ÖAW

AUSTRIAN ACADEMY OF SCIENCES

WHERE KNOWLEDGE GROWS

GMI

GREGOR MENDEL INSTITUTE OF MOLECULAR PLANT BIOLOGY

WHERE KNOWLEDGE GROWS

CONTENTS

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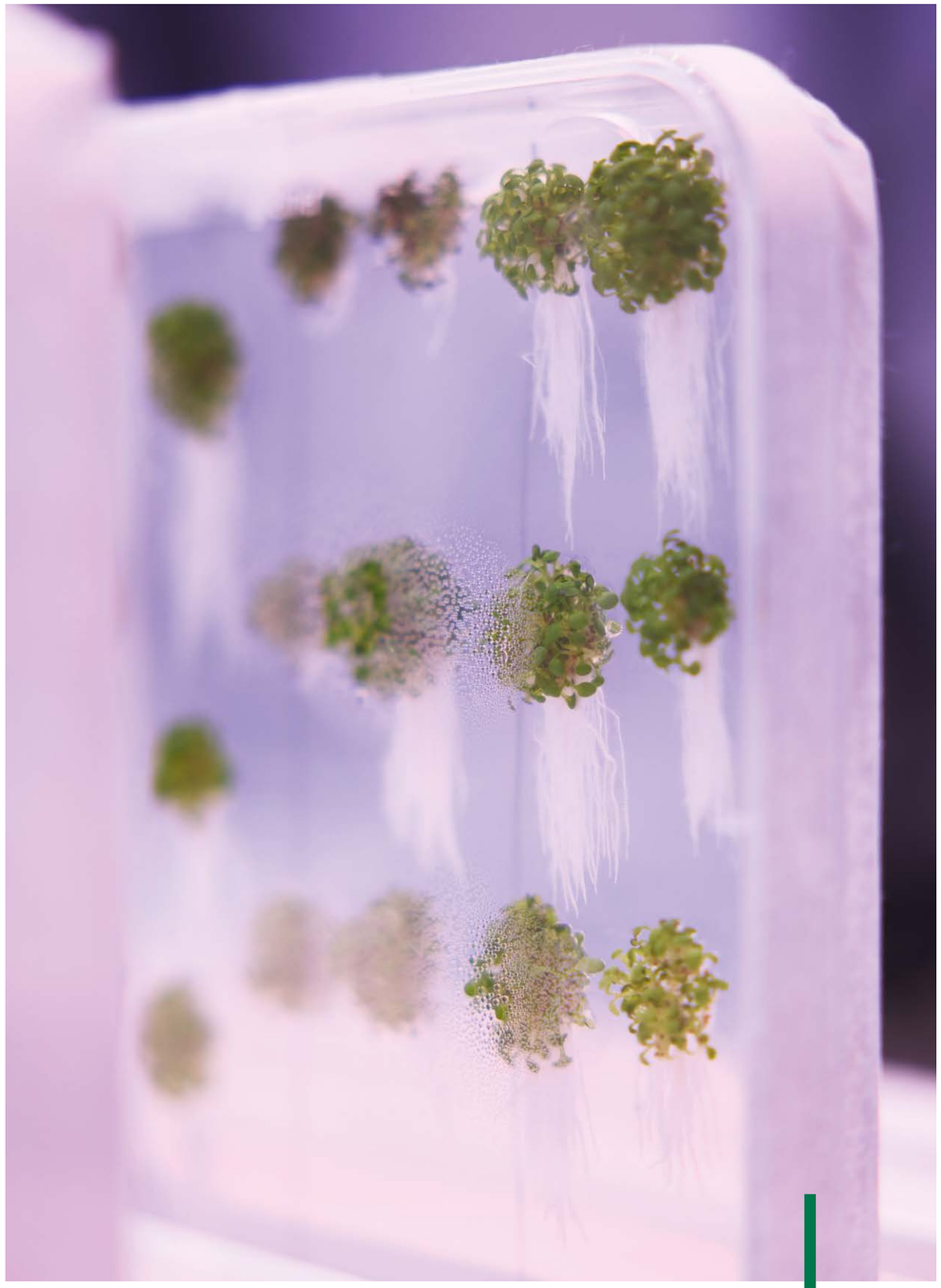
INTRODUCTION



DR. MAGNUS NORDBORG
Scientific Director

DR. MARKUS KIESS
Business Director

DIRECTORS' STATEMENT

At the heart of the GMI's ethos lies a deep-seated commitment to advancing the frontiers of knowledge in plant biology. The GMI holds a unique position, as one of the few institutes worldwide dedicated to basic plant biology research – and the only one in Austria. Our collective vision at the GMI is to contribute to our understanding of plant biology, by carrying out excellent research and exploring fundamental questions. Crucial questions of basic biology are still unanswered, from the intricacies of cell biology and development to the wider realms of evolution and ecology.

The significance of plants in shaping the fabric of life on Earth cannot be overstated: Plants are the architects of our atmosphere and the creators of our fossil fuel reserves, both outcomes of millions of years of photosynthesis. Today, we find ourselves at a crossroads. Humanity is reversing these natural processes over the span of just a few generations, and time is running out to mitigate the effects. This context makes our research into fundamental plant biology not just relevant, but imperative.

As directors, our responsibilities extend to cultivating a research environment that fosters excellence. By ensuring efficient administration, providing top-tier services and securing financial support for our research groups, we strive to create fertile ground for innovation and discovery. Our philosophy is clear: we build the "sandbox", setting the stage for our researchers to explore, innovate and collaborate freely. The true measure of our success is the progress and growth of our students and postdocs, their pursuit of independent ideas, and their evolution into future leaders in science.

At the end of 2023, we bid farewell to Kelly Swarts, one of our junior group leaders, who left the GMI for a permanent position at the Umeå Plant Science Center in Sweden – one of the global leaders in tree biology. We congratulate her on this new outstanding opportunity and are confident that she will continue to make significant contributions to understanding how forests adapt. Simultaneously, we are thrilled to welcome two new junior group leaders, Yan Ma and Nick Irwin, who will start their research groups at the GMI in 2024. Their arrival marks a new chapter for the GMI, bringing fresh perspectives and expertise to our vibrant community.

This year has brought into sharp focus the critical challenges facing humanity, underscoring the vital role of science in navigating these unprecedented times. Our efforts, and the strides we have made, are only possible through the continuous support of the Austrian Academy of Sciences and the Federal Ministry of Education, Science, and Research. Additionally, our thanks go to the Ministry and the City of Vienna for their support of the Vienna BioCenter, a hub of scientific excellence and collaboration.

Finally, we acknowledge and appreciate the collective efforts of all our colleagues at the institute. Their dedication and passion make the GMI not just a place to work, but a vibrant community of scientific inquiry and discovery. Looking ahead, we are inspired by the possibilities and challenges facing us and remain committed to furthering our understanding of plant biology.

INTRODUCING THE GMI

PROFILE

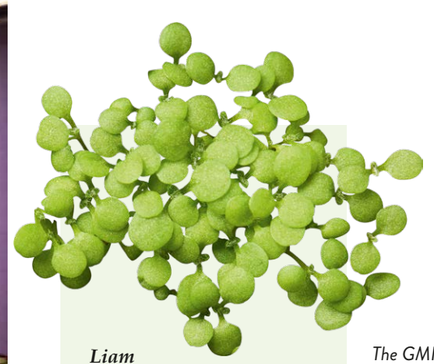
The Gregor Mendel Institute of Molecular Plant Biology (GMI) was founded by the Austrian Academy of Sciences (ÖAW) in 2000 to promote research excellence in molecular plant biology. It is the only international center for basic plant research in Austria and one of the very few research institutes dedicated to fundamental plant biology throughout the world. Our goal is to make fundamental discoveries that help us understand how plants function — discoveries that may be essential to address global challenges like climate change.

The GMI is located in the Vienna BioCenter, a leading life science cluster near Vienna's city center. The Vienna BioCenter includes biotech companies and five other research institutes: the Institute of Molecular Biotechnology (IMBA), the Research Institute of Molecular Pathology (IMP), the Max Perutz Labs, the Faculty of Life Sciences and the Centre for Microbiology and Environmental Systems Sciences (both University of Vienna). This life science cluster creates a forward-looking and fast-growing environment for scientists at the GMI to pursue their research and make fundamental discoveries.

RESEARCH

Research at the GMI covers many aspects of molecular plant genetics, including basic mechanisms of epigenetics, transposon biology, chromosome biology, autophagy, plant-pathogen interactions, developmental biology, and population genetics. During the last 20 years, the model plant *Arabidopsis thaliana* has emerged as the primary experimental system for plant molecular biology. While *Arabidopsis* remains the main model organism at the GMI, scientists at the GMI work on a range of photosynthetic organisms, from algae, through the liverwort *Marchantia* and crops such as maize and wheat to trees. Research is carried out by independent research groups.

Research activities at the GMI are supported by a streamlined administration, world-class scientific infrastructure, and a diverse set of scientific core facilities and services which provide access to state-of-the-art equipment. Core funding is received from the Austrian Academy of Sciences, and scientists at the GMI are highly successful in acquiring third-party funds from a variety of Austrian, European Union, and international funding agencies.



Liam
DOLAN

The GMI offers a dynamic environment, fostering vibrant collaborations that bridge diverse research areas. Thanks to the collective expertise and support from fellow scientists at the GMI and the exceptional backing from the Vienna BioCenter Core Facilities, our lab has achieved breakthrough discoveries that were previously unattainable.

IMPORTANCE OF EXPERIMENTAL PLANT RESEARCH

Plants are the primary producers of the world's ecosystem and thus essential for all life on Earth. This basic fact gains newfound relevance in an era marked by rising food prices, diminishing fossil fuel reserves, and a changing climate. To guarantee sustainable food and energy production in the 21st century, major innovations will be required. Some of these innovations can only come from basic plant research like that carried out at the GMI.

Research on plants can also lead to fundamental scientific breakthroughs beyond plant biology, including many that can be applied to medicine and agriculture. Gregor Mendel's discovery of the basic principles of genetics, Barbara McClintock's discovery of transposons, and the recent work on epigenetics and RNA silencing are only a few of the dozens of examples.

What critical discoveries will plant research bring in the future? These are exciting times, for there is still much to learn, from the network interactions of receptor kinases, chloroplast biogenesis, and protein quality control, to how histones and their modifications define genomic regions. The possibility of fundamental discoveries in these and other areas is high, and everyone at the GMI is excited to push the limits of what we know about plant biology.

EDUCATION

The GMI offers many of its PhD positions through the international Vienna BioCenter PhD Program, and is also part of several externally funded doctoral programs. The education of PhD students plays a major role at the GMI, and the institute offers a flexible and rigorous training program aimed at developing essential skills and competencies. Transferable skills courses and career development resources are provided by the Vienna BioCenter Scientific Training Unit.

Every summer, GMI research labs host undergraduate students as part of the Vienna BioCenter Summer School. In 2021, the GMI launched the International Internship Program I²P, which highlights the diverse and engaging world of basic plant science at the GMI for those embarking on scientific careers.

The GMI is committed to communicating the societal values of plant science research and accomplishes this, among other measures, through outreach events in collaboration with cultural and educational institutions in Austria and all over Europe.

