
ÖAW
AUSTRIAN ACADEMY OF SCIENCES
EXPLORING
the UNKNOWN
IMBA RESEARCH REPORT 2023
IMBA
Institute of Molecular Biotechnology
of the Austrian Academy of Sciences

# EXPLORING *the* UNKNOWN

IMBA RESEARCH REPORT 2023

# Contents



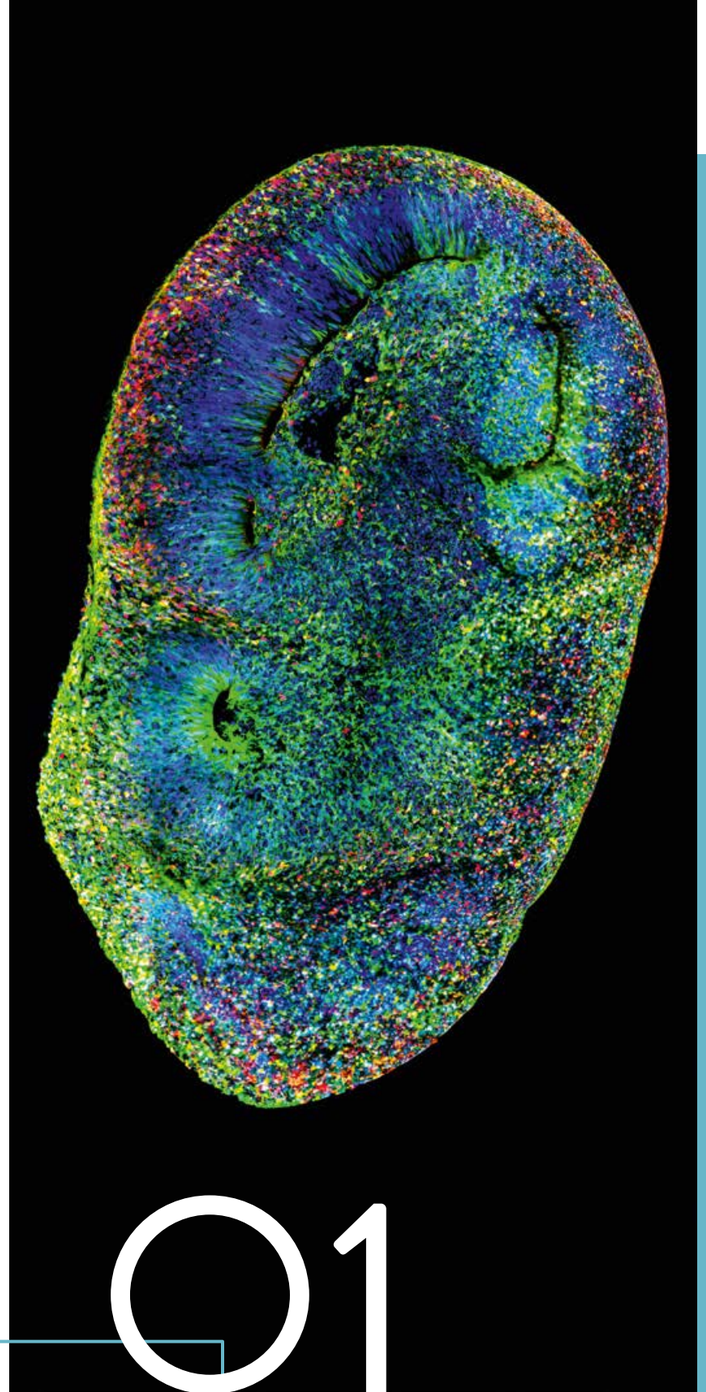




IMBA scientists are united by a curiosity to explore the unknown. This curiosity is reflected in the visual narrative of this research report, which transforms research images into kaleidoscopes. The kaleidoscopes visually represent the multifaceted nature of explorations by IMBA scientists.

IMBA's 20th Anniversary: In June 2023, IMBA celebrated 20 years of discoveries to mark the start of its research activities. This annual report celebrates the milestone anniversary by reflecting on the past and looking forward to future successes.

IMBA
Institute of Molecular Biotechnology
of the Austrian Academy of Sciences
20 YEARS



# 01

# INTRODUCTION

In 2023, researchers at IMBA presented a new brain organoid system in which the effect of multiple mutations can be simultaneously studied at the single-cell level.

INTRODUCTION

# Our curiosity to *explore*

**Jürgen Knoblich and Markus Kiess explore the scientific advances made at IMBA in 2023 and give an outlook on IMBA's future.**

At IMBA, we are committed to unravel life's inner workings from the molecular to the whole organism scale. By addressing the big questions in the life sciences, we want to gain mechanistic insight that will serve as the foundation for tomorrow's innovations in medicine and beyond. We cover a broad range of topics ranging from RNA and genome biology to stem cells, differentiation, and organoid research, which provide many opportunities to bridge scales and scientific disciplines. Our curiosity to explore the unknown is reflected in the visual narrative of this research report, in which research images are transformed into kaleidoscopes, visually representing the multifaceted nature of our explorations that often take unexpected turns leading to new insights.

## 20 years of research

2023 marked a milestone for IMBA: 20 years had passed since the first researchers began carrying out experiments at the then recently founded IMBA. This year, we celebrated the many scientific discoveries made by scientists at IMBA over the previous two decades. Scientific breakthroughs include creating the first organoids for disease research, identifying RANKL as a critical gene for osteoporosis, unraveling the molecular mechanisms of the piRNA pathway for genome defense, understanding how the genome dynamically reorganizes during cell division – and many more.

During the 20th anniversary celebrations for IMBA, Maria Leptin, the President of the European Research Council and a member of IMBA's Scientific Advisory Board, delivered a thought-provoking message on fundamental values of basic research in shaping our world. Tony Hyman, who chaired IMBA's Scientific Advisory Board for over a decade in the institute's formative early years, reflected on how IMBA has grown to become an internationally visible hotspot for the life sciences. In this report, read more about Maria Leptin's and Tony Hyman's insights into IMBA's trajectory towards scientific discovery.

IMBA scientists explore the fundamentals of life to gain new perspectives that could transform biology as we know it today or influence medical practices of the future. This year, they discovered horizontal gene transfer vectors, produced the first multi-chamber heart organoids, showcased computational tools for 3D genome navigation, used single-cell brain organoid screening to characterize autism-causing mutations, and made many other ground-breaking discoveries.

We celebrate the achievements of our colleagues, but also bid farewell to those moving on to new horizons. In 2023, Bon-Kyoung Koo left IMBA for a position as Director at the Institute of Basic Science in South Korea – a great opportunity for carrying on IMBA's mission to advance basic research. We look forward to continuing our successful scientific collaboration with our valued colleague.

In 2023, scientific director Jürgen Knoblich and business director Markus Kiess steered IMBA's course.

## Future outlook

In 2024, IMBA is also looking forward to new perspectives: Elly Tanaka, a highly accomplished researcher and pioneer in the field of regenerative biology, will become the institute's next scientific director. Elly Tanaka was previously Director at the DFG Center for Regenerative Therapies at TU Dresden, Germany, and then senior group leader at the Research Institute of Molecular Pathology, IMBA's sister institute at the Vienna BioCenter. Everyone at IMBA is excited to welcome Elly Tanaka as Scientific Director. Elly will bring a powerful blend of leadership and innovative spirit. With her at the helm, IMBA is ready to write the next chapter of scientific breakthroughs.

IMBA's journey is possible due to the generous support of the Austrian Academy of Sciences and the Federal Ministry of Education, Science and Research. We extend our gratitude for their commitment to scientific excellence over the past decades. We also thank sponsors and donors who have supported scientific projects at IMBA.

Lastly, we appreciate the collaborative spirit of our institute's community. It is your dedication and passion that transform IMBA into a vibrant hub of scientific inquiry and discovery. As we look to the future, we remain inspired by the potential that molecular life sciences hold, and we reaffirm our commitment to advancing knowledge in this ever-evolving field.

INTRODUCING IMBA

# Creativity *and* Collaboration

## Introducing what makes IMBA special

Despite its young age and moderate size, the Institute of Molecular Biotechnology (IMBA) is one of Europe's flagship institutes in the fields of molecular biology and biomedical research. IMBA is a research institute of the Austrian Academy of Sciences and part of the Vienna BioCenter, a vibrant international hub for the life sciences. Located in the heart of Europe, the Vienna BioCenter is a thriving campus where research institutes, universities and biotech companies come together to foster a dynamic community dedicated to basic research, applied research, and education.

### Research

Driven by curiosity and a great passion for experimentation and discovery, researchers at IMBA are tackling challenging questions, pioneering new research fields and advancing our molecular understanding of life at its most fundamental levels. Our research areas are broad and range from RNA biology and chromosome biology to neurobiology, stem cell and organoid research, and disease modeling.

IMBA fosters creativity. Our scientists – from established experts to the youngest talents – can pursue their ambitious goals with the utmost financial and technical support. World-class scientific support facilities, led by experts, collaborate with our scientists in experimental design, instrumentation, experimentation and data analysis. IMBA also stimulates collaboration between research groups across campus, bridging thematic and institutional boundaries and fostering the exchange of ideas to open up new avenues of research. Embedded in this highly supportive and collaborative environment, IMBA scientists conduct internationally competitive research.

IMBA receives generous core funding from the Austrian Academy of Sciences. In addition, our scientists are highly successful in attracting third-party funding from various national and international funding agencies. These resources give IMBA scientists the freedom to develop new and bold approaches, design innovative technologies, create novel model systems – and ultimately make groundbreaking discoveries.

### Education

The foundation of IMBA's success are our young scientists on their path towards excellence in research. A world-class training program makes IMBA a top destination for researchers at all stages of their careers, from interns to PhD students and postdocs. The international Vienna BioCenter doctoral and post-doctoral programs play a major role at IMBA, offering rigorous training aimed at developing scientific independence and leadership qualities.

Key assets of IMBA include an outstanding infrastructure, a world-renowned community of interdisciplinary scientists, and a vibrant and synergistic environment in Vienna – one of the world´s top-ranked places to work and live.

> ***"IMBA is defined by its diversity and intellectual freedom. As a scientist who has spent more than ten years at IMBA, I've experienced first-hand the transformative power that a truly collaborative environment can have. It's inspiring to see researchers from diverse backgrounds and experience coming together, challenging each other and pushing the boundaries of what's possible. The most valuable lesson I've learned at IMBA is that scientific leaps often emerge from unexpected corners but are always driven by diverse minds and a contagious curiosity that characterizes our institute."***
>
> Julius Brennecke, Senior Scientist

### Working at IMBA

IMBA's goal is to enable unique and high-quality research. To achieve this, IMBA is committed to providing a safe, collegial, and inclusive work environment in which all employees can flourish.

Research at IMBA is evaluated annually by a Scientific Advisory Board (SAB), consisting of independent international experts. The SAB advises the institute's management and the Austrian Academy of Sciences on the quality of the science being undertaken at the institute.

> ***"Our goal is to empower curious researchers. Scientists at IMBA have access to world-class facilities, allowing them to push the boundaries of their projects and gain invaluable hands-on experience. Witnessing young researchers thrive and supporting them to turn an initial spark into a groundbreaking discovery is incredibly rewarding."***
>
> Daniel Gerlich, Senior Scientist

# 20 years of *discoveries*

**Since IMBA's start of research operations in 2003, scientists at the institutes have made breakthroughs in uncovering new results and answering open questions, and also in translating these insights into innovations.**

## 1999

Foundation of IMBA, initiated by the Austrian Academy of Sciences (ÖAW) and Boehringer Ingelheim.

