 4th of April 2025 at the Department of Forest Genetics and Plant Physiology, SLU.

Title of the thesis: **Regulation of flowering time and phenology in Populus trees**



PhD student Alice Marcon has studied flowering and seasonal growth in trees.

Highlights from 2024-2025

PhD Graduates

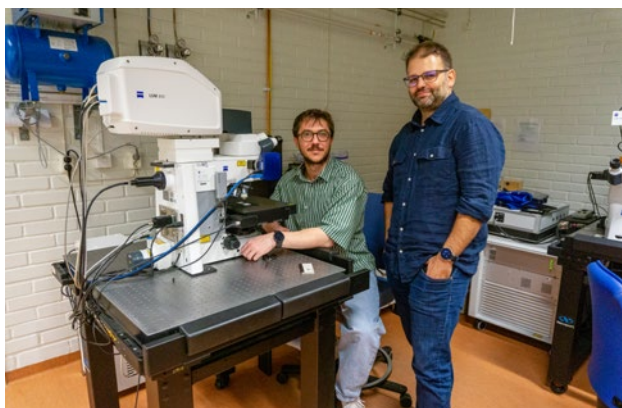
Small but mighty – nitrogen fertilisation affects (some) microbial communities in boreal forests

Microbes like bacteria and fungi are all around us, yet we rarely notice them. Tinkara Bizjak-Johansson studied microbial communities in boreal forests and showed that fertilisation shifts fungal community composition in the soil but does not affect nitrogen-fixing bacteria in conifer needles. She defended her PhD thesis at the Department of Forest Genetics and Plant Physiology, SLU, on the 5th of June 2025.

Title of the thesis: **Some aspects on boreal forest microbiotas and nitrogen**



Always fascinated by microbes, Tinkara Bizjak-Johansson investigated bacterial and fungal communities in boreal forests during her PhD in Annika Nordin's research group (photo: Anne Honsel).



PhD student Özer Erguvan (left) at his favourite microscope, together with his supervisor Stéphane Verger (right) (photo: Anne Honsel).

New discovery challenges old assumptions about how plant cells stick together

PhD student Özer Erguvan discovered two key sites in plant cell walls that help cells stick together - findings that challenge textbook knowledge. He also found that sugars play a role in this process. Özer Erguvan defended his PhD thesis at the Department of Forest Genetics and Plant Physiology, SLU, on the 3rd of October 2025.

Title of thesis: **Ultrastructural and molecular basis of cell-cell adhesion in plants**

Thinner snow, colder roots – boreal trees show unique cold responses

Climate change likely leads to thinner snow cover during winter in northern Europe, leaving tree roots more exposed to cold. PhD student Tuuli Aro found that boreal tree species respond differently to this kind of stress and highlights how genomic tools can help breed for more frost-tolerant trees. She defended her PhD thesis on the 9th of October 2025 at the Department of Forest Genetics and Plant Physiology, SLU.

Title of thesis: **Colder in a warming world - global warming challenges low temperature resilience of boreal trees**



PhD student Tuuli Aro has studied how the roots of boreal trees, such as birch, respond to cold (photo: Anne Honsel).

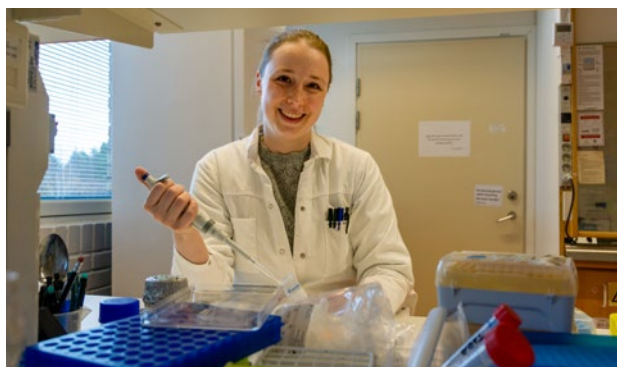
Highlights from 2024-2025

PhD Graduates

New insights into how plants regulate the uptake of organic nitrogen

Plants can absorb amino acids as an alternative nitrogen source to nitrate and ammonium but little is known about how this process is regulated. PhD student Laura Tünnermann has now identified new molecular regulators, offering insights that may help reduce fertilizer-related pollution. She defended her PhD thesis at the Department of Forest Genetics and Plant Physiology, SLU, on the 17th of October 2025.