WORKING AT THE GMI

At the GMI, we offer a lively, international, and inclusive environment for scientific growth, with around 120 staff from over 30 countries in a primarily English-speaking setting.

The institute is an ideal place for developing a career in science, providing access to excellent infrastructure and generous funding, which encourages a culture of intellectual exploration and freedom.

The academic calendar at the GMI is thoughtfully structured, including a packed schedule of seminars, an annual retreat, and conferences organized by the institute, alongside regular, low-key social events. Events are intentionally designed so that students can form important social and professional relationships and connect with different career paths. Group leaders are mentors first and foremost, and actively create a space for students to openly discuss ideas. The work environment is complemented by minimal hierarchy and bureaucracy, a subsidized cafeteria, flexible working hours, and on-site day care facilities.

Aethionema arabicum
STONECRESS

In 2023, 111 scientists pursued molecular plant biology across 8 research groups at the GMI.

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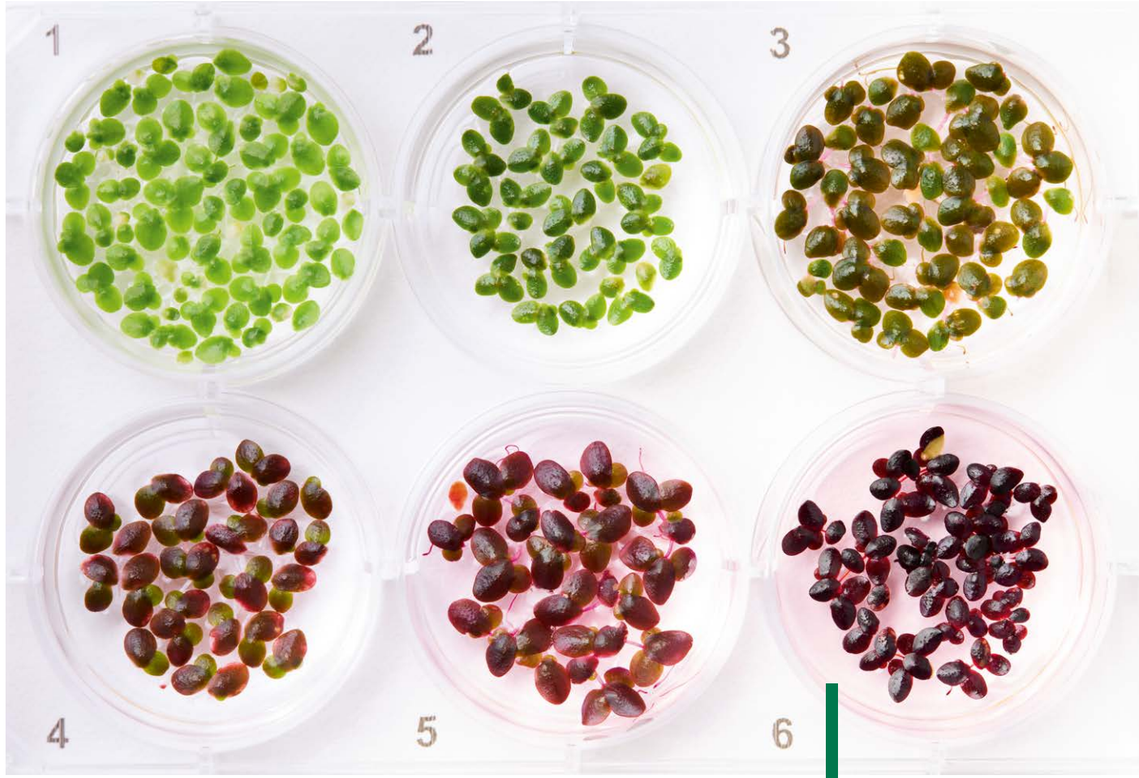
RESEARCH GROUPS



BERGER GROUP

DAGDAS GROUP

DOLAN GROUP

MARÍ-ORDÓÑEZ GROUP

MITTELSTEN SCHEID GROUP

NORDBORG GROUP

RAMUNDO GROUP

SWARTS GROUP

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PUBLICATIONS & PREPRINTS - HIGHLIGHTS IN 2023

Hisanaga T, Romani F, Wu S, Kowar T, Wu Y, Lintermann R, Fridrich A, Cho C, Chaumier T, Jamge B, Montgomery S, Axelsson E, Akimcheva S, Dierschke T, Bowman J, Fujiwara T, Hirooka S, Miyagishima S, Dolan L, Tirichine L, Schubert D, Berger F (2023) The Polycomb repressive complex 2 deposits H3K27me3 and represses transposable elements in a broad range of eukaryotes. Curr Biol 33(20):4367-4380.e9.

Jamge B, Lorković Z, Axelsson E, Osakabe A, Shukla V, Yelagandula R, Akimcheva S, Kuehn A, Berger F (2023) Histone variants shape chromatin states in *Arabidopsis*. eLife12:RP87714. eLife.87714.3

Lorkovic Z, Klingenbrunner M, Cho C, Berger F (2023) Co-evolution of functional motifs and H2A.X in the context of DNA damage response identifies the plant mediator of DNA Damage Checkpoint 1. biorXiv 2023.05.19.541430.

RESEARCH

Understanding chromatin function is essential for unravelling the complexities of genome regulation in eukaryotes. Chromatin's fundamental subunit is the nucleosome, which is formed by DNA wrapped around a set of eight histone proteins. Research in the Berger group focuses on investigating the evolutionary origins and functions of histone variants and remodelers, crucial components in the regulation of chromatin.

In the last year, the Berger group demonstrated that histone variants interact crucially with histone post-translational modifications, shaping chromatin states that instruct transcriptional regulation. The histone variant H2A.X plays a key role in the machinery that repairs DNA. The Berger group identified two key actors of this pathway in *Arabidopsis*. Moreover, they characterized a chromatin remodeler involved in the deposition of a specific type of histone variants which regulate transposon activity. The group lately also showed that during the evolution of land plants, the post-translational modification H3K27me3 switched its target from transposons to cis-elements that control gene silencing. This new function of H3K27me3 had the potential to reshape the genomes of plants.

CURRENT PROJECTS

– Transposon silencing mechanisms beyond DNA methylation
Transposons are foreign elements that invade eukaryotic genomes. As these mobile elements are mutagenic, the activity of their genes that enable their movement is normally suppressed by the host genome. It was assumed that DNA methylation plays a key role in suppressing transposon activity. The Berger group recently showed that mechanisms other than DNA methylation are important in silencing transposons.

– Chromatin as a central controller of living systems
The Berger group uncovered a radically new form of imprinting whereby the entire paternal genome is silenced. The researchers are exploring the mechanisms that reprogram this process. This work challenges our views on the significance of meiosis.

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PUBLICATIONS & PREPRINTS - HIGHLIGHTS IN 2023

Picchianti L, Sánchez de Medina Hernández V, Zhan N, Irwin N, Groh R, Stephani M, Hornegger H, Beveridge R, Sawa-Makarska J, Lendl T, Grujic N, Naumann C, Martens S, Richards T, Clausen T, Ramundo S, Karagöz G, Dagdas Y (2023) Shuffled ATG8 interacting motifs form an ancestral bridge between UFMylation and autophagy. EMBO J 42(10):e112053.

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Picchianti L, Sedivy A, Dagdas Y (2023) Characterization of ATG8-Family Interactors by Isothermal Titration Calorimetry. Methods Mol Biol 2581:149-176.

RESEARCH

Yasin Dagdas and his team seek to understand how selective autophagy renovates and remodels plant cells to cope with stress. Selective autophagy is an intracellular immune system and involves modular receptor proteins recognizing cargo proteins labeled as non-self, which are then delivered to the vacuole for recycling. The Dagdas group aims to discover new cargo receptors and to understand how the receptors are integrated within the cell's stress signaling pathways.

The Dagdas group pursues a comparative-mechanistic approach, moving beyond single model organisms to instead perform comparative studies. The researchers use mechanistic tools to further dissect and understand the pathways they uncover. With this comparative-mechanistic approach, the group uniquely positions itself at the combination of quality control and plant biology research. Recently, the group characterized the first autophagy adaptor in plants and showed that it contributes to cargo sorting via amphisomes. They also uncovered the evolution of a unique motif identified in the protein C53, using phylogenomic profiling and structural analysis.

CURRENT PROJECTS

– Discovery of new autophagy pathways
All known autophagy receptors interact with a core autophagy protein, ATG8. To fill the gaps in knowledge around plant-selective autophagy, the team is seeking to find new autophagy receptor candidates and degradation pathways.

– Cell-type specific autophagy
To maintain homeostasis, each cell type must employ various quality control mechanisms. Using plants for high resolution cellular biology, the Dagdas group is exploring cell-type-specific autophagy responses and investigating how these are involved in reprogramming and communication.

– Ribosome stalling & autophagy
In earlier work, the Dagdas group discovered a new autophagy receptor, C53, that is activated by the stalling of ER-bound ribosomes and regulated by UFMylation. Since neither ribosome stalling nor UFMylation had been studied in plants so far, the Dagdas group branched out to explore these mechanisms.

DOLAN GROUP

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PUBLICATIONS & PREPRINTS - HIGHLIGHTS IN 2023

Mulvey H, Dolan L (2023) RHO of plant signalling was established early in streptophyte evolution. Curr. Biol. 33, 5515–5525.

Mulvey H, Dolan L (2023) ROP GTPase regulates polarised cell growth and cell division orientation during tissue development and organogenesis in *Marchantia polymorpha*. Curr. Biol. 33, 2897-2911.

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PREVIOUSLY

Head of Department (2012–2017): Dpt. of Plant Sciences, University of Oxford, UK

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Professorial Fellow (2009–2020): Magdalen College, Oxford, UK

Project Leader (IMP 2/Band H) with tenure (1996–2009): John Innes Centre, Norwich, UK

Independent Research Fellow (1995–1996): John Innes Centre, Norwich, UK

Postdoctoral Researcher (1992–1995): John Innes Centre, Norwich, UK

Postdoctoral Researcher (1991–1992): University of Pennsylvania, US

RESEARCH

The Dolan group uses the liverwort *Marchantia polymorpha* to discover mechanisms of plant development that are difficult to investigate in other model organisms or specific to bryophytes. Currently, the group focuses on two research areas where there are substantial gaps in our knowledge: Firstly, how does polarity develop *de novo* in unpolarized cells? Second, how do meristems arise from non-meristematic cells? These questions are difficult to tackle in most model plants, but in *Marchantia* spore and sporeling, they are experimentally tractable. Filling these gaps, our knowledge could lead to the discovery of new principles of plant development.

CURRENT PROJECTS

– *De novo* polarization in cells

Polarity – the asymmetric localization of activities, molecules or structures in a cell – is a characteristic of almost all cells. Much is known about how polarity is inherited from one generation to another, and how cells communicate polarity and asymmetry to each other within plant tissues. However, little is known about how polarity is generated *de novo*, i.e. how cells transition from an apolar state to a polar state. The haploid body of a *Marchantia* plant develops from spores. Since they lack polarity early in their development, they are ideal models for studying these questions. The Dolan group has shown that *Marchantia* spores develop polarity within the first 20 to 28 hours of their development. Current research aims to discover which mechanisms operate within this narrow time window to polarize the spore cell. Preliminary data indicate that migration of the nucleus from the geometrical center of the cell to the cell cortex is a key stage in polarization. Currently, the group is investigating how blue light and the cytoskeleton work together during polarization, ultimately aiming to define the polarization mechanism.