## 2003

Michael Krebs joins IMBA as administrative director.

IMBA's birth year: Barry Dickson starts as the first research group leader hired by IMBA.

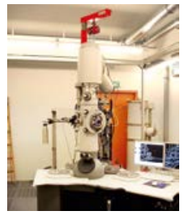
## 2002

Josef Penninger joins IMBA as Scientific Director.

The first PhD student at IMBA starts in the PhD Program.

## 2005

Josef Penninger and his team single RANKL out as the key gene involved in osteoporosis.



## 2007

Austria's first cryo-electron microscope is established by IMBA and IMP.

The RNAi library, a genome-wide *Drosophila* RNAi resource, is established.

## 2006

Inauguration of the ÖAW Life Science Building hosting IMBA and GMI.

Launch of the yearly Microsymposium on RNA biology at IMBA.

## 2011

Research led by Thomas Marlovits at IMBA characterizes the infectious machinery of *Salmonella*.

## 2012

Julius Brennecke and his team identify Maelstrom as an essential effector of Piwi-mediated transposon silencing.


## 2010

Launch of the Vienna Biocenter Core Facilities, a centralized research infrastructure at the Vienna BioCenter.



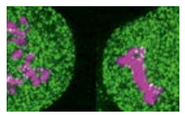
## 2013

Jürgen Knoblich and Madeleine Lancaster develop the first brain organoid for the study of disease.

IMBA celebrates its 10-year anniversary.

## 2016

Daniel Gerlich and his team identify Ki-67 as a key regulator of mitotic chromosome assembly.



Launch of the DBA initiative, which until 2023 has raised nearly 1 million Euro to fund research on the rare disease Diamond-Blackfan anemia.

Kikuë Tachibana and her team describe a surveillance system that ensures repair of DNA lesions during zygotic reprogramming.

The IMBA Stem Cell Core Facility is founded to support research groups using stem cells.

IMBA hosts its first Bioethics Symposium.

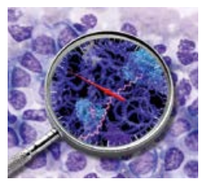

Kikuë Tachibana and her group uncover key mechanisms in chromatin organization unique to zygote nuclei.

Josef Penninger and his team develop a reversible haploid mouse embryonic stem cell biobank resource for functional genomics.

## 2017

## 2018

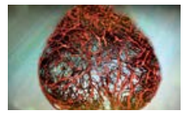
Stefan Ameres and his team, together with researchers at the IMP, develop SLAM-seq, a method that allows them to characterize cancer genes.



Jürgen Knoblich named as IMBA Scientific Director.

Launch of SY-Stem, the symposium for the next generation of stem cell researchers at IMBA and the IMP.

Josef Penninger and his team develop human blood vessel organoids.



Founding of a:head bio, a spin-off using brain organoids to develop new therapies for brain disorders.

Julius Brennecke and his team show how the piRNA pathway upcycles building blocks to protect genome integrity.

## 2019

## 2020

Markus Kiess named as IMBA Administrative Director.

Research by Daniel Gerlich and his lab uncovered how cytoplasm is removed from the nucleus after cell division.

Quantro Therapeutics, a spin-off company to generate a cancer drug discovery pipeline, is founded.

Josef Penninger uncovers how the thymus contributes to healthy pregnancies.

Sasha Mendjan and his team produce cardioids, heart organoid models that simulate the heartbeat in a dish.

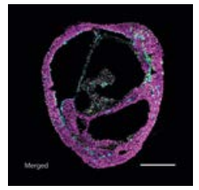
HeartBeat.bio is launched as a spin-off to develop new drugs for heart disease based on cardiac organoids.

Launch of Angios Biotech, a spin-off that uses human vascular organoids to develop new approaches for vascular therapy.

Ulrich Eling and his team develop a system for multiplexed detection of SARS-CoV-2 and establish the primary COVID surveillance system in Austria.

Bon-Kyoung Koo develops Red2Onco, a new mouse model to detect initial steps in cancer development.

## 2021




## 2022

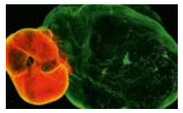
Daniel Gerlich and his lab discover how chromatin compaction mechanically stabilizes chromosomes during cell division.

Launch of dawn-bio, a spin-off using human blastoids to improve *in vitro* fertilization and infertility treatments.

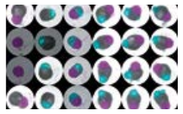
## 2023

The 100th IMBA PhD student graduates from the Vienna BioCenter PhD Program.

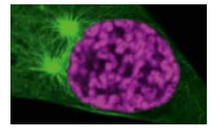
Alejandro Burga and his team identify *Mavericks* as a vector of horizontal gene transfer.



Jürgen Knoblich and his team develop a novel technique to study the effect of multiple mutations in organoids at a single-cell level.



Sasha Mendjan and his lab develop the first multi-chamber cardiac organoids that recapitulate the normal functioning of the heart.



# 20 years of *recognized excellence*

Group leaders at IMBA are innovative scientists at the frontiers of their fields. Over the past 20 years, this excellence has been recognized through many internationally renowned grants and awards, and elections to learned societies.

## ERC GRANTS

### Consolidator Grants

5

2020 Nicolas Rivron
2019 Stefan Ameres
2018 Kikuë Tachibana
2016 Julius Brennecke
2014 Fumiyo Ikeda

### Starting Grants

8

2022 Joanna Jachowicz
2019 Alejandro Burga
2013 Fumiyo Ikeda
2013 Kikuë Tachibana
2013 Stefan Ameres
2011 Daniel Gerlich
2010 Julius Brennecke
2008 Mochizuki Kazufumi

### Advanced Investigator Grants

5

2021 Daniel Gerlich
2016 Jürgen Knoblich
2013 Josef Penninger
2010 Jürgen Knoblich
2008 Josef Penninger

### Proof of Concept Grants

3

2022 Nicolas Rivron
2018 Stefan Ameres
2015 Jürgen Knoblich

## EMBO & EMBO YIP MEMBERSHIPS

### EMBO YIP Members

4

2023 Alejandro Burga
2016 Stefan Ameres
2016 Kikuë Tachibana
2007 Javier Martinez

### EMBO Members

07

2018 Kikuë Tachibana
2017 Daniel Gerlich
2015 Javier Martinez
2014 Julius Brennecke
2008 Josef Penninger
2004 Barry Dickson
2002 Jürgen Knoblich

## OTHER GRANTS, PRIZES & AWARDS

2021 Prize of the City of Vienna
Jürgen Knoblich

2019 FWF SFB
Jürgen Knoblich, Noelia Urban, Stefan Ameres

2018 HFSP Young Investigator Grant
Bon-Kyoung Koo

2018 Decoration of Honour for Services to the Republic of Austria
Josef Penninger

2017 Walther Flemming Medal
Kikuë Tachibana

2012 Innovator Award
Josef Penninger

2012 Erwin Schrödinger Prize
Jürgen Knoblich

2010 START Prize FWF
Julius Brennecke

2007 Carus Medal
Josef Penninger

## 3 WITTGENSTEIN AWARDS

2014 Josef Penninger
2009 Jürgen Knoblich
2005 Barry Dickson

## OTHER MEMBERSHIPS

2022 Academia Europaea
Daniel Gerlich

2020 Pontifical Academy of Sciences
Jürgen Knoblich

2015 European Academy of Sciences and Arts
Josef Penninger

2013 Academia Europaea
Jürgen Knoblich

2012 AAAS (Honorary Membership)
Josef Penninger

2009 Academia Europaea
Josef Penninger

2004 New York Academy of Sciences
Josef Penninger

2004 German Academy of Sciences Leopoldina
Josef Penninger

## ÖAW MEMBERSHIPS & YOUNG ACADEMY

### Corresponding Member

1

2010 Jürgen Knoblich

### Full Members

2

2013 Jürgen Knoblich
2007 Josef Penninger

### Young Academy Members

25

2022 Alejandro Burga
2015 Stefan Ameres
2014 Kikuë Tachibana
2011 Julius Brennecke
2008 Kazufumi Mochizuki

# Voices of *support*

**At IMBA's 20th anniversary celebrations, Maria Leptin and Tony Hyman spoke about IMBA's development and the transformation of life science research in Vienna.**

## Maria Leptin

President of the European Research Council, Member of IMBA's Scientific Advisory Board


*Over the last 20 years, IMBA has been at the forefront of scientific discoveries and societal contributions.*

A little over 20 years ago, we in the scientific community first heard about IMBA, the new institute to be established in Vienna. And I remember that people looked to Vienna excitedly, wondering how the institute and Vienna's scientific community would develop. The result is clear: after only 20 years, IMBA has become a world-class institute – an impressive accomplishment. But what makes a world-class institute? And how do you quantify "world-class"?

Above all, there are the discoveries, awards, grants, the training of outstanding young talent and the broader contributions to society, such as innovations, patents or contributions to our public discourse. In all these areas, IMBA's achievements are outstanding. The understanding of many aspects of cell division, chromosome structure, early human development, the role of non-coding DNA and the development of brain and heart organoids are among IMBA's groundbreaking scientific achievements.

Some of these discoveries are close to application, whereas for others, potential applications may be less obvious. With some discoveries, you might even ask yourself: who, other than the researchers themselves, should be interested? I think it's excellent that such purely curiosity-driven research is being conducted at IMBA. The rapid development of COVID vaccines has illustrated just how important apparently "useless" basic research can be.

We must not forget: conducting curiosity-driven research is valuable in its own right, as long as it is high-quality research – even if the research never yields applicable results. It allows us to understand the world around us! And the public recognizes this, too. A black hole, discovered far away in space, will not help us address the climate crisis, it won't get us through the next pandemic, nor will it ease global poverty. And yet, this discovery makes the front page of every newspaper, which to me shows that citizens understand: Basic research in itself is the fulfillment of human curiosity and a cultural value that should be supported and is worth supporting.

Over the last 20 years, IMBA has been at the forefront of scientific discoveries and societal contributions. The breadth of contributions to society is impressive, ranging from COVID tests to collections of haploid cell libraries and fly lines used by the global scientific community. All of this comes from basic research! Importantly, the researchers who established the foundations for rapid COVID tests at IMBA and the Vienna BioCenter did not work toward this for decades. No, there was a need by society, and scientists applied the knowledge gained from their research to develop something to help humanity. Researchers don't need to be told where to go. Scientists are citizens, too, and know what the most interesting problems are and where the best solutions lie. And when they are needed, scientists take their knowledge where it is required.

Basic science is important for innovation, and innovation is important for the prosperity and health of all citizens. We must preserve the freedom and independence of research – because it benefits society.





## Tony Hyman

Director of the Max Planck Institute of Molecular Cell Biology & Genetics, Dresden, Chair and Co-Chair of IMBA's Scientific Advisory Board (2007–2017)

*IMBA has developed into a world-class institute, one of the handful worldwide that define excellence in relating molecular mechanisms and disease.*

As co-chair and chair of IMBA's scientific advisory board for almost a decade, it was my privilege to watch the institute grow. In the past 20 years, IMBA has developed into a world-class institute, one of the handful worldwide that define excellence in relating molecular mechanisms and disease.