Title of the thesis: **Organic nitrogen – molecular regulation of uptake and physiological implications**



PhD student Laura Tünnermann studied how plants take up amino acids (photo: Anne Honsel).



Léa Bogdziewicz has developed new tools that make it possible to study how plant cells attach to each other, a feature that enables trees to grow several meters tall (photo: Roxane Bogdziewicz).

New tools to study how plant cells stick together

How can a tree grow several meters tall? The answer lies in the ability of plant cells to attach to each other. This process has long been difficult to study, but PhD student Léa Bogdziewicz has developed methods that make it possible to study the process on a whole new level. She defended her PhD thesis at the Department of Forest Genetics and Plant Physiology, SLU, on the 30th of October 2025.

Title of the thesis: **Who comes first? Implications of the plant-microbiome-soil continuum feedback on plant performance**

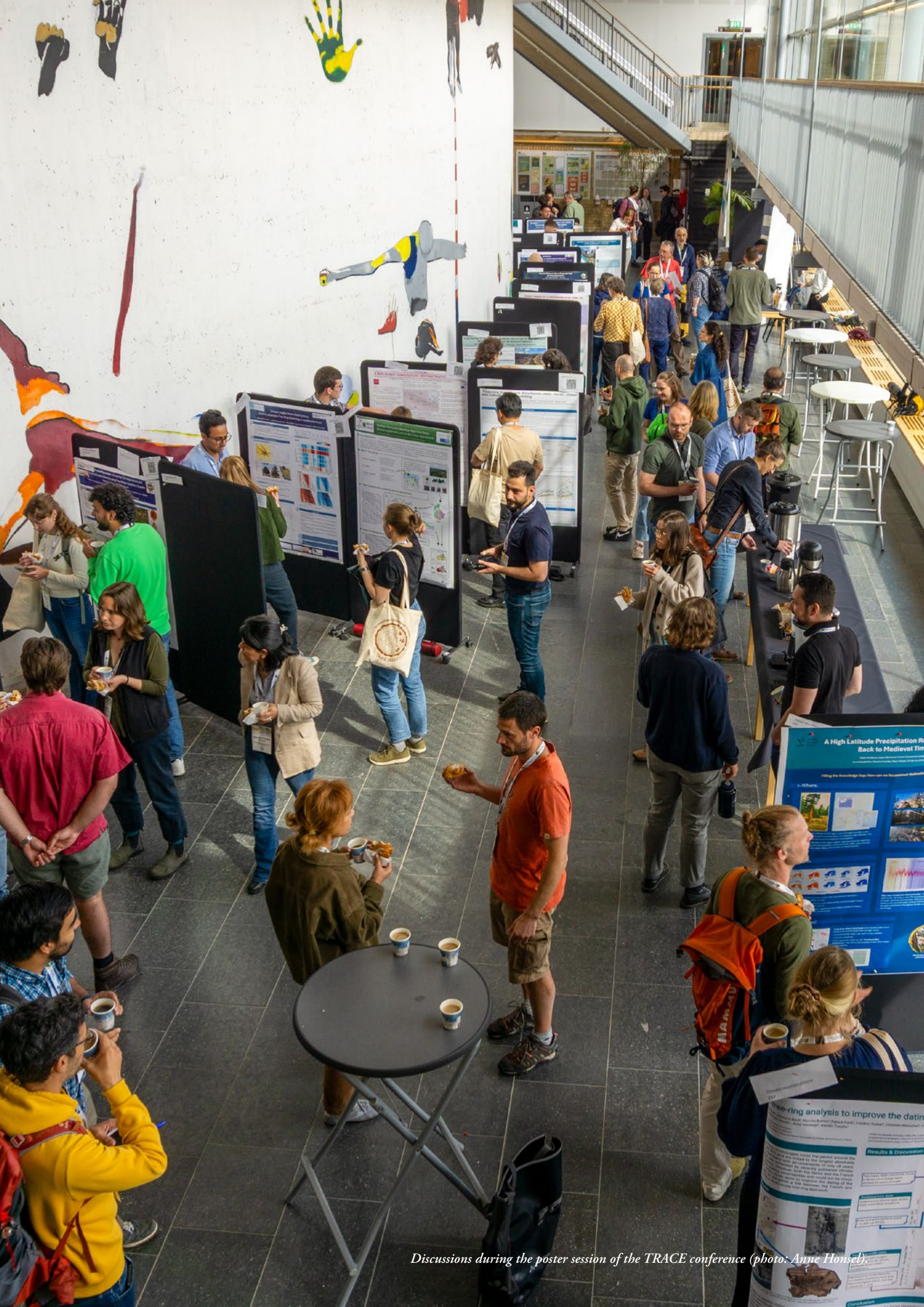
Nitrate affects wood development, not just growth