– Meristem formation

Plant bodies – in contrast to animal bodies – are highly modular. This modular body plan develops through the activity of meristems, which consist of regenerative cells and their dividing derivatives. While the functioning and maintenance of mature meristems are well understood, less is known about the mechanism by which meristems develop from groups of non-meristematic cells. Research in the Dolan group uses the sporelings of *Marchantia polymorpha* to explore how meristems develop *de novo*. Currently, the group is defining the cell lineage of the initiating meristem and identifying candidate genes involved in meristem initiation. The ultimate goal of the Dolan group is to define a time-resolved molecular mechanism for meristem initiation in *Marchantia* and to draw comparisons with mechanisms in other plants, thereby uncovering general principles of meristem development.

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RESEARCH

Transposable elements (TEs), often referred to as molecular parasites, replicate within the genomes of their hosts. They play a crucial role in the development and evolution of eukaryotic genomes, acting as a major source of genetic variation and innovation. However, their ability to move within the genome also poses a risk to the structural integrity and overall health of the host. To combat the potentially harmful effects of TEs, a range of mechanisms have evolved in organisms to keep these elements in check, primarily through transcriptional silencing. Significant advancements in understanding these silencing processes have been made through plant research. Despite this, the early steps of how a plant detects an active TE invasion and initiates a defense response remain largely unexplored. Research in the Marí-Ordóñez group focuses on unraveling this mystery: how plants recognize TEs and activate a silencing response against them.

CURRENT PROJECTS

– Understanding the recognition and silencing of TEs in plants
In eukaryotes, the silencing of transposable elements typically involves the formation of dense heterochromatin, a state that is incompatible with canonical RNA Polymerase II transcription. This heterochromatin is distinguished by specific silencing markers, such as DNA methylation and histone modifications, partially maintained through a process known as RNA-directed DNA methylation (RdDM) in plants. At the core of RdDM are small RNAs, which guide silencing complexes to TE sequences in the genome. To investigate TE silencing in plants beyond *Arabidopsis*, the group focuses on understanding silencing mechanisms in duckweeds. Unlike many other plants, duckweeds do not possess certain known silencing components, have low RdDM activity and display unique small RNA patterns. By studying TE silencing in duckweeds, the Marí-Ordóñez group aims to gain deeper insights into epigenetic silencing and TE regulation.

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PUBLICATIONS & PREPRINTS - HIGHLIGHTS IN 2023

Bradamante G, Nguyen V, Incarbone M, Meir Z, Bente H, Donà M, Lettner N, Mittelsten Scheid O, Gutzat R (2023) Two ARGONAUTE proteins loaded with transposon-derived small RNAs are associated with the reproductive cell lineage in *Arabidopsis*. Plant Cell koad295.

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Postdoc (1985-1987): Hans-Georg Schweiger Lab, Max Planck Institute for Cell Biology, Ladenburg, DE

RESEARCH

The research conducted by Ortrun Mittelsten Scheid's laboratory primarily addressed genetic and epigenetic regulation in plants. Most recently, the focus was on stem cells in the shoot apical meristem. The stability of genetic and epigenetic information of these stem cells is especially important as in flowering plants, these cells develop into flowers, sexual organs, and gametes and thereby contribute to the next generation. The group's research delved into the mechanisms regulating transposons in the germline, strategies to prevent viral infiltration in the meristem, and approaches to enhance resistance against DNA damage.

The group also developed CRISPR-based tools to trace developmental lineages in living plants. They further established *Aethionema arabicum* as a new model plant to study light-regulated seed germination.

FUTURE CONTRIBUTIONS

At the end of March 2023, and after nearly twenty years at the GMI, Ortrun Mittelsten Scheid retired as a senior group leader. With her research and her mentoring, she contributed significantly to the GMI and its further development.

Mittelsten Scheid acted also as interim scientific director of the GMI from 2007 to 2009. Mittelsten Scheid and her group shed light on many aspects of epigenetic changes in plants.

Currently, Mittelsten Scheid holds several international advisory functions and contributes to science communication.

Arabidopsis thaliana
THALE CRESS

Our 16 phytotrons span 160 square meters, providing precision-controlled environments to investigate the intricate responses of plants to various ecological conditions.

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PUBLICATIONS & PREPRINTS - HIGHLIGHTS IN 2023

Voichek Y, Hristova G, Mollá-Morales A, Weigel D, Nordborg M (2023) Widespread transcriptional regulation from within transcribed regions in plants. biorXiv 2023.09.15.557872.

Kornienko A, Nizhynska V, Morales A, Pisupati R, Nordborg M (2023) Population-level annotation of lncRNAs in *Arabidopsis* reveals extensive expression variation associated with transposable element-like silencing. The Plant Cell. [epub.]

Pisupati R, Nizhynska V, Mollá Morales A, Nordborg M (2023) On the causes of gene-body methylation variation in *Arabidopsis thaliana*. PLoS Genet 19(5):e1010728.

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RESEARCH

As Theodosius Dobzhansky famously argued, "nothing in biology makes sense except in the light of evolution." Work in the Nordborg group therefore spans molecular genetics to speciation, combined with applying models from evolutionary biology and population genetics to make sense of modern data. Overall, the Nordborg group seeks to understand the nature of the differences that give rise to phenotypic variation. How has natural selection molded this variation? How can we use our understanding of evolution to make sense of what we see in the genome? The lab combines computational biology with lab and field work to address these questions.

The Nordborg group tends to focus on population-scale genomic data sets generated by the group. Probably the most important large data set generated by the Nordborg group is the continuation of the 1001 Genomes Project – a decades-long effort to provide the genetics community with genotypes and phenotypes for a large collection of publicly available natural inbred lines of *Arabidopsis thaliana*. By the end of 2023, the Nordborg group and collaborators have generated several hundred such genomes. Comparison of these genomes will grant new insights into the nature and mechanisms of genetic variation.

CURRENT PROJECTS

– The "actually existing" mobileome
Our understanding of transposable element (TE) biology is currently hindered by inadequate data, with short-read sequencing falling short in detecting TE polymorphisms and genomes being annotated using inconsistent methods. The research group aims to overcome these limitations by analyzing whole genome sequence data to identify active TEs, a method that has shown promising results in clustering structural variants across genomes.

– The genetics of epigenetics
The Nordborg group also researches the role of epigenetics in adaptive variation, from gene body methylation, which could affect gene regulation, to the genome-immune system that is silencing TEs. Work is primarily done via genetic crosses between lines that differ in methylation levels.

– The adaptive importance of seed size
As part of our long-standing interest in local adaptation, the Nordborg group is carrying out field studies to investigate the advantages and disadvantages of producing large seeds.

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PUBLICATIONS & PREPRINTS - HIGHLIGHTS IN 2023

Picchianti L, Sánchez de Medina Hernández V, Zhan N, Irwin N, Groh R, Stephani M, Hornegger H, Beveridge R, Sawa-Makarska J, Lendl T, Grujic N, Naumann C, Martens S, Richards T, Clausen T, Ramundo S, Karagöz G, Dagdas Y (2023) Shuffled ATG8 interacting motifs form an ancestral bridge between UFMylation and autophagy. EMBO J 42(10):e112053.

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PhD: University of Geneva, CH

PREVIOUSLY
HHMI Research Specialist (2018-2021): Peter Walter Lab, University of California, San Francisco, US

EMBO and SNF Postdoc (2013-2018): Peter Walter Lab, University of California, San Francisco, US

RESEARCH

Chloroplasts play a central role in the viability, productivity, and stress tolerance of eukaryotic photosynthetic organisms. These organelles fulfill many critical functions, such as the conversion of light into chemical energy during photosynthesis and the production of essential amino acids. Beyond these roles, chloroplasts serve as important signaling hubs during plant development and stress adaptation, influencing the expression of a multitude of nuclear genes and impacting other cellular processes.

The Ramundo group uses the unicellular green alga *Chlamydomonas reinhardtii* to advance our knowledge of the molecular mechanisms that monitor and maintain chloroplast health.

CURRENT PROJECTS

– Chloroplast unfolded protein response
The Ramundo group pioneered the discovery of the chloroplast unfolded protein response (cpUPR), an extensive gene expression program that photosynthetic cells activate when damaged proteins accumulate in the chloroplast. The cpUPR operates through a yet-to-be-identified signaling cascade that connects the chloroplast, where the stress from damaged proteins arises, to the nucleus. Currently, the team is employing several orthogonal approaches to define the molecular components of this pathway. The ultimate goal of the Ramundo group is to understand how this chloroplast stress response contributes to the overall resilience and functionality of photosynthetic organisms in challenging environments.

– Molecular and structural characterization of the chloroplast RNA polymerase
Chloroplasts contain a multisubunit eubacterial-like RNA polymerase that is essential for the transcription of organellar genes encoding components of the photosynthetic apparatus.

In collaboration with the Schuller group at the SYNMIKRO Research Center, the Ramundo group recently achieved the first molecular and structural resolution of this essential machinery in chloroplast gene expression. Ongoing efforts focus on investigating the regulation of this complex, both *in vitro* and *in vivo*.

SWARTS GROUP

POSTDOC
Miguel Vallebueno

PHD STUDENT
Vasilina Akulova

TECHNICIANS
Kirill Akulov
Alex Arizpe
Miroslav Polacek
Lucyna Slusarz

STUDENT HELPERS & INTERNS
Anna Gsteu
Paige Guevarra
Wagner Mandez Guzman
Giulia Micai
Anni Nurmisto
Lisa Weidlich
Chun Chieh Yen

PUBLICATIONS & PREPRINTS - HIGHLIGHTS IN 2023

Poláček M, Arizpe A, Hüther P, Weidlich L, Steindl S, Swarts K (Epub: 2023) Automation of tree-ring detection and measurements using deep learning. Methods Ecol Evol. 2023;14:2233–2242.

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KELLY SWARTS

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JOINED GMI
in January 2019

PhD: Cornell University, Ithaca, US

PREVIOUSLY
Postdoc (2017-2018): Hernan Burbano Lab, Max-Planck Institute for Developmental Biology, Tübingen, DE

RESEARCH

In temperate climates, conifers are ecologically dominant and economically important, but due to climate change, mature trees are no longer adapted to their environment. Globally, conifers are succumbing to drought, disease, early budding and other challenges. If we could predict how individual tree genotypes responded to different environments, we could plant the right tree in the right space.

The Swarts group is developing a system for quickly estimating adaptive responses for any forest tree, using tree increment core samples, which provide both DNA for genotyping and annual growth data. They integrate historical climate recordings (from weather stations) and historical growth data (from tree-rings) in a quantitative genetics framework focusing on Norway Spruce (*Picea abies*) as a model. This method shifts the observation level to annual growth rings in natural populations, allowing the researchers to estimate the variance in annual growth attributed to genotype, environmental parameters, and genotype-environment interactions, without the need to grow trees in costly and slow designed trials. The group's ultimate goal is to predict genetic responses to new environments. Their work spans various complementary systems: The primary focus lies in establishing a model for trees based on annual ring width measurements, this approach is augmented by parallel research in conifer biology (mountain pine (*Pinus mugo*)), maize, and bark beetles.