On IMBA's anniversary, I would like to first and foremost congratulate the Austrian Academy of Sciences. When I think back to IMBA's founding years, it was a brave decision to found an institute and link it to another institute, the IMP, which is privately funded by a company. This is a difficult legal structure, and it's hard to imagine anyone having the guts to set this up. But it was this brave decision of the Austrian Academy of Sciences that cemented the Vienna BioCenter's place as a world-class campus. IMBA and IMP together gave the campus the weight and size necessary to punch above its weight.

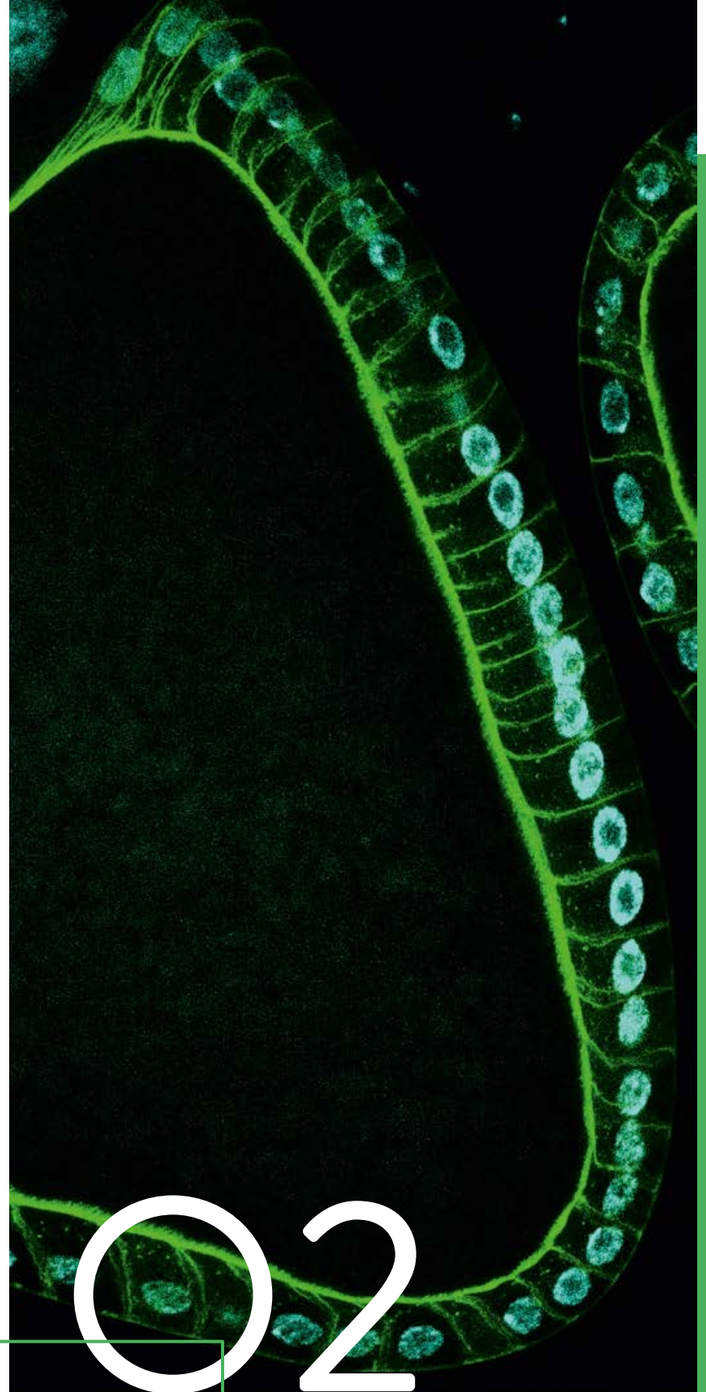
I'm part of many scientific advisory boards and people often ask me: "How do I build a world-class scientific institute?" And I say: "Go and study Vienna, you will see how it has grown from the seventies." In the early eighties, when I did my Ph.D., you'd never have dreamt of going to Vienna as a scientist – now, any scientist would think very seriously about coming to Vienna.

What does it take to be successful as a scientist? Of course, money. But most importantly, scientists seek stability. Stability depends on a healthy political structure that recognizes that for science to be successful, funding must be provided continuously for decades. Austria clearly has this stability, as continuous investments in Vienna and elsewhere in Austria ensure its top role in biomedical research worldwide.

Another key decision taken by the Academy from the beginning – and one that we supported strongly – was to implement a model of career development that was unusual in Austria at the time. Understanding that different stages of a scientist's career require different mentoring, funding and expectations is key, and was also established at the core of the European Research Council's funding model. This model of junior and senior group leaders was implemented at IMBA from the start, cementing career development in Austria as a key component of the institute's mission: training the next generation of leaders and attracting the brightest minds.

Tim Hunt, a renowned scientist, once said that a scientific director's key job is to have good taste: good taste in science and good taste in people. Both Josef Penninger and then Jürgen Knoblich have shown how true this is. There's no question that they have had good taste for over 20 years, which has been central to shaping IMBA as a world-class institute.

I want to thank the directors and all the scientists at IMBA for making my ten years on IMBA's SAB such a wonderful time. I remember these years with great fondness.



# RESEARCH *at* IMBA

02

Researchers at IMBA are at the forefront of understanding transposon biology. The *Drosophila* ovary is the battleground between these genomic parasites and the host.

INTERVIEW

# Fostering talent *and* curiosity

## Alejandro Burga, group leader at IMBA, gives an insight into how discoveries are made at IMBA.

Alejandro Burga has been a Group Leader at IMBA since 2019. His research focuses on studying how genetic conflict, stemming from selfish elements, shapes life on Earth: from molecular innovations leading to novel protein functions, to population and ecological dynamics leading to speciation. In the last years, the Burga lab has made several fundamental discoveries that reveal unexpected mechanisms of horizontal gene transfer. Alejandro Burga explains what his recipe for success has been, and how IMBA has contributed to it.

**What made you choose IMBA as a place to establish your research group?**
From the beginning of my application process, the level of professionalism was extremely high. Paperwork and interviews were organized efficiently, and I was welcome to meet other faculty members and the leaders of some of the associated facilities. That gave a very good first impression of the institute. Established support systems also make sure that a new group leader has everything they need to start their group, ensuring that the transition process is smooth and efficient.

**How would you describe the scientific culture at IMBA?**
The first objective of IMBA is to make its scientists successful. Everyone at IMBA actively tried to make us feel welcome and help us in every step of the way. For example, the Fly facility, which performed microinjections and genome engineering in *Drosophila*, offered to adapt their procedures to our model organism, nematodes, which hadn't been used at the Vienna BioCenter before. The facility – now the Fly and Worm facility – has proved to be an invaluable resource for us over the years, streamlining the generation of novel animal models that are expanding the toolkit of the whole scientific community and opening new research opportunities.

In addition, IMBA hosts scientists who work in very different fields, which encourages researchers to delve into areas that they wouldn't have contemplated otherwise, enriching their own research and leading to new avenues. This creativity is not only encouraged but supported.

**IMBA's motto is "Curiosity-driven research". How does IMBA foster creative freedom?**
Researchers at IMBA are encouraged to follow their curiosity regardless of whether some of their projects take a long time to complete, meaning that we have the time to think about the best way to tackle big questions. This philosophy has ultimately proven to be very successful judging by the scientific achievements of the last years, including securing important and highly competitive funding.

Regardless of what external funding you may secure, the institute provides consistent and substantial funding for every research group. This unusual approach ensures a high level of stability that allows scientists to focus on doing high-quality research that takes big leaps, and not get stuck on incremental steps.

**How important is collaboration for making scientific discoveries?**
The highly collaborative and diverse scientific environment at IMBA and the Vienna BioCenter is an amazing resource. Having an open mind and being exposed to many different topics increases our general scientific knowledge and leads to new ideas that wouldn't have existed otherwise. Being able to work on these ideas together with other research groups and combine our expertise is key to producing high-quality research.

My favorite thing as a Group Leader is getting three or four people together and brainstorming to find a solution to a scientific problem. This collaborative thinking between people with different scientific and technical expertise not only produces the best ideas, but also strengthens the bonds between colleagues.

**How do the scientific facilities available at the Vienna BioCenter contribute to research at IMBA?**
The Core Facilities are an invaluable resource for our scientists. They provide state-of-the-art equipment and technologies, as well as dedicated experts who help us design, perform and analyze experiments. This is an amazing learning opportunity for our scientists to expand their knowledge and technical skills, while allowing us to bring our research to the next level. Having such a concentration of experts has helped the campus reach a critical mass of innovation and collaboration that makes it a unique environment for scientific discovery.

**How would you describe your role as a Group Leader?**
I help the researchers and students in my group to direct their efforts to the right scientific questions. Sometimes, having a preconceived idea of where your research is going to take you can limit creativity. You can get too enamored with a beautiful hypothesis and lose perspective.

My role is to provide resources and advice for students to learn how to narrow down their scientific questions to solvable problems. Another important aspect is helping students keep perspective on what is important about their research, instead of obsessing over little details. Additionally, I encourage my lab members to learn as much as possible about the field they're studying, often even more than I know. This allows them to follow their curiosity and deviate from their original plans when an unexpected result or idea comes along.

Ultimately, the discoveries that arise from this kind of approach are the most rewarding and provide the biggest learning opportunities.

*The first objective of IMBA is to make its scientists successful.*

**Getting from an initial idea to a finalized project can be a challenging process. How do you support your group members during their projects?**
I strive to help my group members find the right balance between being personally involved in their projects and managing their own expectations. The lack of immediate reward inherent to the scientific process means you must believe strongly in yourself and your project to keep going. Persistence is often the key to success.

Another crucial element is fostering a healthy work-life balance. Scientists can get too invested in their projects, and it is good to have enough personal time outside of the lab to disconnect and clear one's mind. Having a strong social circle is also a necessary foundation for success. This can be a struggle especially for international researchers, and creating a close-knit community in the lab and the institute is essential.

As a Group Leader, sometimes it's necessary to take a step back and understand that science is an individual intellectual adventure that needs solid support. In my case, having a family and being a parent has helped me better understand the needs of other people and how to communicate with them. I encourage my group members to reach out to me when they are having personal issues so that I can give them the time and support they need. Also, it is important to understand that failures will happen, and that they are part of the process.

# Genome organization *and* RNA biology

## In 2023, scientists at IMBA explored the dynamics of genome organization, and the biology and function of RNA molecules.

A central pillar of research at IMBA is dedicated to genome dynamics and RNA biology. One research area is the elucidation of the genome's structural basis, to understand the changes that occur during cell division and the dynamic regulation of the genome during development. IMBA scientists are also investigating the arms race between selfish genetic elements and the genome's defense mechanisms and trying to decipher the biology and function of RNA molecules involved in a variety of cellular processes. The contributions of the different molecular players and their influence on dynamic genome organization and function are crucial to unravel the secrets of development, differentiation and disease.

In 2023, researchers at IMBA made important discoveries in the fields of genome organization and RNA biology. They revealed how endogenous retrotransposons evolved to adapt to different cell types, disentangled the complex movements of chromosomes during the cell cycle, and uncovered the mechanisms behind the remarkable ability of genes to leap across species. These discoveries not only deepen our understanding of the molecular underpinnings of life but also pave new paths for scientific exploration.