Different nitrogen fertilisers increase tree growth, but nitrate also specifically affects wood formation and wood properties. Anna Renström has shown this in her PhD thesis, offering new fundamental insights that can support more sustainable nitrogen use in forests. She defended her PhD thesis on the 15th of December 2025 at the Department of Forest Genetics and Plant Physiology, SLU.

Title of the thesis: **Physiological and molecular responses to nitrogen-stimulated cambial growth in aspen**



Anna Renström has applied different nitrogen sources to hybrid aspen trees to test their effect on wood formation (photo: Anne Honsel).



Discussions during the poster session of the TRACE conference (photo: Anne Honsel).

Collaborations and Scientific Exchange

UPSC maintains strong national and international collaborations, connecting researchers with leading scientific environments around the world. These collaborations take many forms, ranging from joint projects between individual research groups to long-term institutional partnerships. One example is the trilateral INUPRAG cooperation with INRAE in France and CRAG in Barcelona, Spain, which met in Montpellier in October 2025 for scientific exchange.

An important national partner is the Science for Life Laboratory (SciLifeLab), including the Wallenberg National Data-Driven Life Science (DDLs) programme hosted by SciLifeLab. This collaboration has been further strengthened in 2024-2025 by the expansion of the bioinformatics environment at UPSC and the integration of staff from SciLifeLab infrastructures such as NBIS and the Training Hub.

Beyond these formal partnerships, UPSC researchers actively contribute to and organise conferences, workshops, and networking events that bring together the plant science community. Selected examples from 2024 and 2025 are highlighted below.

Conferences and meetings in Umeå

The year 2024 began with the Auxentric meeting in Umeå, organised by Stéphanie Robert, Stéphane Verger, Petra Marhava, and Karin Ljung. Around 70 researchers working in the auxin field came together for three days of discussion, creating an interactive setting for sharing ongoing research and strengthening collaborations.

Later that year, the international conference Plant Energy Management – Molecular Mechanisms and Metabolic Signaling brought researchers from across the world to Umeå. Organised by Johannes Hanson together with Vanessa Wahl (UK) and Benoît Menand (France), the week-long meeting focused on different aspects of plant energy management. The exchanges during the conference



Participants at the TRACE conference in Umeå (photo: Anne Honsel).

led to a special issue in the Journal of Experimental Botany, published in the beginning of 2026.

In 2025, the focus shifted to interdisciplinary collaboration with the TRACE (Tree Rings in Archaeology, Climatology and Ecology) conference, hosted by Kelly Swarts and her group. Bringing together around 150 researchers and students from archaeology, climatology, and ecology, the conference provided a platform for exchanging knowledge and methodologies in tree-ring research. A strong emphasis was placed on supporting early-career researchers, with prizes awarded for outstanding theses and conference presentations. Among this year's awardees was Vasilina Akulova, a PhD student in Kelly Swarts' group, who received the prize for best talk.

UPSC also continued to organise the annual UPSC Symposium for Early Career Plant Scientists, bringing young researchers to Umeå and providing a platform for scientific exchange and career development.



Career discussions at the UPSC Symposium for Early Career Plant Scientists (photo: Anne Honsel).

Workshops and collaborative initiatives

Within the framework of NorthFood: Plant Science for Change, one of Umeå University's prioritised research areas, several workshops were organised to stimulate collaboration. For example, a workshop on potato research brought together researchers and stakeholders to exchange scientific insights and practical perspectives in potato farming.

In October 2025, SweTree Technologies AB co-organised, together with UPSC, an Innovation Day focused on challenges and future needs in the forest sector. Representatives from major Swedish forest companies - including Stora Enso, Sveaskog, Holmen, SCA, and Södra - as well as UPSC researcher participated. The event provided a platform for discussing challenges and exploring potential solutions in interactive and creative formats.