CURRENT PROJECTS

– Tree-ring genomics for understanding the genetics underlying environmental adaptation
"Assisted migration", meaning the movement of adapted tree genotypes to suitable environments, requires the identification of such trees beforehand. Given their longevity and stationary nature, mature conifers have endured significant environmental fluctuations, both within and between years in temperate zones. Focusing on annual growth data from tree rings, rather than individual trees, offers insights into genotypes across numerous year-environments. Applying these growth measurements in genome-wide association studies (GWAS) helps unravel the genetic basis of environmental adaptation and phenotypic plasticity in natural populations – a fundamental question in population genetics and evolutionary biology.

– Maize adaptation to novel environments
The team is examining whole genome data from maize, covering a 5,000-year span across the Americas, as well as data from over 10,000 modern maize populations and their wild relatives. Their objective is to decipher the genetic consequences of maize's spread into diverse environments.

– Upright habit in *Pinus mugo*
In some populations in Bavaria, *Pinus mugo* is co-occurring in tree and shrub form. To understand the relative contribution of genetics and environment to these growth forms, the group has GBS genotyped samples and is parsing contributions with GWAS.

NEW GROUP LEADERS IN 2024

NICK IRWIN

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HORIZONTAL GENE TRANSFER IN PLANTS AND ALGAE

Horizontal gene transfer (HGT) involves the transmission of genes across distantly related species, a process that, though rare, facilitates rapid cellular innovation and adaptation, enabling organisms to acquire new cellular characteristics. Although this process is well characterized in bacteria, where HGT plays an important role in adaptation and antibiotic resistance, its impact on eukaryotic cells remains unclear. In particular, the frequencies of these transfers, their mechanisms of integration, and their functional contributions to eukaryotic biology and evolution have yet to be understood.

Nick Irwin aims to understand the nature of horizontal gene transfer in eukaryotes by integrating large-scale phylogenomics with high-throughput genetics in model organisms such as *Arabidopsis, Marchantia,* and *Chlamydomonas*. This approach will help uncover the role of HGT in both ancient and recent plant evolution, understand its implications in various cellular contexts (like multicellular and unicellular organisms), and reveal how HGT contributes to phenotypic evolution – from environmental adaptation to the establishment of symbioses – and emergence of new cellular biology.

Nick Irwin will start at the GMI in January 2024

JOINING GMI
in January 2024

PhD: University of British Columbia, CA

PREVIOUSLY
Junior Research Fellow in Biology (2020 –2023): Merton College, University of Oxford, UK

YAN MA

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JOINING GMI
in February 2024

PhD: The Sainsbury Laboratory (TSL), Norwich, UK

PREVIOUSLY
Postdoc (2018 – 2023): Niko Geldner Lab, DBMV, University of Lausanne (UNIL), CH

Postdoc (2017 – 2018): Jonathan Jones Lab, The Sainsbury Laboratory (TSL), Norwich, UK

PLANT DEVELOPMENT AND DEFENSE SIGNALING

Galls are fascinating examples of host plant manipulation. Different gall formers hijack existing plant developmental pathways to induce these ectopic plant structures in a range of shapes and colors. Insects induce the most diverse and complex galls, which serve as protective and nutritional structures for the insects. However, these galls are formed at the expense of plant health. Because galls originate from the manipulation of only a few cells at oviposition or feeding sites, they present a unique entry point to not only understand host manipulation, but also to study the interaction between growth and defense at the single cell level.

The Ma lab is set to utilize gall-inducing insects, nature's own plant manipulators, to delve into the complex relationship between plant development and defense signaling.

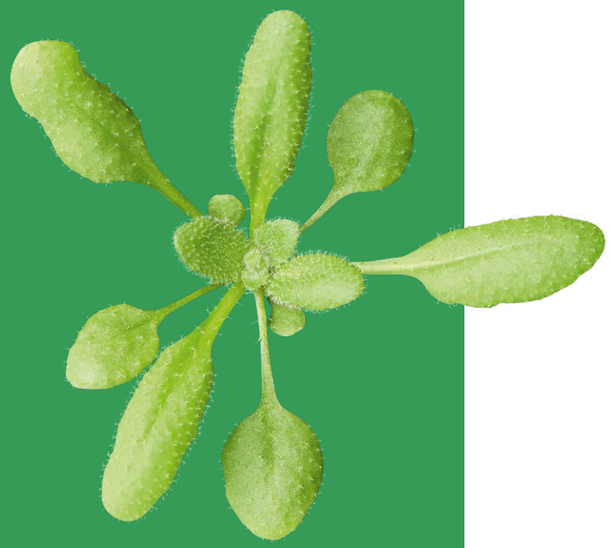
The lack of a plant model for insect-induced galls has left the molecular mechanisms behind insects' ability to redirect plant signaling for gall formation largely unexplored. The Ma lab plans to pioneer a novel gall model by pairing the model plant *Arabidopsis thaliana* with the Swede Midge (*Contarinia nasturtii*), a major pest in all cultivated *Brassicaceae*. This innovative model system will enhance our understanding of gall induction and insect-plant interactions at the molecular level. By integrating genetics, transcriptomics, metabolomics, molecular biology, and advanced imaging, the group aims to uncover the genetic and signaling determinants of gall formation and characterize key hormonal and receptor/signaling pathways involved, from the single cell to the whole organ. This research promises to illuminate the enigmatic process of gall formation and provide new perspectives to understand the interplay between development and defense signaling.

Yan Ma will start at the GMI in February 2024

03

THE GMI IN REVIEW

KEY FACTS



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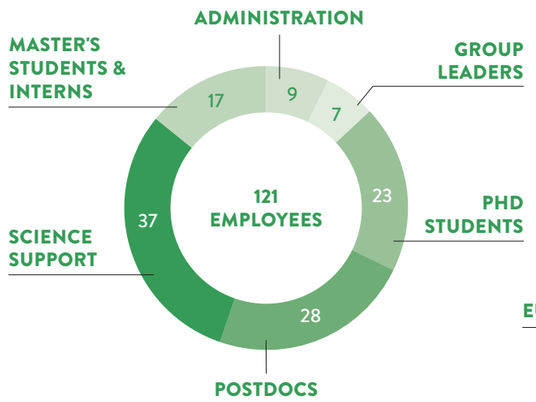

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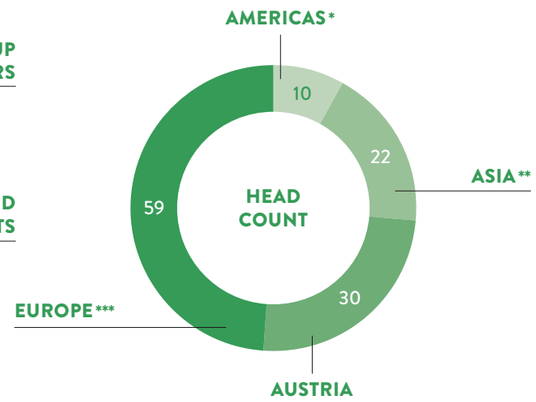
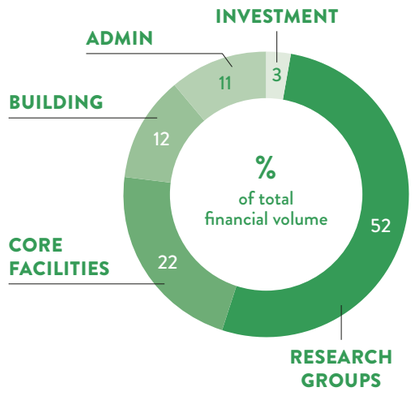
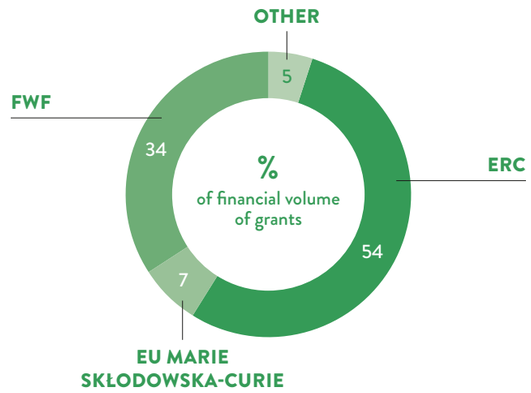


EXPENDITURES



RESEARCH GRANTS



as of December 31, 2023

* Canada, Mexico, US | ** Armenia, China, Hongkong, India, Israel, Japan, Kazakhstan, Malaysia, South Korea, Taiwan, Turkey

*** Bulgaria, Croatia, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Poland, Portugal, Russia, Serbia, Slovakia, Spain, Sweden, Switzerland, UK

Lemna minor
DUCKWEED

In 2023, researchers at the GMI published more than 80 studies in journals and as preprints.

PUBLICATIONS (IN 2023)

BERGER GROUP

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Hisanaga T, Wu S, Schafran P, Axelsson E, Akimcheva S, Dolan L, Li F, Berger F (2023) The ancestral chromatin landscape of land plants. New Phytol 240(5):2085-2101.

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DAGDAS GROUP

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DOLAN GROUP

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Mérai Z, Graeber K, Xu F, Donà M, Lalatović K, Wilhelmsson PKI, Fernandez-Pozo N, Rensing SA, Leubner-Metzger G, Mittelsten Scheid O, Dolan L (2023) Long days induce adaptive secondary dormancy in seed of the Mediterranean plant *Aethionema arabicum*. bioRxiv 2024.01.08.574645.

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Streubel S, Deiber S, Rötzer J, Mosiolek M, Jandrasits K, Dolan L (2023) Meristem dormancy in *Marchantia polymorpha* is regulated by a liverwort-specific miRNA and a clade III SPL gene. Curr Biol 33(4):660-674.e4.

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MITTELSTEN SCHEID GROUP

Bradamante G, Nguyen V, Incarbone M, Meir Z, Bente H, Donà M, Lettner N, Mittelsten Scheid O, Gutzat R (2023) Two ARGONAUTE proteins loaded with transposon-derived small RNAs are associated with the reproductive cell lineage in *Arabidopsis*. Plant Cell, online ahead of print.

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Donà M, Bradamante G, Bogojevic Z, Gutzat R, Streubel S, Mosiolek M, Dolan L, Mittelsten Scheid O (2023) A versatile CRISPR-based system for lineage tracing in living plants. Plant J 115(5):1169-1184.

Durut N, Kornienko A, Schmidt H, Lettner N, Donà M, Nordborg M, Mittelsten Scheid O (2023) Long noncoding RNAs contribute to DNA damage resistance in *Arabidopsis thaliana*. Genetics 225(1):iyad135

Incarbone M, Bradamante G, Pruckner F, Wegscheider T, Rozhon W, Nguyen V, Gutzat R, Mérai Z, Lendl T, MacFarlane S, Nodine Mittelsten Scheid O (2023) Salicylic acid and RNA interference mediate antiviral immunity of plant stem cells. Proc Natl Acad Sci U S A 120(42):e2302069120.