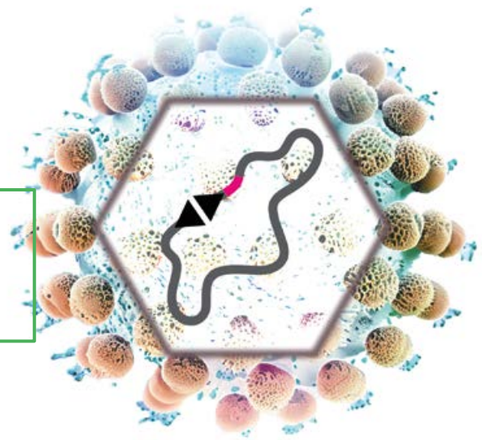
### Virus-like transposons cross the species barrier

Scientists have known for decades that genes in plants and animals can be transferred from one species to another in a process called horizontal gene transfer. However, the mechanism of how such an event occurs remained unknown. In 2023, a study by the group of Alejandro Burga uncovered one of the long-sought vectors of horizontal gene transfer in nematodes: the ancient virus-like transposons called *Mavericks*.

The Burga team demonstrated that *Mavericks* are responsible for a horizontal gene transfer event between two nematode species whose genomes are as divergent as those of humans and fish. Their research is a first step for understanding whether *Mavericks* and analogous elements can mediate horizontal gene transfer in other animal lineages including vertebrates, and how this may have shaped their evolution.

Sonya A. Widen*, Israel Campo Bes*, Alevtina Koreshova, Pinelopi Pliota, Daniel Krogull, and Alejandro Burga (2023). Virus-like transposons cross the species barrier and drive the evolution of genetic incompatibilities. Science. DOI: 10.1126/science.ade0705

*Co-first authors



*Mavericks* are virus-like particles, and were found to be vectors of horizontal gene transfer.





### Endogenous retroviruses can evolve and diversify to adapt to different cell types

Transposable elements are mobile genetic elements that make up substantial portions of plant and animal genomes and play an essential role in evolution. Transposable elements alter the genetic sequence of their host and provide coding and non-coding sequence elements that underlie biological innovation such as the emergence of new gene regulatory elements. However, the mechanisms and principles driving transposable element diversification are poorly understood.

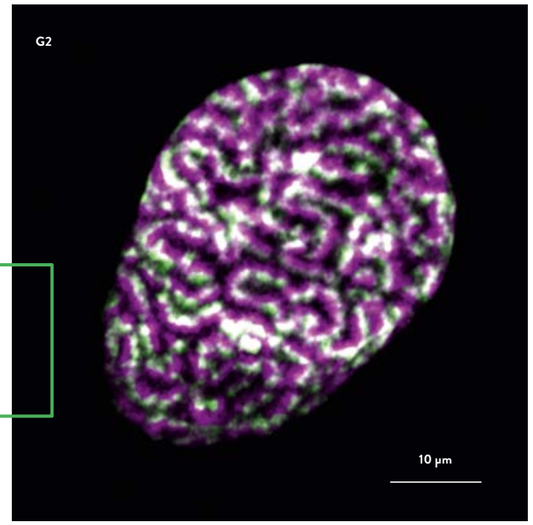
In 2023, the laboratory of Julius Brennecke showed how retrovirus-like transposable elements in the fruit fly *Drosophila melanogaster* evolved distinct expression patterns that maximize their ability to infect germline cells from various surrounding cells. They also discovered that loss of infectivity constricted some endogenous retroviruses to switch their expression to the germline to maintain access to the oocyte genome. This research provides a blueprint for how endogenous retroviruses diversified their regulatory sequences, an important step towards understanding TE-host coevolution and how it shapes biological diversity.

Kirsten-Andre Senti, Dominik Handler, Baptiste Rafanel, Carolin Kosiol, Christian Schlötterer, Julius Brennecke. (2023) Functional Adaptations of Endogenous Retroviruses to the *Drosophila* Host Underlie their Evolutionary Diversification. bioRxiv 2023.08.03.551782; DOI: 10.1101/2023.08.03.551782

### A cohesin-regulated tug-of-war inside chromosomes

Cohesin, a ring-shaped protein complex, tethers the two DNA copies contained in each replicated chromosome so that they can be properly moved during cell division. In 2023, the laboratory of Daniel Gerlich showed that a subset of cohesin complexes, known for its ability to extrude DNA loops, also facilitates the separation of duplicated DNA molecules into bottlebrush-like bodies that can be efficiently moved apart by the spindle apparatus when cells divide. These findings support the notion that DNA loop extrusion is an evolutionarily conserved mechanism promoting the segregation of replicated genomes into daughter cells.

Paul Batty, Christoph CH Langer, Zsuzsanna Takács, Wen Tang, Claudia Blaukopf, Jan-Michael Peters. Daniel W Gerlich (2023). Cohesin-mediated DNA loop extrusion resolves sister chromatids in G2 phase. The EMBO journal, e113475. DOI: 10.15252/embj.2023113475




The resolution of sister chromatids – the identical copies of a chromosome as DNA is replicated – is mediated by cohesin.

# Organoids *and* developmental biology

## New models advanced organoid research in 2023.

One of the key research areas at IMBA includes organoids, 3D tissue culture models of human organs that can be used to analyze development and study diseases. Scientists at IMBA study organoids that mimic the intricate development and functionality of vital organs such as the brain and heart, and blastoids that replicate the initial stages of embryonic development and implantation. How adult tissues form from embryos as they differentiate into tissue-specific stem cells, and how tissues respond to injury and disease is another major pillar of research at IMBA.

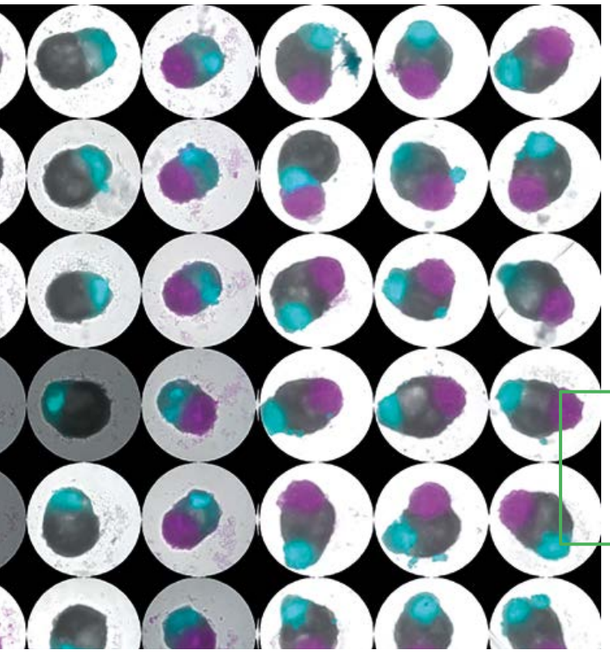
In 2023, researchers at IMBA achieved remarkable milestones. Scientists at IMBA developed the world's first multi-chamber heart organoid model, uncovered a critical role for a lipid pathway in muscle health and disease, and developed a groundbreaking brain organoid model to explore the effects of different genetic mutations at the single-cell level.

### World-first multi-chamber heart organoids developed

Heart disease kills 18 million people each year, but the development of new therapies faces a bottleneck: no physiological model of the entire human heart exists – so far. By recapitulating heart development in an unprecedented way, Sasha Mendjan and his laboratory developed the first multi-chamber heart organoid, which closely mirrors the heart's intricate structure and function.

The new organoid model has enabled the Mendjan team to advance their understanding of early heart development, revealing for the first time how the heart starts beating. They also set up a screening platform that can simultaneously analyze hundreds of heart organoids to uncover the effects of teratogens and mutations on heart development, as well as to develop new therapies.

Clara Schmidt, Alison Deyett, Tobias Ilmer, Simon Haendeler, Aranxa Torres Caballero, Maria Novatchkova, Micheael A. Netzer, Lavinia Ceci Ginistrelli, Estela Mancheno Juncosa, Tanishta Bhattacharya, Amra Mujadzic, Lokesh Pimpale, Stefan M. Jahnel, Martina Cirigliano, Daniel Reumann, Katherina Tavernini, Nora Papai, Steffen Hering, Pablo Hofbauer and Sasha Mendjan. Multi-chamber cardioids unravel human heart development and cardiac defects. Cell. DOI: doi.org/10.1016/j.cell.2023.10.030



Multi-chamber cardioids can be cultured in high-throughput and recapitulate heart development.





Giant Plasma Membrane Vesicles derived from muscle membranes.

### Muscle health depends on lipid synthesis

Muscle degeneration in inherited diseases and aging affects hundreds of millions of people worldwide. Degeneration of skeletal muscles, the body's protein reservoir, leads to general physiological decline, a condition called frailty. In 2023, a team of researchers led by Domagoj Cikes and Josef Penninger uncovered the central role of the enzyme PCYT2 in muscle health.

Based on patient data and using laboratory mouse and zebrafish models, the researchers demonstrated that PCYT2 deficiency in muscles affects mitochondrial function and the physicochemical properties of the myofiber membrane, leading to muscle degeneration in vertebrates.

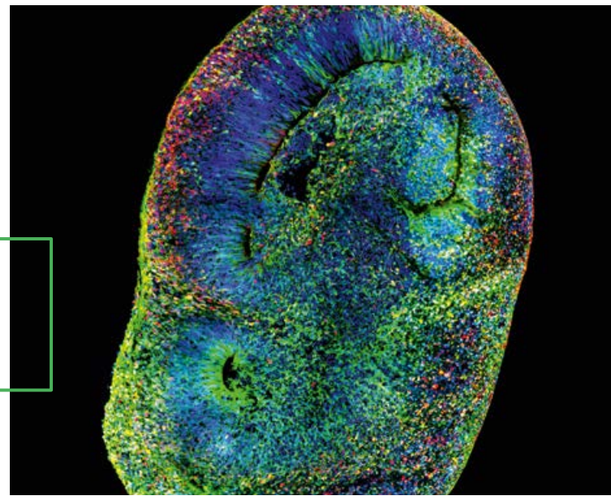
Domagoj Cikes, Kareem Elsayad, Erdinc Sezgin, Erika Koitai, Ferenc Torma, Michael Orthofer, Rebecca Yarwood, Leonhard X Heinz, Vitaly Sedlyarov, Nasser Darwish Miranda, Adrian Taylor, ..., Josef M Penninger (2023). PCYT2-regulated lipid biosynthesis is critical to muscle health and ageing. Nature metabolism, 5(3), 495–515. DOI: 10.1038/s42255-023-00766-2

### Single-cell brain organoid screening to identify developmental defects

Using a combination of brain organoid and CRISPR/Cas9 technologies, the laboratory of Jürgen Knoblich and the group of Barbara Treutlein at ETH Zurich developed CHOOSE, a breakthrough method that can simultaneously test the effect of multiple mutations at the single-cell level, providing unprecedented resolution in studying disease-associated genes.

With this organoid system, they showed that mutations in 36 different genes, known to put carriers at high risk of autism, lead to specific cell type changes in the developing human brain. The highly versatile and transferable CHOOSE system could be adapted to identify the cell types and gene regulatory networks involved in disease etiology and progression in other types of organoids.

Chong Li, Jonas Simon Fleck, Catarina Martins-Costa, Thomas R. Burkard, Jan Themann, Marlene Stuempflen, Angela Maria Peer, Abel Vertesy, Jamie B. Littleboy, Christopher Esk, Ulrich Elling, Gregor Kasprian, Nina S. Corsini, Barbara Treutlein, Jürgen Knoblich (2023). Single-cell brain organoid screening identifies developmental defects in autism. Nature 621, 373-380. DOI: 10.1038/s41586-023-06473-y



The CHOOSE system in a human brain organoid enables single-cell screening for developmental defects.