Highlights from 2024-2025

UPSC Outreach Activities

Communicating our research and activities to the wider society is a central part of UPSC's mission. We pursue this in a variety of ways and highlight below some key outreach activities from 2024 and 2025.

Events at UPSC

In June 2024, UPSC celebrated its 25th anniversary with the **UPSC 25th Anniversary Symposium**, a two-day symposium bringing together current researchers and alumni. The programme highlighted key scientific achievements from the past 25 years, including plant hormone profiling, genomics, photosynthesis, and wood biology, and featured presentations from both alumni and current researchers. Alongside scientific presentations, the symposium also created space for reconnecting and exchange across generations of UPSC researchers.

On 19 October 2024, UPSC marked the 7th International Fascination of Plants Day by opening its facilities to the public for the **UPSC Open House**. Visitors explored our research through guided tours and hands-on activities. The event was primarily aimed at students but open to all, with moderate advertising. Around 100 visitors attended, and the event was covered in the local newspaper.



Muhammad Shahzad Anjam talks about his research on plant-parasitic nematodes at the UPSC Open House (photo: Alexis Brun).

Reaching out through public events and activities

Beyond activities hosted at UPSC, researchers contributed to a range of public outreach events in 2024 and 2025. At “ForskarFredag” and the SLU Open House, organised by Umeå University and SLU respectively, families and young visitors explored plant science through interactive activities.

Other formats reached broader audiences. At “Pint of Science”, organised annually by the Umeå Postdoc Society, UPSC postdoc Maximiliano Estravis Barcala presented research in an informal pub setting. In Researchers’ Grand

Prix, a science communication competition for secondary school students, UPSC PhD student Laura García Romañach presented her research in a competitive format.

UPSC also continued to host school classes and visiting groups, offering guided tours of its research and facilities.



The Minister for Climate and the Environment Romina Pourmokhtari visited SLU in Umeå in May 2025 and came also to UPSC to hear more about tree breeding (photo: Annika Mossing)

Sharing Research and Staying Connected

UPSC continued to develop its digital communication channels. LinkedIn remains the main platform, reaching more than 7,500 followers by the end of 2025, primarily professionals in research and education, with a strong base in Sweden and India. In 2025, UPSC discontinued its activities on X and began building a presence on Bluesky, focusing on the research community.

To complement these efforts, UPSC launched the newsletter UPSC Insights in October 2025. Published four times per year, it focuses on engaging the UPSC community, particularly alumni. Each issue includes an alumni interview alongside research highlights and updates. The newsletter is still in its initial phase, with ongoing efforts to expand its subscriber base.



Some of the UPSC researchers participating at the SLU Open House in 2025 (photo: Sujan Maharjan).

Highlights from 2024-2025

Working at UPSC

At UPSC, collaboration and exchange across research groups are actively encouraged through shared laboratories, equipment, and office spaces, as well as joint seminars, meetings, and other activities. Our aim is to create an open and stimulating work environment where people can thrive and carry out excellent research.

Since 2021, we have conducted an annual work environment survey to identify areas for continuous improvement. Over the past five years, the results have been encouraging, although certain topics such as stress are raised repeatedly. We remain committed to listening to staff feedback and continuously improving the work environment.



PhD students at the UPSC retreat in September 2025 during a workshop on graphical abstract illustration (Photo: Elena Mondino, instructor at “Visualize your Science”).

Community, Development and Exchange

Alongside everyday interactions, UPSC fosters exchange through retreats and internal events. While 2024 was largely shaped by the 25th anniversary celebrations, regular activities resumed in 2025, including retreats for PhD students, postdocs, staff scientists, and principal investigators. Each group organises its own retreat, focusing on topics relevant to their roles and often inviting external trainers.

For example, PhD students participated in workshops on academic productivity, stress management, and science communication, while staff scientists held a full-day workshop to define a shared direction, develop an action plan, and strengthen their sense of community.

UPSC also continued to organise regular Welcome meetings, as well as recurring events such as the Christmas and Midsummer lectures. Information sessions on Swedish academia and career paths, introduced after the UPSC Days in Saxnäs in 2022, remain part of the programme.