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Mérai Z, Graeber K, Xu F, Donà M, Lalatović K, Wilhelmsson PKI, Fernandez-Pozo N, Rensing SA, Leubner-Metzger G, Mittelsten Scheid O, Dolan L (2023) Long days induce adaptive secondary dormancy in seed of the Mediterranean plant *Aethionema arabicum*. bioRxiv 2024.01.08.574645.

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NORDBORG GROUP

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RAMUNDO GROUP

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FORMER GROUPS AND CORE SERVICES

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GRANTS (ACTIVE OR ACQUIRED IN 2023)

BERGER GROUP

EMBO Postdoctoral Fellowship (Arie Fridrich)
EMBO (European Molecular Biology Organization): ALTF914-2021
€ 138,600
January 2022 – December 2023

A new paradigm for genomic imprinting
FWF (Austrian Science Fund): P 36231-B
€ 399,540.75
September 2022 – August 2026

VIP² Fellowship (Pierre Bourguet)
H2020-MSCA-COFUND-2018: 847548
€ 131,520
January 2020 – December 2022

VIP² Fellowship (Tetsuya Hisanaga)
H2020-MSCA-COFUND-2018: 847548
€ 131,520
January 2021 – December 2024

The role of histone variants in chromatin organization
FWF (Austrian Science Fund): P 32054-B21
€ 397,745
May 2019 – April 2023

Impact of dynamics of H2A variants on transcription
FWF (Austrian Science Fund): P 33380-B
€ 406,518
May 2020 – April 2024

A novel code to interpret genetic information
FWF (Austrian Science Fund): TAI 304-B
€ 152,382
June 2021 – May 2023

Evolutionary insights into H2A.Z function in gene regulation (Zachary Harvey)
FWF (Austrian Science Fund): ESP-213
€ 324,015.98
December 2022 – November 2025

Molekulare Evolution von Histon-Varianten
FWF (Austrian Science Fund): PAT-1104523
€ 399,995,95
December 2023 – November 2027

DAGDAS GROUP

MENTOR - Molecular mechanisms to improve plant resilience (Marintia Nava)
FWF (Austrian Science Fund): DOC 111-B
€ 201,029.61
October 2021 – September 2025

Decrypting UFMylation through chemical biology
WWTF (Vienna Science and Technology Fund): LS21-009
€ 241,690
June 2022 – May 2026

How does autophagy rescue stalled ribosomes?
ERC (European Research Council) Consolidator Grant: 101043370
€ 1,999,006
October 2022 – September 2027

Illuminating the journey of autophagosomes in plants
FWF (Austrian Science Fund): P 34944-B
€ 404,586
January 2022 – December 2025

C53 and UFMylation regulation in endoplasmic reticulum-autophagy (ER-phagy) (Ni Zhan)
H2020-MSCA-IF-2020: 101028611
€ 186,167.04
May 2021 – April 2023

VIP² Fellowship (Juan Carlos de la Concepcion)
H2020-MSCA-COFUND-2018: 847548
€ 98,640
March 2021 – February 2025

Targeted protein degradation – from small molecules to complex organelles
FWF (Austrian Science Fund): F 7912-B
€ 399,530
March 2020 – February 2024
€ 436,876
March 2024 – February 2028

Functional evolutionary analysis of a novel autophagy adaptor in plants (Jierui Zhao)
ÖAW (Austrian Academy of Sciences) Doc Fellowship: 25966
€ 38,000
August 2021 – July 2023

Posttranslation Regulierung des RNA-Silencing
FWF (Austrian Science Fund): I 6760-B
€ 219,948.75
December 2023 – November 2027

VIP² Fellowship (Gao Peng)
H2020-MSCA-COFUND-2018: 847548
€ 98,640
January 2023 – December 2025

DOLAN GROUP

***De novo* development of polarity in plant cells**
ERC (European Research Council) Advanced Grant: 787613
€ 1,959,500
October 2018 – September 2023

VIP² Fellowship (Shuangyang Wu)
H2020-MSCA-COFUND-2018: 847548
€ 98,640
January 2022 – December 2024

EMBO Postdoctoral Fellowship (Zohar Meir)
EMBO (European Molecular Biology Organization): ALTF839-2022
€ 54,000
April 2023 – December 2023

HFSP Long Term Fellowship (Zohar Meir)
HFSP (Human Frontier Science Program): LT0024
€ 228,036
January 2024 –December 2026

NORDBORG GROUP

Elucidating the causes and consequences of the global pattern of epigenetic variation in *Arabidopsis thaliana*
ERC (European Research Council) Advanced Grant: 789037
€ 2,498,468
June 2018 – May 2024

Climate adaptation in *Arabidopsis thaliana* through evolution of transcription regulation (Yoav Voichek)
H2020-MSCA-IF-2020: 101028014
€ 186,167.04
March 2022 – February 2024

Genetic architecture in presence of selection
FWF (Austrian Science Fund): F 9109-B
€ 702,197.75
January 2024 – December 2028

VIP² Fellowship (Haijun Liu)
H2020-MSCA-COFUND-2018: 847548
€ 98,640
January 2021 – December 2023

VIP² Fellowship (Tal Dahan)
H2020-MSCA-COFUND-2018: 847548
€ 98,640
April 2023 – March 2026

RAMUNDO GROUP

Chloroplast protein degradation via autophagy and UPS
FWF (Austrian Science Fund): F 7916-B
€ 456,484.24
March 2024 – February 2028

Targeted degradation of chloroplast proteins via autophagy and the ubiquitin-proteasome system
FEBS (Federation of European Biochemical Societies)
€ 100,000
December 2023 – November 2026

SWARTS GROUP

Developing tree-ring genomics to prepare forests for changing climate
ERC (European Research Council) Starting Grant: 101078208
€ 1,498,590
January 2023 – December 2027

VIP² Fellowship (Miguel Vallebueno)
H2020-MSCA-COFUND-2018: 847548
€ 98,640
January 2020 – December 2024

EVENTS & SEMINARS

Throughout the year, scientists at the GMI hosted international scientists as speakers at seminars, events and symposia, fostering collaboration and innovation at the forefront of plant biology research.

The 20th Annual Vienna BioCenter PhD Symposium, titled "A Mixtape of Science," marks two decades of scientific collaboration and networking among Europe's research community.

Below: Siobhan Brady, University of California Davis, keynote speaker at the 2023 Mendel Early Career Symposium. At right, researchers share a laugh during one of the breaks.

JOHN ARCHIBALD (Dalhousie University, Canada)
Gene exchange across the eukaryotic tree of life: Highways, byways, and bike paths

SIR DAVID BAULCOMBE (University of Cambridge, United Kingdom) | RNA silencing in plants and its effects on evolvability and the costs of disease resistance

NEHA BHATIA (Max Planck Institute for Plant Breeding Research, Cologne, Germany) | Developmental patterning and morphogenesis in plants

THEKLA VON BISMARCK (Max Planck Institute of Molecular Plant Physiology, Golm, Germany) | Light acclimation interacts with thylakoid ion transport to govern the dynamics of photosynthesis

ALEX CANTO PASTOR (University of California, Davis, United States) | Gene regulation and cell type-specific mechanisms underpinning plant defense

KIN PAN CHUNG (Max Planck Institute of Molecular Plant Physiology, Potsdam, Germany) | Control of cytoplasmic inheritance in plants

SOURAV DATTA (Institute of Science Education and Research, Bhopal, India) | Light and abscisic acid interplay in early seedling development

GAUTAM DEY (EMBL Heidelberg, Germany) | Mitotic rewiring on evolutionary timescales

JOSE R. DINNENY (Stanford University, United States)
Diversifying our understanding of plant-environment interactions

TINA DOMINGUEZ-MARTIN (University of Cordoba, Spain) | Structural insights into the light-harvesting antenna and photoprotection mechanism in cyanobacteria

JONATHAN DRAGWIDGE (VIB-UGent Center for Plant Systems Biology, Belgium) | Biomolecular condensates and how they organize endocytic trafficking

IDAN EFRONI (The Hebrew University of Jerusalem, Israel) | Local and systemic signals in root regeneration

BEVERLY GLOVER (University of Cambridge Botanic Garden, United Kingdom) | The evolution and development of sexual deception in *Gorteria diffusa*

SHAN HE (Princeton University, United States)
Structure and regulation of the CO_2-concentrating organelle, the pyrenoid

RAINER HEDRICH (University of Würzburg, Germany)
Ion channel based optogenetics - New tools to answer long-standing questions in plant biology

NICOLAS HESLOT (Limagrain Europe, France) | How can we breed for stable performance?

MARTIN HÖFER (University of Münster, Germany)
Elucidating non-target-site resistance mechanisms to diquat in *Spirodela polyrhiza* using GWAS

LUKAS HÖRMAYER (Institute of Science and Technology Austria, Austria) | Wound healing in plants: How immobile cells overcome physical constraints

BOŽENA KLODOVA (Charles University, Czech Republic) | Navigating the complex world of pollen gene expression

SVEN KLUMPE (Max Planck Institute of Biochemistry Munich, Germany) | Paving the way for structural developmental biology: Imaging cells and tissues at molecular resolution and beyond

KARL KREMLING (INARI, Cambridge, United States)
Assessing the use of functional variant information in genomic prediction and life at an agtech startup

TRAVIS LEE AND COLLEAGUES (Salk Institute, United States) | Generation of a single-nucleus atlas of seed-to-seed development in *Arabidopsis*

LUKE MACKINDER (University of York, United Kingdom)
Convergent evolution of CO_2-fixing liquid-liquid phase separation

CLAIRE MCWHITE (Princeton University, United States)
The language of proteins

IOANNA MORIANOU (Imperial College London, United Kingdom) | Gene drive systems for sustainable vector and pest control

ALISON SCOTT (Max Planck Institute for Plant Breeding Research, Germany) | Evolution on the polyploid circuit

VINAY SHUKLA (University of Oxford, United Kingdom)
In the ground, out of breath: How roots meet their oxygen demand

DMITRY SHVAREV (Osnabrück University, Germany)
A story of macromolecular complexes: From ABC transporters via membrane tethering to chlorophyll biosynthesis

BEREND SNEL (Utrecht University, Netherlands)
The birth and death of macromolecular complexes in eukaryotic evolution

NEMANJA VUKASINOVIC (VIB-UGent, Belgium)
Brassinosteroid homeostasis and root development

PETER WALTER (Bay Area Institute of Science at Altos Labs, United States) | Targeting the cell's stress pathways for therapeutic benefit

TOBIAS WARNECKE (MRC London Institute of Medical Sciences, Imperial College London, United Kingdom)
What's the point of chromatin?

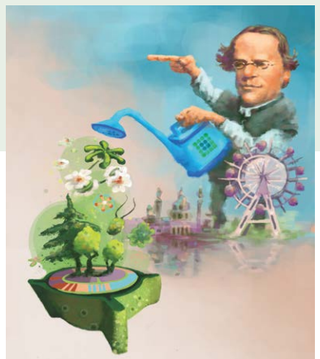
SYMPOSIA

1. FAREWELL SYMPOSIUM FOR ORTRUN MITTELSTEN SCHEID – CELEBRATING TWO DECADES AT GMI

The Farewell Symposium celebrated Ortrun Mittelsten Scheid's contributions at the GMI for nearly 20 years. The symposium featured nine speakers with past affiliations with Ortrun, highlighting her impact and mentorship, and was attended by 140 colleagues and friends. The half-day symposium concluded with a celebratory party recognizing Ortrun's contribution and influence on the GMI.