RESEARCH GROUPS

# Research *groups* at IMBA

**At IMBA in 2023, scientists worked together in – and across – 14 research groups to advance our understanding of life in all its facets.**

Curiosity, passion for knowledge, academic freedom, and pioneer spirit drive scientists at IMBA to explore the unknown. In 2023, 14 research groups brought together scientists at all career levels, from students to principal investigators, to answer outstanding questions and make novel discoveries in the life sciences.

All principle investigators at IMBA lead their own, independent research groups and programs. While promising young researchers are supported to start their groups as junior group leaders, established excellent scientists also contribute to institute leadership as senior group leaders.

## Julius Brennecke

Joined IMBA in 2009 | PhD: EMBL Heidelberg / Ruprecht-Karls University Heidelberg, DE

PREVIOUSLY
Postdoc (2006 – 2008): Gregory Hannon Lab, Cold Spring Harbor Laboratories (CSHL), New York, US
Postdoc (2005 – 2006): Stephen Cohen, European Molecular Biology Laboratory (EMBL), Heidelberg, DE

### Research

The genome of all living organisms contains the information necessary for the precise expression of all genes, a central process underlying development, homeostasis, and diseases. However, instead of being harmonious, with all features accurately arranged, eukaryotic genomes are rather chaotic. This is largely attributable to transposable elements, mobile, selfish genetic elements that spread within genomes and constitute about 50% of the human genome and up to 80% of some plant genomes. Due to their mutagenic nature, transposons pose a serious threat to genome integrity, compelling host organisms to develop effective defense systems. This has led to a classical arms race, where transposons and hosts co-evolve in a process that has resulted in numerous remarkable biological innovations. The Brennecke group focuses on the transposon-host conflict, with a particular emphasis on the fruit fly *Drosophila melanogaster* as a model system. Specifically, the group investigates the molecular mechanisms and principles of a genome defense system based on small RNAs, known as the piRNA pathway, and the strategies that transposons have developed to evade silencing.

### Current Projects

**The host side:** Understanding the molecular basis of the piRNA pathway: Similar to CRISPR-Cas phage silencing systems in prokaryotes, the piRNA pathway is a highly specific and effective system for silencing foreign nucleic acids. Combining genetics, biochemistry, molecular biology, cell biology and structural biology, the group aims to understand the concepts and molecular mechanisms underlying this fascinating silencing system. More than forty different proteins are involved in the piRNA pathway. Several projects in the group focus on selected aspects of piRNA biogenesis, piRNA-directed heterochromatin formation and transcription of heterochromatic piRNA source loci.

**The transposon side:** Understanding the evolutionary adaptation of transposable elements to their host: *Drosophila* is a rich system to study how transposons have co-evolved with their hosts. The Brennecke group is particularly interested in a group of infectious transposable elements, the errantiviruses, which are able to enter the germline from neighboring somatic cells as viral particles. By combining phylogenetic studies with fly genetics, modern imaging techniques and controlled transposon invasion experiments, the Brennecke group aims to understand how the different traits of transposons, e.g. their expression or their infectivity, co-evolve with the host gonadal ecosystem.

Brennecke Group

PUBLICATIONS & PREPRINTS – HIGHLIGHTS IN 2023

Baumgartner, L., Ipsaro, J. J., Hohmann, U., Handler, D., Schleiffer, A., Duchek, P., Brennecke, J. (2023). **Evolutionary adaptation of the chromodomain of the HP1-protein Rhino allows the integration of chromatin and DNA sequence signals** (p. 2023.09.29.560096). bioRxiv

Senti, K.-A., Handler, D., Rafanel, B., Kosiol, C., Schloetterer, C., Brennecke, J. (2023). **Functional adaptations of of endogenous retroviruses to the *Drosophila* host underlie their evolutionary diversification.** (p. 2023.08.03.551782). bioRxiv

Yelagandula, R., Stecher, K., Novatchkova, M., Michetti, L., Michlits, G., Wang, J., Hofbauer, P., Vainorius, G., Pribitzer, C., Isbel, L., Mendjan, S., Schübeler, D., Elling, U., Brennecke, J., Bell, O. (2023). **ZFP462 safeguards neural lineage specification by targeting G9A/GLP-mediated heterochromatin to silence enhancers.** Nature Cell Biology, 25(1), 42–55

TEAM IN 2023

**Senior Group Leader:** Julius Brennecke
**Research Associates:** Dominik Handler, Kirsten Senti, Laszlo Tirian
**Postdocs:** Maja Gehre, Ulrich Justin Bernhard Hohmann, Maya Shinan Voichek, Changwei Yu
**PhD Students:** Ralf Jansen, Julia Portell I De Montserrat, Liudmila Protsenko, Baptiste Rafanel
**Trainee:** Hannah Beneder

# Alejandro Burga

Joined IMBA in 2019 | PhD: EMBL-CRG Systems Biology Unit and Pompeu Fabra University, Barcelona, ES

PREVIOUSLY
Postdoc (2013–2018): Leonid Kruglyak Lab, Department of Human Genetics, University of California, Los Angeles, US
Postdoc (2012–2013): Leonid Kruglyak Lab, Lewis-Sigler Institute, Princeton University, US

## Research

Selfish genetic elements are regions of the genome that promote their own survival while being neutral or even harmful to their host. These fascinating genetic parasites can create multiple copies of themselves, bias the segregation of alleles during meiosis, or, in the most extreme scenario, kill individuals that do not inherit them. Although selfish elements are universal features of genomes, surprisingly little is known about their molecular diversity and how they contribute to phenotypic variation, evolution, and disease. The Burga lab aims to understand how genetic conflict stemming from selfish elements shapes life on Earth: from molecular innovations leading to novel protein functions, to population and ecological dynamics leading to speciation.

## Current Projects

**Toxin-antidote selfish elements:** Toxin-antidote elements are genetic dyads that subvert the laws of Mendelian segregation by killing individuals that do not carry the antidote. Such toxin-antidote elements occur in fungi, insects, nematodes, and plants. However, the molecular mechanisms behind their action – how toxins poison the embryo, and how antidotes counteract their toxicity – remain largely unknown. The Burga group dissects the molecular mechanism underlying the action of eukaryotic toxin-antidote elements. Understanding the molecular mechanisms of such a selfish element could aid in designing more efficient and specific synthetic drive elements which can be used, for instance, for mosquito population control to avoid transmission of diseases like malaria and dengue.

**Vector of horizontal gene transfer:** While studying a selfish gene in nematodes, the Burga group discovered the first vector of horizontal gene transfer (HGT) between animals. While scientists have known for decades that genes can be transferred from one species to another both in animals and plants, the mechanism of how such an unlikely event occurs remained unknown. In 2023, the Burga group uncovered the first recurrent vector of HGT in animals: ancient virus-like transposons called *Mavericks.* The researchers demonstrated that *Mavericks* are responsible for numerous HGT events between highly divergent nematode species on a global scale.

Burga Group

PUBLICATIONS & PREPRINTS – HIGHLIGHTS IN 2023

Widen, S. A., Bes, I. C., Koreshova, A., Pliota, P., Krogull, D., Burga, A. (2023). **Virus-like transposons cross the species barrier and drive the evolution of genetic incompatibilities.** Science (New York, N.Y.), 380(6652), eade0705

TEAM IN 2023

**Group Leader:** Alejandro Burga
**Postdoc:** Sonya Angeline Widen
**Senior Research Assistant:** Pinelopi Pliota
**Research Assistant:** Andreas Hagmüller
**PhD Students:** Alevtina Koreshova, Daniel Ciro Krogull, Hana Marvanova, Florian Pühringer, James Julian Ross, Polina Tikanova
**VBC Summer Student:** Fiorella Cristina Ojeda Quispe
**Master's Student:** Anja Koller



# Ulrich Elling

Group Leader at IMBA since 2015 | PhD: Mathias Treier Lab, EMBL Heidelberg, DE

PREVIOUSLY
Postdoc (2006–2014): Josef Penninger Lab, IMBA, Vienna, AT

## Research

CRISPR-based genetic screening allows scientists to probe hundreds or thousands of genes at the same time, enabling high-throughput study of gene function. The Elling group has developed novel CRISPR sgRNA library design strategies that allow the researchers to more accurately use CRISPR-based genetic screening. They have also developed CRISPR-Switch, an inducible CRISPR screening system that allows temporal genome editing control, further increasing editing precision. The group's goal is to apply these techniques to elucidate the mechanisms behind cell identity and differentiation in development and disease.

## Current Projects

**Inducible CRISPR for screening gene function *in vivo:*** Until recently, CRISPR screening technology could only be used *in vitro,* which limited our understanding of what happens in a more complex *in vivo* context. The Elling lab is working on applying their inducible CRISPR-Switch system to xenograft and allograft models in a new system called CRISPR-StAR. This new system will allow them to perform CRISPR screening of gene function *in vivo* in animal models. The Elling group is applying this technology to study melanoma, liver regeneration, and hepatocellular carcinoma.

**Understanding neuronal cell differentiation:** Differences in gene expression are the main drivers of cell differentiation and establish the various cell types in an organism. Understanding how cells determine their fate and adopt their specific cell type is crucial for cell-based regenerative medicine. In 2023, the Elling lab used CRISPR-Cas9 screens to demonstrate that mouse embryonic stem cells can convert into neurons through two independent signaling pathways regulated by closely related transcription factors.

**COVID sequencing:** The advanced sequencing capabilities of the Elling group led the team to co-develop SARSeq, a new high-throughput SARS-CoV-2 detection and sequencing platform. The group collaborated with the Austrian Agency for Health and Food Safety, having established a pipeline capable of analyzing spike protein variants in samples from over 10000 Austrian patients per month. This effort constituted the primary COVID surveillance system in Austria.

Elling Group

PUBLICATIONS & PREPRINTS – HIGHLIGHTS IN 2023

Li, C., Fleck, J. S., Martins-Costa, C., Burkard, T. R., Themann, J., Stuempflen, M., Peer, A. M., Vertesy, Á., Littleboy, J. B., Esk, C., Elling, U., Kasprian, G., Corsini, N. S., Treutlein, B., Knoblich, J. A. (2023). **Single-cell brain organoid screening identifies developmental defects in autism.** Nature, 621(7978), 373–380

Vainorius, G., Novatchkova, M., Michlits, G., Baar, J. C., Raupach, C., Lee, J., Yelagandula, R., Wernig, M., Elling, U. (2023). **Ascl1 and Ngn2 convert mouse embryonic stem cells to neurons via functionally distinct paths.** Nature Communications, 14(1), 5341

Taubenschmid-Stowers J, Orthofer M, Laemmerer A, Krauditsch C, Rózsová M, Studer C, Lötsch D, Gojo J, Gabler L, Dyczynski M, Efferth T, Hagelkruys A, Widhalm G, Peyrl A, Spiegl-Kreinecker S, Hoepfner D, Bian S, Berger W, Knoblich JA, Elling U, Horn M, Penninger JM. (2023) **A whole-genome scan for Artemisinin cytotoxicity reveals a novel therapy for human brain tumors.** EMBO Molecular Medicine, e16959

TEAM IN 2023

**Group Leader:** Ulrich Elling
**Project Manager SARSeq:** Olga Frank
**Research Assistants:** Melanie Acosta, Juliane Christina Baar, Julia Sinner, Jiaye Yang
**PhD Students:** Stephan Forisch, Joonsun Lee, Nicole Anna Rogowski, Esther Coreline Henriette Uijttewaal
**Master's Students:** Milanka Gavrilovic, Boris Paunovic
**Trainee:** Julia Sinner
**VBC Summer Student:** Kerstin Schmiederer

# Daniel Gerlich

Joined IMBA in 2012 | PhD: University of Heidelberg, DE

PREVIOUSLY
Assistant Professor (2005–2012): Swiss Federal Institute of Technology Zurich (ETHZ), CH
Postdoc (2002–2005): Jan Ellenberg Lab, EMBL Heidelberg, DE

## Research

All living organisms store their genetic information in long DNA molecules that are folded into chromosomes. Chromosome structure is highly dynamic to support various cellular processes at different times and locations, such as gene expression, DNA replication and repair, and cell division. The Gerlich group uses state-of-the-art imaging, genomics, and biochemical reconstitution assays to study the mechanisms of chromosome reorganization involved in these processes from a biophysical and biochemical standpoint.