A Vibrant Community

A key strength of UPSC is its active and engaged community, which organises a wide range of social



Halloween party in the UPSC lunchroom in 2025 (photo: Alexis Brun).

activities throughout the year. These include Thursday pubs, movie nights, pizza and ping-pong evenings, and an annual Halloween party. During the summer, the “UPSCgardeners” cultivate vegetables in garden boxes outside the building.

In early 2025, a “Laughter Club” was introduced, offering sessions of laughter yoga aimed at reducing stress and promoting well-being.

UPSC Day 2025

In August 2025, UPSC Day was held at Hotel Mimer in Umeå, bringing together the entire centre for a day of exchange and interaction. The programme began with updates from UPSC leadership and the WIFORCE initiative, followed by a scientific session featuring talks by future group leaders Susan McEvoy, Juan Alonso-Serra, and Leonard Blaschek.

The day also included a well-received laughter and breathing session led by Sonali Ranade, who runs the Laughter Club. In the afternoon, Matt Low hosted an interactive workshop on artificial intelligence, offering practical insights for both beginners and more experienced users.

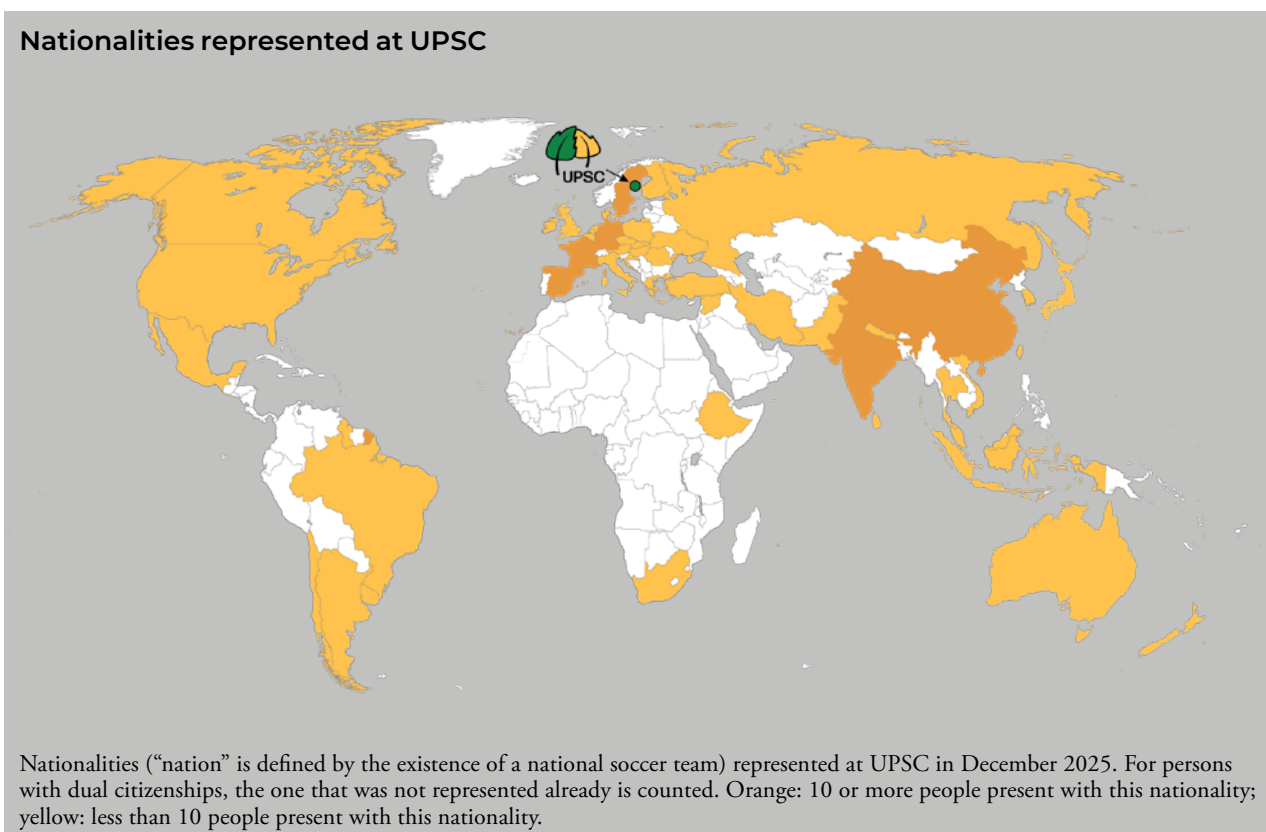
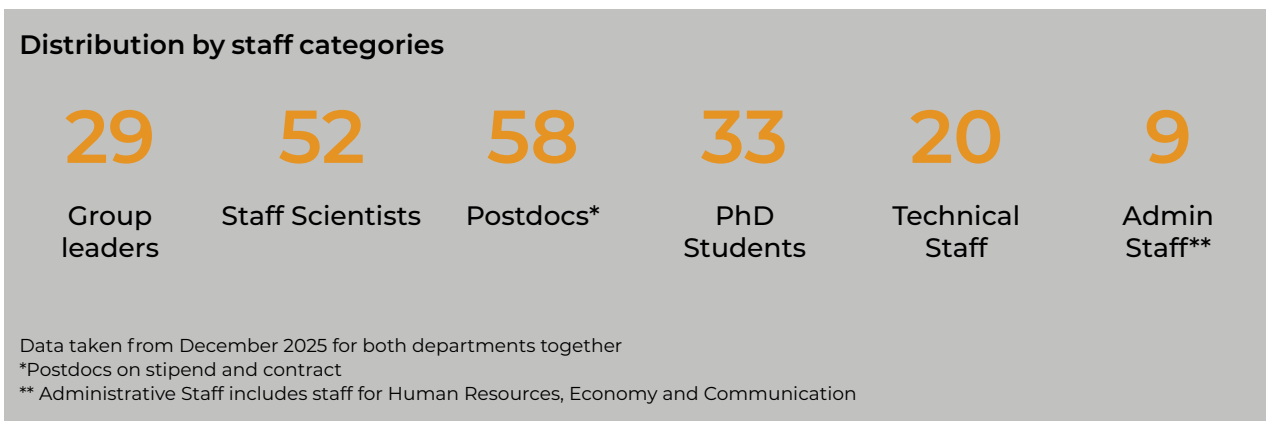
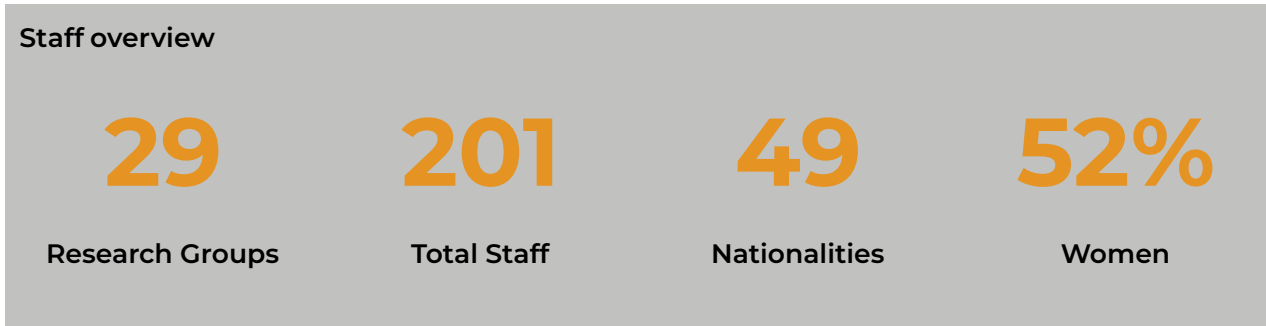


Laughing session at the UPSC Days 2025 in Umeå (photo: Anne Honsel).

5. Institutional Insights

Institutional Insights

People at UPSC



Institutional Insights

Funding

The total funding of Umeå Plant Science Centre for the years 2024-2025 is shown as combined income (figure 1) and costs (figure 2) from the Department of Forest Genetics and Plant Physiology, SLU and the Department of Plant Physiology, Umeå University. The four largest contributors are the Knut and Alice Wallenberg Foundation, the Swedish Research Council, Kempestiftelserna and SciLifeLab.