2. THE 2ND MENDEL EARLY CAREER SYMPOSIUM

The Mendel Early Career Symposium, organized by researchers at the GMI and held at the Vienna BioCenter, provided a platform for early career scientists in plant science. The two-day event was attended by 120 researchers. The symposium featured ten presentations, along with keynote speeches from Siobhan Brady, University of California Davis and Rosa Lozano-Duran, Eberhard Karls University, Tübingen, promoting a collaborative setting for sharing research, ideas, and networking.



Marchantia polymorpha
LIVERWORT

At the Mendel Early Career Symposium, 120 scientists delved into plant science and engaged with the GMI.

GMI @ THE VIENNA BIOCENTER

The GMI is located in the Vienna BioCenter, one of Europe's leading life sciences locations. The campus uniquely integrates research, education, and business, fostering a vibrant environment for scientists at the GMI.

Part of Vienna BioCenter

The Vienna BioCenter is more than just a research location; it is a lively community. It offers joint seminars, conferences, a drama club, sport initiatives, and more, ensuring a rich and collaborative atmosphere.

In addition to the GMI, five research institutes are located at the Vienna BioCenter: the Institute of Molecular Biotechnology (IMBA), the Research Institute of Molecular Pathology (IMP), the Max Perutz Labs, the Centre for Microbiology and Environmental Systems Science (CeMESS), and the Faculty of Life Sciences of the University of Vienna. In 2023, more than **2,800 staff members** from **85 countries**, including **2,000 scientists,** conducted work at the Vienna BioCenter.

The Vienna BioCenter Core Facilities (VBCF) are critical in supporting researchers, offering exclusive access to state-of-the-art scientific infrastructure. Combined with complementary expertise and robust scientific and administrative services, this empowers scientists to pioneer and adopt novel techniques. A growing number of biotech companies and start-up lab spaces further enrich the environment, bridging academic and practical research applications. This comprehensive support has been instrumental for the GMI to become a leading European research institute in plant biology.

EDUCATION & TRAINING

Education is core to the mission of the Gregor Mendel Institute. A comprehensive scientific training program makes the GMI a destination for researchers at all stages of their careers, from interns to postdocs. Researchers at all levels have access to the GMI's core research facilities and scientific training program.

VIENNA BIOCENTER SUMMER SCHOOL

The Vienna BioCenter Summer School, sponsored by the Max Birnstiel Foundation, welcomes undergraduate students to work alongside staff scientists at the Vienna BioCenter's leading life science research institutes, including the GMI. Students form important professional interactions and get a head start in establishing their research profile.

I²P INTERNATIONAL INTERNSHIP PROGRAM

The International Internship Program – short, I²P – is a full-immersion internship program for predoctoral students. For three to six months, interns join a research group at the GMI. Participants assume ownership of a research project, work alongside a dedicated mentor, and earn a salary. The experience opens new ways of thinking about scientific research and scientific careers.

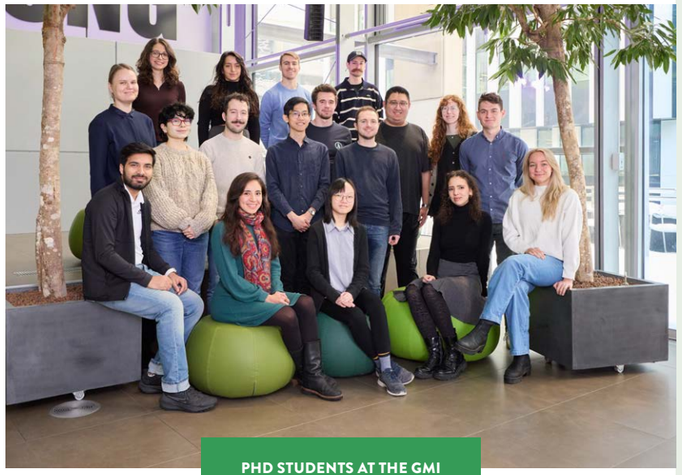
Marco Bellin is an intern in the Ramundo Lab, whose research focuses on chloroplast unfolded protein response (cpUPR).

VIENNA BIOCENTER PHD PROGRAM

The Vienna BioCenter PhD program is one of Europe's leading PhD programs in the life sciences and is a Doctoral school of the University of Vienna and the Medical University of Vienna, in collaboration with the GMI, IMBA, IMP and the Max Perutz Labs.

The mission of the Vienna BioCenter PhD Program is to promote interdisciplinary research in the Life Sciences at the highest level. The Program is designed to help excellent PhD students develop into tomorrow's leading scientists; a comprehensive training program supports them in their first steps in a scientific career. PhD students at the GMI are recruited twice a year in March and September through the Vienna BioCenter PhD Program.

New PhD students engage in the "Prime Your PhD" series. This seminar series serves as an introduction to the breadth of research conducted on campus, covering a wide range of topics and methodologies, from the genetic basis of adaptation to climate change, CRISPR screening and its applications in public health, through mechanisms of human proteasomes, RNA-protein interactions, strategies in virus-host interactions, to statistical concepts.



PHD STUDENTS AT THE GMI

PhD representatives champion mental health initiatives at the GMI

Researchers at the GMI are invited to shape the GMI community and to share their perspectives on institute-wide issues. Meet the three PhD students, who volunteered in 2023 to represent the PhD community of the GMI.

INSIGHTS

PHD REPRESENTATIVES

Jian Yi Kok from the Berger group, **Victor Sanchez de Medina** from the Dagdas group, and **Pamela Vetrano** from the Ramundo group.

What's your motivation for accepting this leadership role on campus?

Victor Sanchez de Medina: *I was intrigued by the effort made by program coordinators and students to build a campus community. I wanted to learn about integrating students into programs and to have the opportunity to contribute and improve them.*

Jian Yi Kok: *Being a PhD student can be challenging, and mental health is a topic that hadn't been much discussed in academia. Being a rep gave me the chance to address this and contribute to ongoing efforts.*

Pamela Vetrano: *This is the first time I've been in a representative role, and initially, I was hesitant. However, I'm starting to see the value and feel that I can be useful.*

What skills have you sharpened to find success in your positions?

Victor: *Through this role, I've learned the science of approaching and conveying problems effectively, so you can have a discussion that is productive for both parties.*

Jian: *I'm learning to listen to and integrate different ideas. This role has taught me the importance of considering various perspectives and formulating solutions that encompass diverse viewpoints and concerns.*

Pamela: *A significant skill I've gained is logistics, essential for planning large events like the PhD retreat, Halloween parties, and Christmas dinners.*

What has been your focus in 2023?

Jian: *A big part of our focus has been on improving communication between various academic levels as misunderstandings are often where issues stem from.*

Victor: *A major focus has been maintaining the PhD survey as a consistent and reliable data collection tool. The PhD survey is sent out annually to all PhD students on campus. Maintaining the consistent data collection is crucial for understanding the evolving concerns of PhD students. We've used these insights to launch a mental health campaign in 2023.*

Pamela: *In terms of practical steps, the mental health campaign was a significant first move. The campaign helped bring the issue to the forefront. Together with EHS and other stakeholders at the institute, we've worked on increasing access to consultations with well-being professionals. These actions are aimed at offering support from multiple angles, recognizing that there's no one-size-fits-all solution.*

VIENNA INTERNATIONAL POSTDOCTORAL (VIP²) FELLOWSHIP PROGRAM

The GMI is a member of the Vienna International Postdoctoral (VIP²) Fellowship Program, a 3-year postdoctoral fellowship program. The VIP² program is designed as an attractive career opportunity for researchers who hold a PhD in the life sciences (or a related discipline) and who propose projects that may lead to distinct research lines. The fellowship is fully funded and offers prime research conditions, exposure to different sectors, and a two-mentor scheme. Fellows are advised and supported by an inter-sectoral advisory board.

THE VIENNA BIOCENTER LEADERSHIP PROGRAM

NEW IN 2023

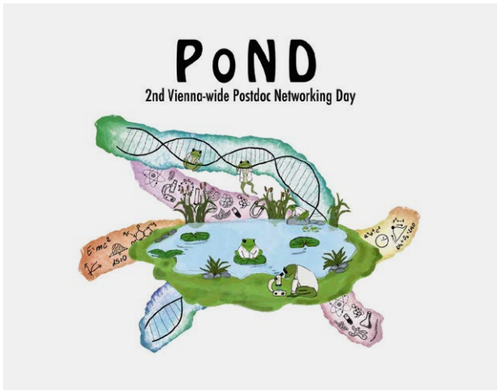
Academic leaders face a complex landscape of global competition and expanding responsibilities, which can impact their teams and impede groundbreaking discoveries. At the Vienna BioCenter, including the GMI, we run a comprehensive leadership program that sharpens leadership skills and fosters collaboration among leaders from the various institutes on campus. Through practical modules and a peer-mentoring network, it empowers participants to guide their teams effectively towards innovative discoveries.

EXPERT-LED RESEARCH TRAINING

While "Prime Your PhD" gives new students an overview of various research areas, the "How do you do it?" series offered to all researchers focuses on detailed methodologies like protein quality control, AI applications with ChatGPT, and creating DNA nanostructures. These seminars, led by experts, offer Master's students, PhD students, and postdocs hands-on experiences to enhance their practical skill sets in current scientific practices.

Complementing educational seminars, training in the use of core facilities is a key aspect of the research environment. These facilities, equipped with advanced technologies such as cryogenic electron microscopy, next generation sequencing, high-throughput digital phenotyping, and bioinformatics, are staffed by experts who provide researchers with practical training. This approach ensures that researchers at the GMI, as part of the Vienna BioCenter, are well-equipped with the necessary skills for conducting their research effectively.

Postdoc Networking Day is a multidisciplinary event encompassing a range of fields such as life sciences, chemistry, and computer science.



POSTDOCTORAL FELLOWS AT THE GMI

GMI postdocs foster campus connectivity

At the GMI, postdoc representatives play crucial roles by contributing to decision-making and leading community initiatives such as the Postdoc Networking Day (PoND). Meet Aleksandra Kornienko, Pierre Bourguet, and Anna Igolkina, who represented the postdoctoral community in 2023.

INSIGHTS

POSTDOC REPRESENTATIVES

Anna Igolkina and **Aleksandra Kornienko,** both Nordborg group along with **Pierre Bourguet,** Berger group, served as postdoc reps at the GMI in 2023.

What motivated you to become postdoc representatives?

Anna Igolkina: *I wanted to see how the institute works inside and to be a mediator between different constituencies on campus.*

Pierre Bourguet: *I believe in the power of a group working together to create a better community. We get a lot of career support as Vienna BioCenter postdocs, mainly for academia and pharmaceutical industries. My original goal was to implement networking opportunities in agricultural research and industries as an alternative career for GMI postdocs.*

Aleksandra Kornienko: *Once I started, it was really interesting to attend meetings with the faculty. It's not always easy to see the perspectives of other people. So I think it's good that we have representatives from different branches of science like technicians, PhD students, and postdocs in the same room together.*

Can you elaborate on the initiatives you've worked on?