## Current Projects

**Chromatin phase transitions in mitotic chromosome assembly:** During cell division, chromosomes form dense bodies through DNA looping and chromatin compaction processes, which are regulated by histone deacetylation and the molecular motor function of the protein complex condensin. The Gerlich group studies how these processes contribute to the faithful transmission of the genome to daughter cells. In the past year, they demonstrated that chromatin converts from a soluble state in interphase to an immiscible state during cell division, thereby facilitating the movement of chromosomes by the spindle apparatus.

**Understanding the role of cohesin on sister chromatid conformation:** Interactions between the sister chromatids in replicated chromosomes are necessary for cell division and DNA repair. The Gerlich group developed a new technology, called sister chromatid-sensitive Hi-C, which allows them to study how sister chromatids are aligned but at the same time locally separated from each other. They discovered that two known activities of the protein complex cohesin, DNA loop extrusion and cohesion, have antagonistic effects on sister chromatid organization: loop extrusion moves sister chromatids apart, while cohesion maintains them linked, providing insights into cohesin's role in DNA repair and mitotic chromosome assembly.

**Developing new technologies to map the conformation of the human genome:** Powerful genomics tools have been developed to map the three-dimensional structure of the genome and genomic sites of chromatin-associated proteins. The analysis of such multi-dimensional data, however, has remained challenging. The Gerlich group has developed a visual exploration and machine-learning tool called HiCognition that helps understanding the relationship between the structure and function of the genome.

Gerlich Group

### PUBLICATIONS & PREPRINTS – HIGHLIGHTS IN 2023


Batty, P., Langer, C. C., Takács, Z., Tang, W., Blaukopf, C., Peters, J.-M., Gerlich, D. W. (2023). **Cohesin-mediated DNA loop extrusion resolves sister chromatids in G2 phase.** The EMBO Journal, e113475

Langer, C. C. H., Mitter, M., Stocsits, R. R., Gerlich, D. W. (2023). **HiCognition: a visual exploration and hypothesis testing tool for 3D genomics.** Genome Biology, 24(1), 158

Gibson, B. A., Blaukopf, C., Lou, T., Chen, L., Doolittle, L. K., Finkelstein, I., Narlikar, G. J., Gerlich, D. W., Rosen, M. K. (2023). **In diverse conditions, intrinsic chromatin condensates have liquid-like material properties.** Proceedings of the National Academy of Sciences of the United States of America, 120(18), e2218085120


### TEAM IN 2023

**Senior Group Leader:** Daniel Gerlich
**Postdocs:** Thomas Steinacker, Zsuzsanna Takacs, Federico Teloni
**Senior Research Assistant:** Claudia Blaukopf
**Research Assistant:** Nikki Schütte
**Bioinformaticians:** Christoph Langer, Vincent Patrick Reuter
**Computational PhD Student:** Dmitry Mylarshchikov
**PhD Students:** Paul Daniel Batty, Caelan Bell, Joseph Neos Cruz, Emoke Zsanett Gerocz, Sofia Kolesnikova, Ines Prlesi, Maximilian Frederick Spicer
**VBC Summer Student:** Sanne Wijma



# Anton Goloborodko

Joined IMBA in 2019 | PhD: Massachusetts Institute of Technology, US

PREVIOUSLY
Postdoc (2018–2019): Center for 3D Structure and Physics of the Genome, NIH 4D Nucleome Consortium, Massachusetts, US

## Research

Chromosomes are complex molecules that densely pack a vast amount of information into a very limited space. Manipulation of chromosomal architecture by cell-intrinsic mechanisms is essential to expose specific DNA regions to be read, duplicated or repaired. The Goloborodko lab uses methods from theoretical and statistical physics, computer simulations and computational biology to understand how the three-dimensional structure of the genome is established and modified, and its role in cell function.

## Current Projects

**Understanding the role and interplay of SMCs in mitotic chromosome organization:** Structural Maintenance of Chromosome (SMC) proteins are responsible for two processes in the mitotic nucleus: While cohesin maintains sister chromatids together, condensin and cohesin are responsible for DNA loop extrusion. The Goloborodko group studies how SMC proteins interact and how they form and rearrange DNA loops. In collaboration with the Pavri group at IMP, they have shown that interactions between transcription and cohesin-mediated loop extrusion are involved in antibody class switch recombination in the murine immunoglobulin heavy chain.

**3D architecture of cohered sister chromatids:** The Goloborodko group seeks to further understand the mechanism of cohesion, which maintains sister chromatids close to each other. Therefore, the group – in collaboration with the lab of Daniel Gerlich – uses sister chromatid-sensitive Hi-C chromosome conformation capture to detect interactions between sister chromatids. The Goloborodko group is developing and testing computational models to explain how cohesin produces cohesion between sister chromatids in the replicated DNA.

**Open2C: a community for the development of open-source data analysis tools:** The Goloborodko group is collaborating with several other research groups to establish a community for computational scientists who can share and develop new data analysis software together, as well as collaborate to tackle complex issues in the analysis of chromatin structure data.

Goloborodko Group

### PUBLICATIONS & PREPRINTS – HIGHLIGHTS IN 2023


Costea, J., Schoeberl, U. E., Malzl, D., von der Linde, M., Fitz, J., Gupta, A., Makharova, M., Goloborodko, A., Pavri, R. (2023). **A *de novo* transcription-dependent TAD boundary underpins critical multiway interactions during antibody class switch recombination.** Molecular Cell, S1097-2765(23)00037-0

Hill, L., Wutz, G., Jaritz, M., Tagoh, H., Calderón, L., Peters, J.-M., Goloborodko, A., Busslinger, M. (2023). **Igh and Igk loci use different folding principles for V gene recombination due to distinct chromosomal architectures of pro-B and pre-B cells.** Nature Communications, 14(1), 2316

Corsi, F., Rusch, E., Goloborodko, A. (2023). **Loop extrusion rules: the next generation.** Current Opinion in Genetics Development, 81, 102061


### TEAM IN 2023

**Group Leader:** Anton Goloborodko
**Postdoc:** Flavia Corsi
**Research Assistant:** Christoforos Eseroglou
**PhD Students:** Sonja Berger, Vladimir Dmitriev, Ankit Gupta, Emma Rusch
**Trainee:** Shabnam Sahay

# Sofia Grade

Joined IMBA in 2020 | PhD: University of Coimbra, PT, and Laval University, Québec, CA

PREVIOUSLY
Postdoc (2012–2019): Magdalena Götz Lab, Ludwig Maximilians University (LMU) and Helmholtz Center Munich, DE

## Research

Acute and progressive insults to the brain like stroke and neurodegenerative diseases are the leading cause of disability worldwide and second leading cause of death. When brain damage occurs, the architecture and function of adult brain circuits undergo modifications. New connections can in turn compensate for a loss of function in affected brain areas. However, the mechanisms involved in this response and adaptation are not fully understood. The Grade group aims to elucidate how circuits rewire in the brain and whether stem cell transplantation could be a therapeutic alternative to promote recovery after brain injury.

## Current Projects

**Understanding the relevance of adult neurogenesis in the aftermath of a brain injury:** Our brains have an immense capacity to adapt. Indeed, after a brain trauma, neural stem cells residing in the brain produce an excessive amount of neurons. The Grade group uses mouse models and cutting-edge imaging technology – such as optical clearing and whole-brain imaging – to study whether the generation of new neurons is involved in functional remodeling, and to identify the specific cellular mechanisms driving this process.

**Studying brain rewiring after traumatic brain injury:** Acute injuries to the brain produce local effects that include neuronal cell death, as well as sprouting of new branches from surviving neurons. The latter response has been associated with partial re-emergence of neural function. The Grade group is using circuit-tracking technology and molecular analyses to study connectivity in the diseased brain sites and how rewiring is brought about.

**Neuronal connectivity changes in neurodegenerative diseases:** Neurodegenerative diseases cause progressive neuronal damage, which reduces connectivity between different brain regions. The Grade group is studying how diseases like multiple sclerosis and Huntington's disease affect brain connectivity and the mechanisms involved, especially in the early stages of disease.

**Circuit restoration via stem cell transplantation:** Stem cell therapy shows great promise for tissue regeneration after brain damage. The Grade group, in collaboration with the Knoblich lab, studies the regenerative potential of transplanting organoid-derived neuronal progenitors in the damaged cerebral cortex.

Grade Group

TEAM IN 2023

**Group Leader:** Sofia Grade
**Postdoc:** Maria Nazareth, Gonzalez Alvarado
**Senior Research Assistant:** Sabrina Villar Pazos
**Research Assistants:** Meret Hopf, Anna Dorit Smolka
**PhD Students:** Oisorjo Chakraborty, Petra Schaffer
**Master's Student:** Giourgkert Partalis
**Trainee:** Magdalena Krubner
**VBC Summer Student:** Seohyun Kim
**Visiting PhD student:** Daniel Pinto Benito



# Joanna Jachowicz

Joined IMBA in 2022 | PhD: Institute of Genetics, Molecular and Cellular Biology (IGBMC), Strasbourg, FR

PREVIOUSLY
Postdoc (2017–2022): Mitch Guttman Lab, California Institute of Technology, Pasadena, US
Postdoc (2016–2017): Maria Elena Torres-Padilla Lab, Helmholtz Zentrum Munich, DE

## Research

All cells in a multicellular organism contain the same genetic material, yet they perform different functions and form different tissues and organs. In mammals, the first wave of cell type specification occurs after fertilization when early embryonic cells begin to express cell-type specific genes forming embryonic body or placenta. The Jachowicz group studies how gene expression patterns emerge during these early developmental transitions and what role the "dark" genome elements, encoded by repeats and transposons, play in regulating cell type specification. The group uses genome-wide sequencing methods, as well as microscopy, CRISPR technologies and various biochemical approaches and applies them to embryonic stem cells and mouse embryos to shed light on early gene expression regulation.

## Current Projects

**Understanding how repeat and transposons-derived RNAs regulate early lineage specification:** More than 90% of the mammalian genome is composed of "dark" repetitive and transposable elements that are relicts of ancient viral integration or genome duplications. In most cells of adult organisms these regions do not produce any transcripts. Various silencing mechanisms regulate their low expression, safeguarding genome stability. However, recent observations have shown that during early development a high amount of RNA is produced from the "dark" genome that might be involved in regulating gene expression patterns emerging post fertilization. The Jachowicz group aims to understand which specific elements have regulatory potential and what molecular mechanisms they utilize to regulate early lineage specifications. The group uses long-read single-cell sequencing approaches to identify which specific "dark" genome elements are expressed and perturbs their functions by CRISPRi to understand how their absence affects both gene expression and genome structure.