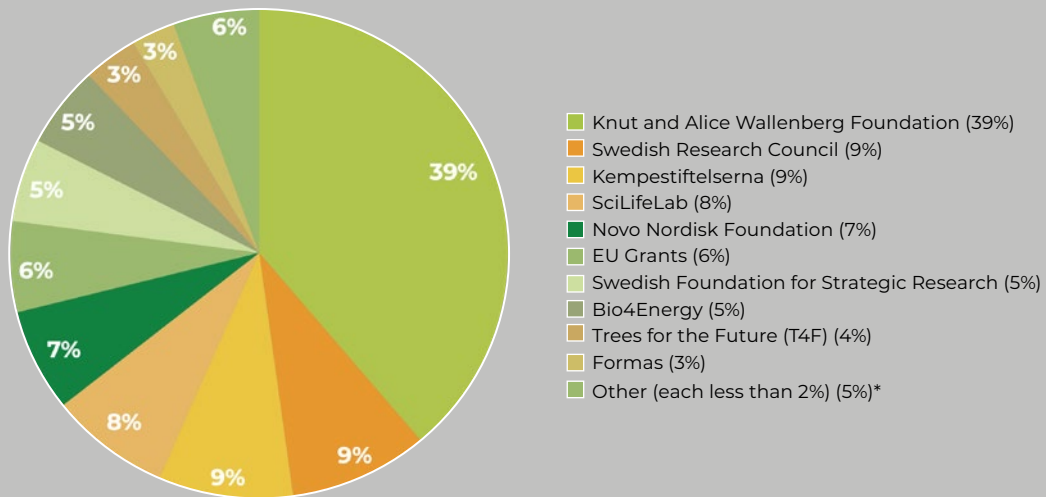
Figure 1: Income of UPSC under 2024 and 2025

a) Total Income 2024/2025:

531,2 MSEK

↑ +14% compared to 2022 and 2023 (462,6 MSEK)

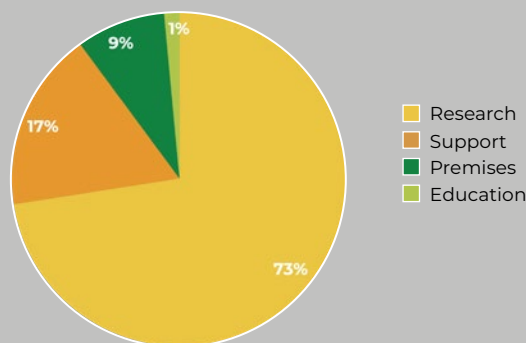
b) Income from External Funders: 268,9 MSEK



* Other funders specified:

Carl Trygger Foundation, Vinnova, Foundations affiliated/associated with SLU/UMU, The Royal Swedish Academy of Agriculture and Forestry, The Royal Swedish Academy of Sciences, Norwegian University of Life Sciences, StoraEnsa, Center for Business and Policy Studies, The Nordic Joint Committee for Agricultural and Food Research, Scandinavian Plant Physiology Society (SPPS), The Swedish Foundation for International Cooperation in Research and Higher Education, King Saudi University, Saudi Arabia, The Swedish International Development Cooperation Agency, Magnus Bergvalls Stiftelse, Föreningen Skogsträdsförädling, Stiftelsen Skogssällskapet, Stiftelsen, Nils och Dorthi Troëdssons forskningsfond, Olle Engkvists Stiftelse, ÅForsk

Figure 2: Spending under 2024 and 2025



Research Projects

A summary of selected research projects that were ongoing at UPSC in 2024 and/or 2025. This list does not include the many postdoctoral scholarships from Kempestiftelserna and the Carl Trygger Foundation that contribute significantly to research at UPSC. Information on collaborative research programmes and projects can be found under section 3.3 of the report.

Formas

Project grant: How do trees survive winter?