Pierre: *We organized the postdoc retreat, which had over 50 participants from across the campus.*

Anna: *The retreat was structured with one-minute talks organized by themes, but the focus was really on socializing and networking. The retreat also included a decision-making workshop, and several speakers who showcased their career paths.*

Pierre: *We also started a new symposium to gather all the postdocs in Vienna. PoND, the Postdoc Networking Day, is a multidisciplinary event encompassing a range of fields such as life sciences, chemistry, and computer science. We also made strides in integrating support for immigrating scientists. The program is about helping international scientists settle in Vienna, providing a roadmap for personal or family visa applications, and helping them navigate Austrian bureaucracy.*

How has your role as representatives impacted your interaction with the campus community?

Aleksandra: *I felt so fulfilled by the opportunity to help people who approached me with complex issues. People can come to us, and we have direct access to the faculty. We can advocate for an issue.*

Pierre: *As reps, we are, on average, more knowledgeable about the resources available on campus. If anyone is experiencing difficulties, we can help simply by directing them to the appropriate person or service.*

OUTREACH

HIGHLIGHTS IN 2023

GMI's outreach initiatives are crucial in connecting basic plant research with the wider community and extending scientific achievements' impact. GMI researchers effectively convey and display complex scientific concepts and recent discoveries through various activities, including lectures, workshops, lab visits, and research stations. These initiatives make research accessible and relevant to a diverse audience and cater to learners of all ages and cultural backgrounds. Scientists and educators of the communications team build extensive connections within the Vienna community to amplify outreach efforts and provide interactive, hands-on experiences that foster a deeper understanding and engagement with science.

GMI PARTNERS WITH BOTANICAL GARDEN FOR ENGAGING EVENTS

NEW IN 2023

GMI partnered with the Botanical Garden of the University of Vienna on Fascination of Plants Day and the Rare Plant Fair.

Interactive stations featured the institute's model plants where families could explore various aspects of plant development and learn about the institute's research areas.

Johannes Rötzer, together with Sebastian Deiber (not pictured), from the Dolan lab, elucidated the intricate connection between pollinators and flowers, showcasing different flower types and how they evolved to attract specific pollinators during Fascination of Plants Day.

INSPIRING YOUNG MINDS: CULTIVATING SCIENTIFIC CURIOSITY

During 2023, GMI welcomed diverse groups of teenagers, including aspiring young female scientists at Daughters' Day, participants of the Austrian Science Olympiads, and students from the Kharkiv-Vienna International Science School. These events provided a direct and practical understanding of GMI's ongoing research, explored scientific methods, and fostered an interest in scientific careers.

During Daughters' Day, aimed at girls exploring careers in STEM (Science, Technology, Engineering, and Mathematics), teenage girls explored Kelly Swarts and her team's research on conifer tree adaptation to climate change and discussed career paths in science.

During a GMI visit, Science Olympiad winners learned from Liam Dolan about the significance of plant research for society.

Austrian Science Olympiads receive an introduction to the Ramundo lab's research. Carla Brillada and Julia Kober showcase a plate of *Chlamydomonas reinhardtii*, illustrating the lab's study on the growth of this organism under controlled conditions.

With the support of researchers of the Dolan group, Victoria Spencer explained molecular biology tools for Kharkiv-Vienna International Science School students, and the team engaged in microscopy activities, fostering a deeper understanding of scientific concepts.

EDUCATIONAL OUTREACH TO KIDS

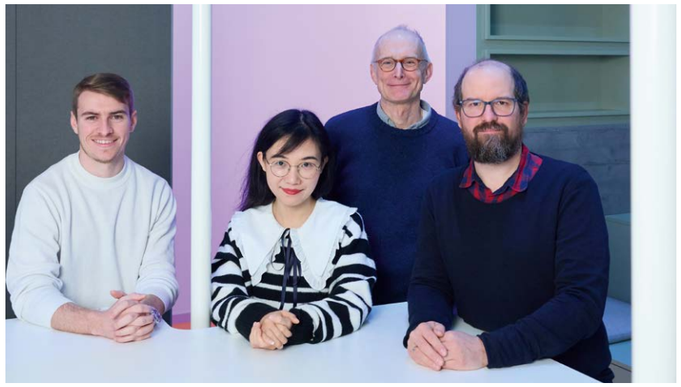
The GMI is committed to encouraging young children's interest in and curiosity about science. This emphasis was evident in an interactive workshop on plant breeding designed by GMI researchers during the Vienna Children's University (KinderuniWien).

Sebastian Deiber and Johannes Rötzer led an interactive workshop on plant breeding practices and molecular tools like CRISPR/Cas9 as part of the Vienna Children's University (KinderuniWien).

SCIENTIFIC FACILITIES

Scientific facilities boosting research excellence

Autophagy, a critical self-cleaning process within cells, is essential to maintain cell health by breaking down and recycling damaged components. In a collaborative effort, GMI and Max Perutz Labs researchers, including GMI group leaders Yasin Dagdas and Silvia Ramundo supported by core facilities, identified a regulatory switch essential for autophagy that is conserved across eukaryotes. Their findings were published in 2023 in The EMBO Journal.



In a collaborative study involving GMI researchers **Victor Sanchez de Medina** and **Ni Zhan** (co-first authors of the study), along with core facility experts **David Drechsel** from Protein Technologies and **Mathias Madalinski** from Peptide Synthesis, a conserved molecular switch controlling autophagy in eukaryotes was identified.

CORE FACILITIES AS A FOUNDATION FOR SUCCESS

The project's success depended on an outstanding collaboration between scientists from different research groups and experts from core facilities. These facilities, equipped with advanced technologies and operated by expert staff, provided support in experimental design, instrument use, and data analysis, enhancing the research output.

Yasin Dagdas, group leader at the GMI and co-corresponding author of the study, explains the key results: "In a collaborative effort, we identified a regulatory switch involving UFM1 and ATG8, two ubiquitin-like molecules, and their interaction with a key protein, C53. This discovery was not straightforward; it was facilitated by the comprehensive support from the facilities, which enabled the team to overcome significant experimental and analytical challenges."

Dagdas underscores the pivotal role played by core facilities in their discoveries, especially the support from BioOptics, Molecular Biology Services, Proteomics Facility, and Plant Sciences.

"The contributions of Mathias Madalinski and David Drechsel – who lead the Peptide Synthesis and Protein Technologies Facilities – extended far beyond providing resources; they brought a wealth of expertise and active engagement that enhanced the research process and tailored methods specifically for our study." As Yasin Dagdas emphasizes, "Developing AIM peptides, both in wild-type and mutant variants, is crucial for our research. These peptides are highly valued and used within our group."

Mathias Madalinski, provides further insight into the specialized approach: "Having worked on AIM peptides extensively, I have developed a specially optimized HPLC method for purifying these peptides. This method uses a unique column and different solvents, a departure from the usual 'one-for-all' peptide purification method."

This collaboration among researchers, aided by core facilities, has advanced the understanding of cellular processes, underscoring the essential role of core facilities in driving scientific excellence.

PUBLICATION

Picchianti L, Sánchez de Medina Hernández V, Zhan N, Irwin N, Groh R, Stephani M, Hornegger H, Beveridge R, Sawa-Makarska J, Lendl T, Grujic N, Naumann C, Martens S, Richards T, Clausen T, Ramundo S, Karagöz G, Dagdas Y (2023) Shuffled ATG8 interacting motifs form an ancestral bridge between UFMylation and autophagy. EMBO J 42(10):e112053

GMI has access to scientific core facilities on campus, shared with IMBA and IMP, and to the support of the Vienna BioCenter Core Facilities (VBCF). Together, the facilities form the backbone of a dynamic research ecosystem. The scientific facilities offer researchers access to advanced equipment and expert knowledge. Their teams are highly skilled professionals with extensive knowledge in experimental design, adept handling of instruments, and data analysis. This support enhances the quality of research and fosters an environment of cooperation and creativity in the scientific community.

SCIENTIFIC CORE FACILITIES

The Proteomics Facility offers protein analysis services.

The Peptide Synthesis Facility offers its expertise for generating and purifying peptides.

BIOOPTICS
offers extensive services, including analytical flow cytometry and cell sorting, 30+ microscopy systems (wide-field, confocal, two-photon, light-sheet, super-resolution, TIRF, FLIM), and advanced image processing and analysis.

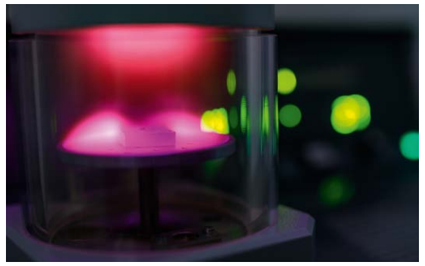
MOLECULAR BIOLOGY SERVICES
provides services including Sanger Sequencing, *E. coli* cell preparation, recombinant protein production, mycoplasma testing, and plasmid preparation in 96-well format, along with molecular biology reagents, high-throughput lab automation, and access to a RIKEN clone repository.

PEPTIDE SYNTHESIS
specializes in peptide synthesis with options for modifications or heavy isotope-labeled amino acids, and conducts purification of antibodies and other proteins, complemented by small-scale RP-HPLC purifications and TAQ purification in collaboration with MBS.

PROTEOMICS FACILITY
provides mass spectrometry service for protein identification, characterization of posttranslational modifications and protein quantitation which includes sample preparation, MS measurement and the respective data interpretation. The facility operates a number of state-of-the-art mass spectrometers that are provided by the VBCF.

PROTEOMICS TECH-HUB
With single cell proteomics (SCP) and crosslinking mass spectrometry (XL-MS), the Proteomics Tech Hub currently focuses on two major lines of research and technological innovation both holding great relevance to the Vienna BioCenter research community.

Protein Technologies offers expertise in recombinant protein technologies.



The Electron Microscopy facility offers a wide variety of preparation and visualization techniques for biological samples.

PHENOPlant is designed for non-invasive, physiological high-throughput phenotyping of mid-size crop plants as well as *Arabidopsis*.

VIENNA BIOCENTER CORE FACILITIES

AUSTRIAN BIOIMAGING/CMI
serves as the national node for Euro-BioImaging, part of the European Research Infrastructure Consortium (ERIC), and provides open access to a broad range of imaging technologies and data services, supporting research and training in biological and biomedical imaging.

CHILD CARE CENTER
advocates for career-family balance by offering childcare for children aged three months to six years for employees at the Vienna BioCenter.

COMPUTATIONAL BIOLOGY TRAINING
is part of the Vienna BioCenter Scientific Training program and provides practical courses on computational data analysis.

ELECTRON MICROSCOPY
offers training and assisted techniques in electron microscopy, including standard methods and advanced cryo-EM for high-resolution imaging, as well as basic scanning EM for surface structure visualization.

HISTOLOGY
equips researchers with diverse equipment and expertise to preserve and visualize the microanatomy of their model organisms utilizing classical tissue processing, histochemistry, immunostaining, and *in-situ* hybridization methods, as well as multidisciplinary approaches, such as spatial transcriptomics, tissue clearing, and multiplex immunofluorescence.

METABOLOMICS
offers quantitative analysis of small molecules and metabolites using LC-MS/MS, combining liquid separation techniques with advanced mass analysis, enabling targeted and nontargeted insights into metabolic pathways and genome-environment interactions.