**Mapping 3D DNA and RNA organization during early developmental transitions:** When sperm and oocyte merge post fertilization massive 3D genome reorganization takes place allowing for the formation of the new embryonic genome. Simultaneously, the newly formed embryonic genome begins the expression of embryo- and then lineage specific genes. Yet, how these rearrangements of 3D genome and the timely regulation of transcriptome are coordinated and interplay remains elusive. To simultaneously map changes of the 3D nuclear space in all cells of a developing embryo, the Jachowicz group develops single-cell multi-omics SPRITE-based methods that allow them to measure 3D RNA localization and DNA organization. These methods will allow the Jachowicz group to build the first 3D map of simultaneous RNA and DNA reorganization post fertilization and begin to understand how their interplay regulates gene expression during early developmental transitions.

Jachowicz Group

TEAM IN 2023

**Group Leader:** Joanna Jachowicz
**Senior Research Assistant:** Agnieszka Gacek-Matthews
**PhD Students:** Jeanne Francoise Couturier, Antonio Docavo Garcia, Ziga Vicic
**Master's Student:** Julia Kernler
**Trainee:** Frantisek Petrlak
**VBC Summer Student:** Maria Julia Mattos Gomes

# Jürgen Knoblich

Joined IMBA in 2004 | PhD: Friedrich Miescher Laboratory of the Max Planck Society, DE

PREVIOUSLY
Scientific Director (2018-2023): Institute of Molecular Biotechnology, Vienna, AT
Full Professor for Synthetic Biology (2021-current): Medical University of Vienna, AT
Adjunct Professor (2016-2019): Medical University of Vienna, AT
Deputy Director (2005-2018): Institute of Molecular Biotechnology, Vienna, AT
Senior Scientist (2004-2018): Institute of Molecular Biotechnology, Vienna, AT
Group Leader (1997-2004): Research Institute of Molecular Pathology, Vienna, AT
Postdoc (1994-1997): University of California, San Francisco, US

## Research

The human brain develops in an extremely intricate process, during which synaptic connections form between neurons in different brain regions. Irregularities in brain development can lead to significant challenges and life-long conditions such as autism or epilepsy. In addition, neurodegenerative diseases slowly and progressively damage existing brain connections, leading to severe effects on the brain. The Knoblich group has developed cerebral organoids derived from human stem cells as a model to study human brain development. The researchers use cerebral organoids to investigate how developmental and neurodegenerative diseases affect the human brain.

## Current Projects

**Understanding autism one cell at a time:** The developmental defects that cause autism are poorly understood. The Knoblich group has established the CHOOSE platform, which uses CRISPR-Cas9-based genetic disruption and single-cell transcriptomics in human brain organoids to study how mutations in autism-associated "high-risk" genes affect cell fate determination in different neuron types. Their research has identified genetic networks involved in the development of autism. The CHOOSE platform can also be employed to study other neurodevelopmental diseases.

**Fusing organoids to model complex brain connections:** In some neurodegenerative diseases, the loss of neurons from one brain area can have detrimental effects on other, connected brain areas. However, studying this connection between brain areas *in vitro* was impossible, until now. This year, the Knoblich group developed a method for fusing brain organoids of different brain areas and showed that neurons within the fused organoids formed long-range connections, replicating normal human brain development. This system was used to study the effects of Parkinson's Disease and cocaine addiction on brain connectivity and will be used in the future to study other neurological diseases.

Knoblich Group

### PUBLICATIONS & PREPRINTS – HIGHLIGHTS IN 2023

Martins-Costa, C., Pham, VA., Sidhaye, J (...) Corsini, NS., Knoblich, JA. (2023). **Morphogenesis and development of human telencephalic organoids in the absence and presence of exogenous extracellular matrix.** EMBO J. :e113213 doi: 10.15252/embj.2022113213

Reumann, D., Krauditsch, C., Novatchkova, M (...) Parmar, M., Knoblich, JA. (2023). ***In vitro* modeling of the human dopaminergic system using spatially arranged ventral midbrain-striatum-cortex assembloids.** Nat Methods. 20(12):2034-2047 doi: 10.1038/s41592-023-02080-x

### TEAM IN 2023

**Senior Group Leader:** Jürgen Knoblich
**Research Associates:** Nina Stefanie Corsini, Peter-Christopher Esk
**Postdocs:** Shamsi Emtenani, Olena Kim, Laura Kracht, Lisa Landskron, Chong Li, Jaydeep Sidhaye, Philipp Trepte, Abel Vertesy, Michael Alexander Zabolocki
**Senior Research Assistants:** Catarina Da Cunha E Silva Martins Costa, Elke Kleiner, Angela Maria Peer
**PhD Students:** Balint Doleschall, Christian Lehmann, Jamie Blaze Littleboy, Sakurako Nagumo Wong, Sandra Schepers, Ana Stravs, Jan Themann
**Medical Researcher:** Oliver Ludwig Eichmüller
**Master's Student:** Andrea Wiegers
**Research Assistants:** Viktoria Leitner, Anna Pianezzola
**Trainees:** Mia Katharina Neumüller, Denise van der Heijden



# Bon-Kyoung Koo

Joined IMBA in 2017 | PhD: Division of Molecular and Life Science, Pohang University of Science and Technology (POSTECH), KR

PREVIOUSLY
Group Leader (2013–2017): Cambridge Stem Cell Institute, University of Cambridge, US
Postdoc (2009–2013): Hans Clevers Lab, Hubrecht Institute, KNAW, NL
Postdoc (2006–2009): Young-Yun Kong Lab, Pohang University of Science and Technology (POSTECH) and Seoul National University, KR

## Research

Tissue homeostasis is an essential process, during which new cells are produced and recruited to regenerate damaged tissues. Genetic mutations can disrupt this maintenance process, potentially leading to the formation of cancerous tumors. The Koo lab studies how tissue-specific stem cells maintain homeostatic tissue regeneration, and how tumor-associated mutations cause tumorigenesis.

## Current Projects

**Understanding the identity and characteristics of adult stem cells in the stomach:** In the stomach, two distinct stem cell populations are involved in maintaining tissue homeostasis. The Koo group identified and defined one of those populations, Troy+ cells. The group uses 3D organoid cultures and mouse models to study how homeostasis or injury conditions affect gene expression in Troy+ cells. For this, the researchers combine lineage tracing, tissue clarification and imaging with single-cell gene expression analysis.

**Analyzing the role of E3 ubiquitin ligases in the maintenance of adult stem cells:** Tissue homeostasis is regulated by the interplay between a multitude of signaling pathways. Ubiquitination is a cellular process in which ubiquitin ligases mark some proteins for degradation, ensuring tight control of the signaling pathways in which these proteins are involved. The Koo group uses gastric organoids to test the effect of the E3 ubiquitin ligase on stem cell function and maintenance. They also investigate which proteins are marked for degradation by E3 ubiquitin ligase and how this affects their signaling pathways.

Koo Group

### PUBLICATIONS & PREPRINTS – HIGHLIGHTS IN 2023

Chatzeli, L., Bordeu, I., Han, S., Bisetto, S., Waheed, Z., Koo, B.-K., Alcolea, M. P., Simons, B. D. (2023). **A cellular hierarchy of Notch and Kras signaling controls cell fate specification in the developing mouse salivary gland.** Developmental Cell, 58(2), 94-109.e6

Colozza, G., Lee, H., Merenda, A., Wu, S.-H. S., Català-Bordes, A., Radaszkiewicz, T. W., Jordens, I., Lee, J.-H., Bamford, A.-D., Farnhammer, F., Low, T. Y., Maurice, M. M., Bryja, V., Kim, J., Koo, B.-K. (2023). **Intestinal Paneth cell differentiation relies on asymmetric regulation of Wnt signaling by Daam1/2.** (p. 2023.01.24.525366). bioRxiv

Meyenberg, M., Hakobyan, A., Papac-Milicevic, N., Göderle, L., Langner, F. L., Markovic, M., Lee, J.-H., Koo, B.-K., Busslinger, G. A., da Silva, I. T., Binder, C. J., Menche, J., Loizou, J. I. (2023). **Mutational landscape of intestinal crypt cells after long-term *in vivo* exposure to high fat diet.** Scientific Reports, 13(1), 13964

### TEAM IN 2023

**Group Leader:** Bon-Kyoung Koo
**Research Assistant:** Seoyoung Choi
**PhD Students:** Isaree Teriyapirom, Szu-Hsien Wu

# Sasha Mendjan

Joined IMBA in 2015 | PhD: EMBL and University of Heidelberg, DE

PREVIOUSLY
Senior Postdoc (2013–2015): Ludovic Vallier Lab, SCI, University of Cambridge, UK
Postdoc (2007–2013): Roger Pedersen Lab, LRM, University of Cambridge, UK

## Research

Heart disease kills 18 million people each year, but the development of new therapies faces a bottleneck: no physiological model of the entire human heart exists – so far. In 2023, the Mendjan lab presented the first multi-chamber heart organoids, which mirror the heart's intricate structure, including the right and the left ventricles and the atrium. Using cardioids, the Mendjan group aims to recapitulate heart development *in vitro* to gain insights into the early stages of human heart development, as well as to discover the molecular mechanisms underlying heart disease and congenital malformations.

## Current Projects

**Development of the first multi-chamber heart organoids:** The newly developed multi-chamber heart organoids enable the Mendjan group to study chamber-specific defects and mutations, as well as to advance screening platforms for drug development and toxicology studies. Multi-chamber cardioids also show accurate signal and contraction propagation between the different chambers, enabling the researchers to further explore cardiac disease and development.

**Pacing and septation in cardioids:** Defects in septation are the most prevalent congenital heart malformations and are often accompanied by arrhythmia and faulty communication between heart chambers. The new cardioid model most closely resembles an embryonic multi-chamber heart at the end of the first month of pregnancy – a stage at which septation and the pacemaker system have not yet developed. As a next step, the Mendjan group is integrating pacemakers and septation into the multi-chamber heart model to dissect heart morphogenesis and signal propagation to understand how septation defects and arrhythmia occur.

**Understanding cardiac regeneration:** One of the biggest challenges in regenerative medicine is replacing the billions of cardiomyocytes lost upon myocardial infarction. While fetal hearts have the potential to regenerate, adult cardiomyocytes only proliferate at a low rate and cannot regenerate damaged heart regions, and instead form a scar. Using cardioids as a model, the Mendjan group dissects the mechanisms driving either scar formation or cardiomyocyte proliferation to ultimately understand heart regeneration.