Stefan Jansson, UPSC, UMU

Project duration: 2022 - 2024

Project grant: A GMO-free approach in plants to boost food production

Peter Kindgren, UPSC, SLU

Project duration: 2022 - 2024

Project grant: Towards improved nitrogen use efficiency in aspen trees

Hannele Tuominen, UPSC, SLU

Project duration: 2022 - 2024

Novo Nordisk Foundation

Emerging Investigator Grant: GoodFib - Establishment of trees with high-yield and high-quality wood fibers for more sustainable improved feedstock

Stéphane Verger, UPSC, SLU

Project duration: 2022 - 2026

Project grant: Adventitious root development in trees: exploring the genetic variation in the Swedish Aspen collection

Catherine Bellini, UPSC, UMU

Project duration: 2024 - 2026

Project grant: A dynamic circuit to increase biomass and stress resilience in crops

Peter Kindgren, UPSC, SLU

Project duration: 2025 - 2027

Marie Skłodowska-Curie Actions (MSCA)

Postdoctoral Fellowship: DECORE - Decoding the molecular control of bud dormance release in trees

Shashank Pandey, UPSC, SLU (Rishikesh Bhalerao)

Project duration: Jan 2022 - Mar 2024

Postdoctoral Fellowship: iCON - Elucidating inner cells contribution to pavement cell shape acquisition in Arabidopsis

Vinod Kumar, UPSC, SLU (Stéphanie Robert)

Project duration: Jun 2025 - Jun 2027

Swedish Research Council

Project grant: Unravelling the genetic network mediating temperature control of dormancy release and bud break in hybrid aspen

Rishikesh Bhalerao, UPSC, SLU

Project duration: 2021 - 2024

Project grant: Molecular mechanisms regulating shape acquisition in plants

Stéphanie Robert, UPSC, SLU

Project duration: 2021 - 2024

Project grant: Establishment of Photosynthesis, a Tale of Two Genomes

Åsa Strand, UPSC, UMU

Project duration: 2021 - 2024

Project grant: Cell-type specific lignification in plant vasculature

Hannele Tuominen, UPSC, SLU

Project duration: 2021 - 2024

Starting grant: Mechanics and dynamics of cell-to-cell adhesion in plants

Stéphane Verger, UPSC, SLU

Project duration: 2021 -2024

Project grant: How do trees survive winter?

Stefan Jansson, UPSC, UMU

Project duration: 2022 - 2025

Research Projects

Project grant: Cell type and organelle specificity in auxin and cytokinin signalling and metabolism during lateral root initiation in Arabidopsis

Karin Ljung, UPSC, SLU

Project duration: 2022 - 2025

Starting grant: How plants deal with heat and cold: molecular mechanism of auxin transport in response to temperature stress

Petra Marhava, UPSC, SLU

Project duration: 2022 - 2025

Project grant: Wood suberin? Unravelling biosynthesis and chemical structure of wood lipophilic compounds

Ewa Mellerowicz, UPSC, SLU

Project duration: 2022 - 2025

Project grant: Deciphering the transcriptional networks that integrate light and hormone signaling pathways during adventitious root initiation in Arabidopsis

Catherine Bellini, UPSC, UMU

Project duration: 2023 - 2026

Project grant: To grow or to defend? - Deciphering defense-growth strategies in Scots pine and Norway spruce under local light conditions in Sweden

Rosario García-Gil, UPSC, SLU

Project duration: 2024 - 2027

Project grant: Molecular control of carbon sequestration into wood

Totte Niittylä, UPSC, SLU

Project duration: 2024 - 2027

Starting grant: Watchers on the Wall: Decoding the Early Stages of Plant Cell Wall Integrity

Laura Bacete, UPSC, UMU

Project duration: 2025 - 2028

Project grant: Protein-water-cofactor interactions in biological water oxidation - a paradigm for base metal activation

Johannes Messinger, UPSC, UMU

Project duration: 2025 - 2028

Project grant: Molecular Regulation of FT-like Genes in Latitudinal Climate Adaptation in Trees

Ove Nilsson, UPSC, SLU

Project duration: 2025 - 2028

Project grant: Coordination of cell shape acquisition during plant morphogenesis

Stéphanie Robert, UPSC, SLU

Project duration: 2025 - 2028

Project grant: Decoding Tissue Patterning: The role of microProteins in epigenetic cell memory

Stephan Wenkel, UPSC, UMU

Project duration: 2025 - 2028

Institutional Insights

Publications

Articles and reviews published in 2024-2025 including at least one of the following affiliations: Umeå Plant Science Centre; Department of Forest Genetics and Plant Physiology, Swedish University of Agricultural Sciences; Department of Plant Physiology, Umeå University. The search was conducted in Scopus (Elsevier) and supplemented with publications from the library databases DiVA at Umeå University and SLUPub at SLU.

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