NEXT GENERATION SEQUENCING
provides DNA and RNA sequencing across short (Illumina) and long-read (PacBio and ONT) platforms. A broad selection of library preparation protocols allows for processing samples from many biomedical research areas. The diverse portfolio comprises customized approaches, user consultation, robotics services, and bioinformatic analysis.

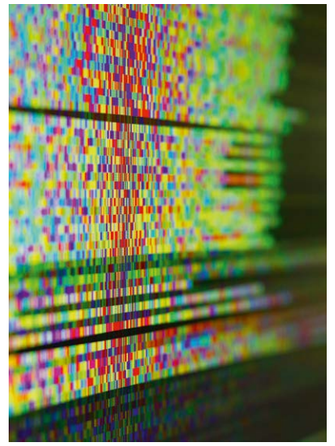
PLANT SCIENCES
(PlantS) operates a state-of-the-art, high-throughput, multi-sensor plant phenotyping research infrastructure (PHENOPlant) and 23 highly specialized phytotrons. We offer expertise and service in high-throughput plant phenotyping, dynamic environmental simulations, soft- and hardware engineering as well as image- and data analysis.

PRECLINICAL PHENOTYPING
(pcPHENO) specializes in advanced mouse *in vivo* studies covering behavior tests, metabolic and cardiovascular measurements, as well as surgical services.

PROTEIN TECHNOLOGIES
(ProTech) aims to advance research in molecular and cell biology, protein biochemistry, and structural biology by offering expertise in recombinant protein technologies and biophysical characterization, with core services including molecular cloning, protein production, purification, and analysis.

VIENNA DROSOPHILA RESOURCE CENTER
(VDRC) is a globally significant bioresource center that promotes scientific discoveries in *Drosophila melanogaster*, primarily maintaining and distributing unique transgenic *Drosophila* stocks and DNA resources locally and internationally.

PHENOPlant facilitates precise environmental simulations.



Molecular Biology Services provides a range of services, including sequencing.

From preparing samples to producing images, the Electron Microscopy Facility (EM) helps researchers look closely at molecules, cells and tissues.

HEADS OF SCIENTIFIC FACILITIES

ADMINISTRATION & INFRASTRUCTURE

Researchers at the GMI are supported by administrative and infrastructure staff, who ensure smooth day-to-day operations. To increase synergies, administrative staff is shared by the GMI and IMBA, the two life science research institutes of the Austrian Academy of Sciences located at the Vienna BioCenter. The infrastructure team enhances resource sharing across the GMI, IMBA and IMP. This collaborative approach ensures an efficient use of resources and fosters a cooperative environment.

ADMINISTRATION

The Assistant to the Directors organizes seminars, conferences, the annual retreat and SAB meetings.

The Finance Department, including Accounting, Controlling & Grants, is responsible for accounting, financial controlling, and financial reporting. The Grant Management team assists in preparing proposals, managing active grants and is responsible for project financial reporting and project audits.

The Human Resources team supports staff in relation to employment and living in Austria, including helping with visa and work permit issues.

The Technology Transfer Office manages the intellectual property assets and the transfer of knowledge, materials and technology to partners, including spin-off companies.

The Communications and Partnerships team makes research at IMBA accessible for diverse audiences and stakeholders.

INFRASTRUCTURE

The **ENVIRONMENT, HEALTH AND SAFETY** team implements occupational health and safety measures. The EHS team provides support in fulfilling legal requirements in accordance with the Employee Protection Act. EHS takes targeted measures in the work and disposal channels to protect the environment and employees. The health of employees is supported by occupational health programs.

FACILITY MANAGEMENT is responsible for building management, technical equipment, waste disposal and operational support.

The **IT DEPARTMENT** operates and supports services including high-performance computing (CLIP), as well as hard- and software and data storage.

LAB SUPPORT is dedicated to helping in the daily operations of scientists by providing support to facilitate the daily lab work and experiments. Its services range from maintenance, repairs, and proactive equipment upkeep to efficient on- and offboarding processes, along with strategic resource allocation.

PURCHASING is responsible for all purchasing activities for goods and services including maintaining the purchase order system and operation of the warehouse.

The **MAX PERUTZ LIBRARY** supports researchers with access to literature, advice about open-access publishing, and the implementation of electronic laboratory notebooks.

The **MECHANICAL ENGINEERING CENTER** assists scientists in any hardware challenge: designing and building prototypes, robotics or any custom-made experimental setup that requires expert skills and professional tools to translate ideas into custom-made products in the service of discovery.

The **STERILE PROCESSING DEPARTMENT** provides researchers directly and indirectly via the Media Lab with sterile glassware and sterilized lab-plastic ware. They also collect dirty glassware from the defined areas, which are cleaned before sterilization.

ADMINISTRATION & INFRASTRUCTURE

SCIENTIFIC ADVISORY BOARD

Research at the GMI is evaluated annually by a Scientific Advisory Board (SAB). The SAB is composed of international experts, whose primary role is to advise the institute's management and the Austrian Academy of Sciences on the quality of the science undertaken at the GMI. The SAB meets with scientists at the GMI over a two-day period, during which they conduct in-depth discussions with all research groups as well as Postdoc, PhD and technical staff representatives.

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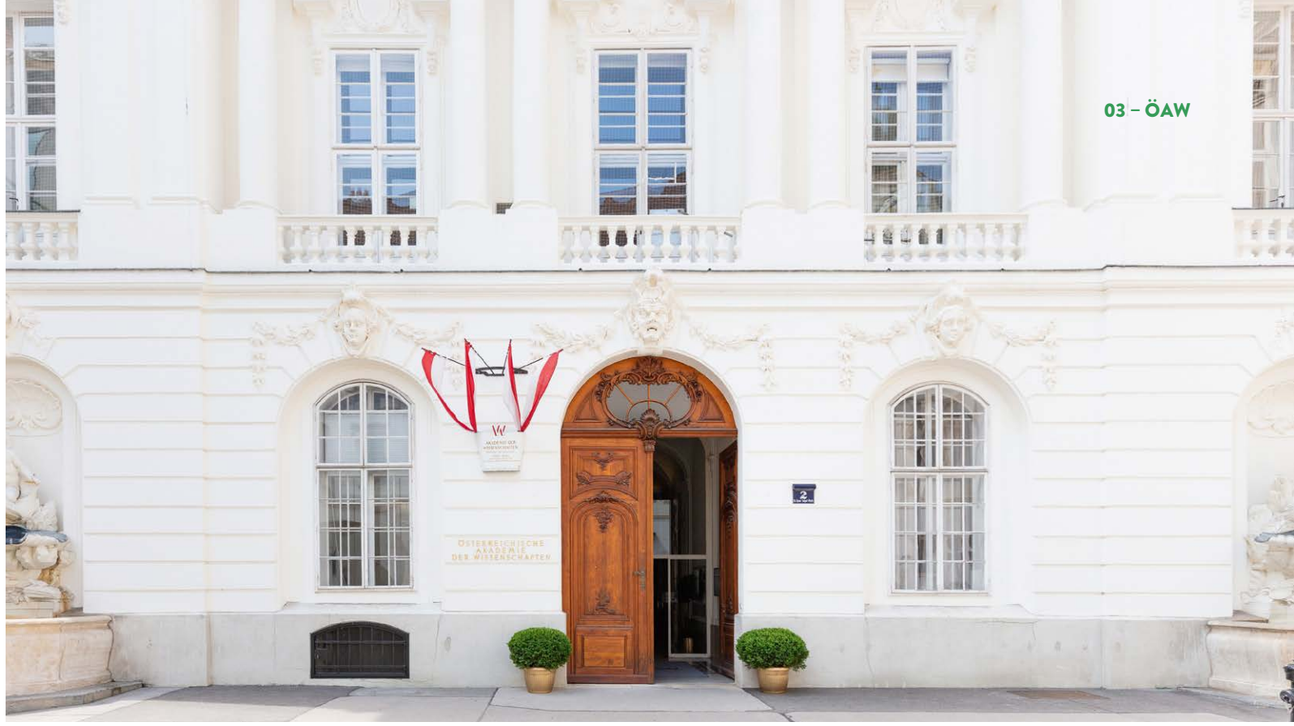


THE AUSTRIAN ACADEMY OF SCIENCES

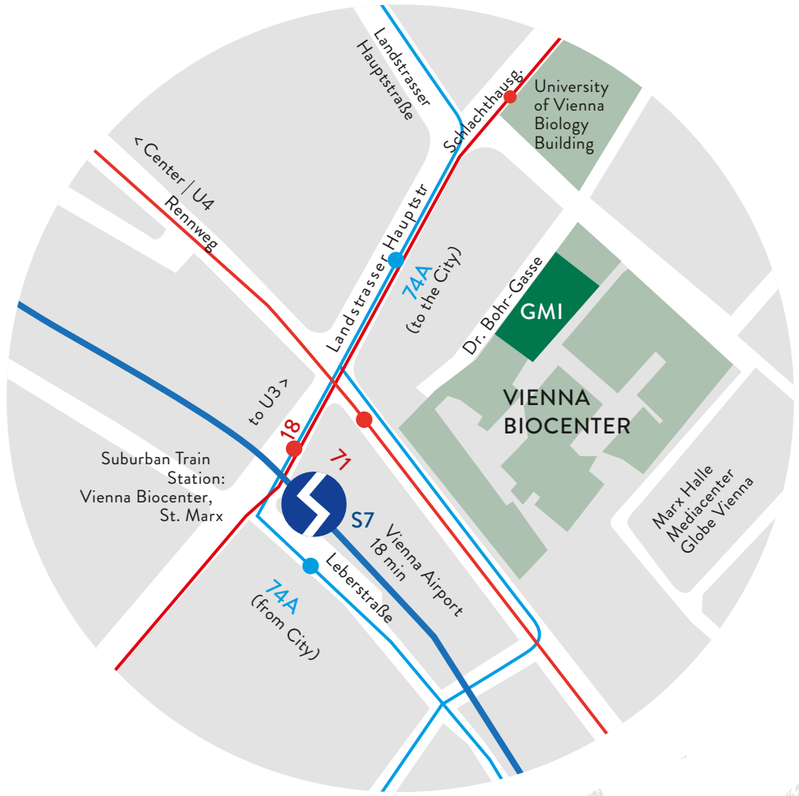
ÖAW AUSTRIAN ACADEMY OF SCIENCES

The Gregor Mendel Institute is a basic research institute of the Austrian Academy of Sciences (ÖAW). The ÖAW is the leading Austrian non-university institution for science and research. Founded in 1847 as a learned society in Vienna, the ÖAW today stands for social discourse, the transfer of new knowledge, and basic research at the highest international level.

With a mission to promote science in every way, the ÖAW fulfills two main functions in Austrian and international science. On the one hand, its 760 members form a scholarly society, advising decision-makers from politics, industry, and society and conveying scientific insights to the public. On the other hand, the Academy is Austria's major supporter of research outside the university system, funding 26 research institutes in both the humanities and the natural sciences – including the Gregor Mendel Institute.

LOCATION

The Gregor Mendel Institute is located at the Vienna BioCenter, a world-leading life science research campus.



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Front page: "Where Knowledge Grows" comes to life as some of GMI's model organisms sprout from the digits "2023." This motif continues inside, with plants winding through the pages and symbolizing the nurturing environment that fosters groundbreaking research.

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