Mendjan Group

PUBLICATIONS & PREPRINTS – HIGHLIGHTS IN 2023

Schmidt, C., Deyett, A., Ilmer, T., Haendeler, S., Torres Cabal-lero, A., Novatchkova, M., Netzer, M. A., Ceci Ginistrelli, L., Mancheno Juncosa, E., Bhattacharya, T., Mujadzic, A., Pimpale, L., Jahnel, S. M., Cirigliano, M., Reumann, D., Tavernini, K., Papai, N., Hering, S., Hofbauer, P., Mendjan, S. (2023). **Multi-chamber cardioids unravel human heart development and cardiac defects.** Cell, 186(25), 5587-5605.e27

TEAM IN 2023

**Group Leader:** Sasha Mendjan
**Senior Research Assistant:** Stefan Jahnel
**Research Assistants:** Tobias Ilmer, Katarzyna Warczok
**PhD Students:** Lavinia Ceci Ginistrelli, Alison Ann Deyett, Anna Dimitriadi, Marie-Christin Leitner, Estela Mancheno Juncosa, Clara Schmidt
**Master's Students:** Tanishta Bhattacharya, Julia Kodnar, Amra Mujadzic
**Trainees:** Anna Dimitriadi, Marion Salmon-Legagneur, Markus Schmidt





# Josef Penninger

Founded IMBA in 2002 | MD: Institute for General and Experimental Pathology, Medical School, University of Innsbruck, AT

PREVIOUSLY (selected)
Scientific Director (since 2023): Helmholtz Center for Infection Research, Brunswick, DE
Professor (since 2023): Medical University Vienna, AT
Director (2018–2023): Life Science Institute UBC, Vancouver, CA
Full Professor (2018–current): Department of Medical Genetics, University of British Columbia, CA
Group Leader (since 2018): Institute of Molecular Biotechnology, Vienna, AT
Scientific Director (2002–2018): Institute of Molecular Biotechnology, Vienna, AT
Full Professor of Immunology (since 2002): University of Toronto, CA

## Research

The Penninger group seeks to understand the architecture and underlying mechanisms of human disease, aiming to identify novel therapeutic strategies. The group develops and deploys a broad range of *in vitro* and *in vivo* tools that reveal the fundamental mechanisms involved in human disease. These approaches include genetic editing, human induced pluripotent cell models of disease, haploid cells for genetic and compound screening paradigms, mouse and human organoid cultures, as well as genetically engineered mice. These multidisciplinary techniques allow the Penninger group to model and study the complexity of human diseases, with a particular focus on understanding disease and biology in bone, brain, heart and the immune system, as well as cancer.

## Current Projects

**Next generation tissue engineering:** The Penninger group explores the potential of human stem cell-derived blood vessel organoids to model disease and to develop the next generation of human tissue engineering. The group has developed novel microfluidic devices that add flow into blood vessel organoids and vascularized organoids *in vitro*. The group has also developed a system to model atherosclerosis, driven capillary organoids to form lymphatic organoids, and is exploring the possibility to generate bone marrow organoids to study hematopoiesis.

**Lipid synthesis and muscle health:** Muscle degeneration in heritable diseases and aging affects millions of individuals worldwide. The Penninger lab recently uncovered the central role of an enzyme called PCYT2 in muscle health. PCYT2 is the bottleneck enzyme in a major synthesis pathway of ethanolamine-derived phospholipids, the phosphatidylethanolamines (PEs). Based on patient data and using mouse and zebrafish models, the group showed that mutations in or reduced activity of PCYT2 are conserved hallmarks of muscle degeneration across vertebrates. Specifically, the researchers demonstrated that PCYT2 deficiency in muscles affects mitochondrial function and the physicochemical properties of the myofiber membrane.

Penninger Group

PUBLICATIONS & PREPRINTS – HIGHLIGHTS IN 2023

Cikes, D., Elsayad, K., Sezgin, E., Koitai, E., Ferenc, T., Orthofer, M., Yarwood, R., Heinz, L. X., Sedlyarov, V., Miranda, N. D., Taylor, A., Grapentine, S., Al-Murshedi, F., Abot, A., Weidinger, A., Kutchukian, C., Sanchez, C., Cronin, S. J. F., Novatchkova, M., ... Penninger, J. M. (2023). **PCYT2-regulated lipid biosynthesis is critical to muscle health and ageing.** Nature Metabolism, 5(3), 495–515

TEAM IN 2023

**Group Leader:** Josef Penninger
**Staff Scientist:** Shane Cronin
**Senior Research Associate:** Astrid Hagelkrüys
**Postdocs:** Tiago Manuel Fontes Oliveira, Simon Licht-Mayer, Stefan Mereiter, Masahiro Onji
**Research Assistant:** Rubina Koglgruber
**PhD Students:** Gustav Jonsson, Max Josef Kellner, Kirill Salewskij
**Master's Students:** Juliana Dias De Souza, Maura Hofmann, Amirmohammad Khodabandeh, Vanessa-Leonora Tkalec, Patrick Zelger
**Trainees:** Victor Edem Kornu, Emanuel Isaias Tenorio Araujo

# Nicolas Rivron

Joined IMBA in 2019 | PhD: MIRA Institute for Biomedical Technology and Technical Medicine, Twente University, NL

PREVIOUSLY
Group Leader (2013–2019): MERLN Institute for Regenerative Medicine, Maastricht University, NL
Guest Group Leader (2013–2019): The Hubrecht Institute for Developmental Biology and Stem Cell Research, NL
Researcher (2011–2013): MIRA Institute for Biomedical Technology and Technical Medicine, Twente University, NL

## Research

Stem cell-based embryo models have emerged as powerful scientific and ethical alternatives to the use of embryos in research. The laboratory of Nicolas Rivron developed a complete embryo model that reflects the blastocyst in the mouse and in the human, and called it blastoid. Blastoids make it possible to explore human peculiarities, in particular the evolutionary origin of our low fertility compared to other mammals. The laboratory is currently exploring human eccentricities to uncover the evolutionary constraints and vulnerabilities, knowledge of which is crucial to the development of novel therapeutic approaches to address global health challenges such as family planning, fertility decline and prenatal preventive medicine. Nicolas Rivron is also helping to outline a roadmap for the gradual, justifiable use of embryo models and for the dissemination of a sensible, accurate picture of contemporary human embryology to maintain public support and ensure societal benefit.

## Current Projects

**Principles of self-organization in development:** Mammalian development is driven by loops of molecular inductions between embryonic and extraembryonic tissues that propagate over time. The Rivron group is uncovering these loops in both mouse and human blastocysts and investigating the resulting self-organizing phenomena regulating tissue size and progression of the extraembryonic tissues mediating the implantation *in utero*.

**The evolutionary origin of human subfertility:** The low fertility of humans is an evolutionary step correlating with deeper invasion into the uterus. Using a comparative approach between primates, the Rivron group is investigating the genetic mechanisms underlying the human specificities of the deeply invasive cells mediating uterus implantation.

**Improving reproductive health:** Worldwide, fertility decline is exacerbating economic and social inequalities. Using a bioengineering approach, the group is using patient-derived uterine stem cells to form a uterine organoid on-a-chip that, in combination with human blastoids, will model the mechanisms of implantation of human blastocysts and their evolved and potentially selected suboptimality. In the long term, this will enable the discovery of therapeutics for reproductive health.

Rivron Group

PUBLICATIONS & PREPRINTS – HIGHLIGHTS IN 2023

Rivron, N. C., Martinez Arias, A., Pera, M. F., Moris, N., M'hamdi, H. I. (2023). **An ethical framework for human embryology with embryo models.** Cell, 186(17), 3548–3557

Heidari Khoei, H., Javali, A., Kagawa, H., Sommer, T. M., Sestini, G., David, L., Slovakova, J., Novatchkova, M., Scholte Op Reimer, Y., Rivron, N. (2023). **Generating human blastoids modeling blastocyst-stage embryos and implantation.** Nature Protocols 18, 1584-1620

Rivron, N. C., Martinez-Arias, A., Sermon, K., Mummery, C., Schöler, H. R., Wells, J., Nichols, J., Hadjantonakis, A.-K., Lancaster, M. A., Moris, N., Fu, J., Sturmey, R. G., Niakan, K., Rossant, J., Kato, K. (2023). **Changing the public perception of human embryology.** Nature Cell Biology, 25(12), 1717–1719

TEAM IN 2023

**Group Leader:** Nicolas Rivron
**Postdocs:** Martina De Santis, Heidar Heidari Khoei, Alok Javali, Harunobu Kagawa, Saurabh Jagdish Pradhan, Jinwoo Seong
**Senior Research Assistant:** Jana Slovakova
**Research Assistant:** Yvonne Suzanne Scholte Op Reimer
**PhD Students:** Viktoria Holzmann, Marlene Müller, Giovanni Sestini, Theresa Maria Sommer
**Master's Students:** Samaneh Alinaghian Elyaderani



# Shambaditya Saha

Joined IMBA in 2019 | PhD: Yale University, US

PREVIOUSLY
Postdoc (2013–2018): Anthony A. Hyman Lab, Max Planck Institute of Molecular Cell Biology and Genetics, DE

## Research

Cells organize their contents in defined compartments. While most of these compartments are surrounded by lipid membranes that isolate them from the rest of the cell, some compartments (also called 'biomolecular condensates') are not enclosed within lipid membranes. One such membraneless compartment is called nuage. Found only in germline cells, nuage hosts RNA processing machinery essential for gametogenesis and reproduction. The Saha group investigates how the biophysical properties and composition of nuage contribute to germ cell fate and fertility using the roundworm *C. elegans* as a model system.

## Current Projects

**Role of protein composition in nuage function:** The Saha group aims to address the importance of condensate formation in nuage function. Specifically, they address the hypothesis that nuage composition is optimized for its function.

**Role of LOTUS domain proteins in nuage:** The Saha group is studying how proteins containing LOTUS domains contribute to the assembly and function of nuage.

**Mechanisms that regulate diffusion rate of macromolecules in nuage:** Rates of biochemical processes hosted within nuage depend on diffusion rate of constituents. The Saha group strives to identify the mechanisms that regulate diffusion rate of macromolecules in the nuage compartment, and how these mechanisms could support robust functionality in germ cells.

Saha Group

TEAM IN 2023

**Group Leader:** Shambaditya Saha
**Research Assistant:** Philipp Czermak
**PhD Students:** Stela Jelenic, Aswini Kumar Panda, Balashankar Radhakrishna Pillai
**Master's Student:** Lisa-Maria Frasz

# Noelia Urbán

Joined IMBA in 2017 | PhD: University of Barcelona, ES

PREVIOUSLY
Investigator Scientist (2014–2017): Francois Guillemot Lab, The Francis Crick Institute, London, UK
Postdoc (2009–2014): Francois Guillemot Lab, National Institute for Medical Research, London, UK

## Research

Stem cells are essential for tissue homeostasis and repair in adult tissues. In the brain, adult neural stem cells (aNSCs) in specific niches generate new adult-born neurons essential for functions such as olfaction, memory, and mood regulation. Interestingly, aNSCs have a limited capacity to self-renew. Therefore, their numbers progressively decline over time, which is, in turn, associated with aging-related neurodegeneration. The Urbán group studies how the balance between aNSC activation and quiescence is regulated by internal and external factors to prevent aNSC exhaustion during aging.

## Current Projects

**Identifying signals that control NSC quiescence:** Adult neurogenesis can be regulated by many local signals and systemic stimuli. However, the molecular mechanisms involved in this regulation are mostly unknown. Understanding how NSC quiescence is regulated by the interplay between different stimuli, and which signaling pathways are involved, is the first step toward understanding and modulating adult neurogenesis.

**Effects of systemic stimuli on adult neurogenesis:** The Urbán group is investigating how diet and fasting as systemic stimuli affect neurogenesis. In 2023, they demonstrated that intermittent fasting does not affect the activation of aNSCs, and also doesn't affect neurogenesis in the hippocampus. The group also studies how diet-driven changes in insulin and IGF levels can alter the behavior of aNSCs, and which signaling pathways drive this regulation.

**Generating a model of human NSC quiescence:** So far, most research performed in aNSCs has used rodents as a model. However, human aNSCs seem to stop dividing at very early stages compared to rodent aNSCs, which hints that their quiescent states may be different. The Urbán group is developing the first *in vitro* model to study human aNSCs, which will help understand the dynamics of human aNSC exhaustion of neural progenitors.

Urbán Group

PUBLICATIONS & PREPRINTS – HIGHLIGHTS IN 2023

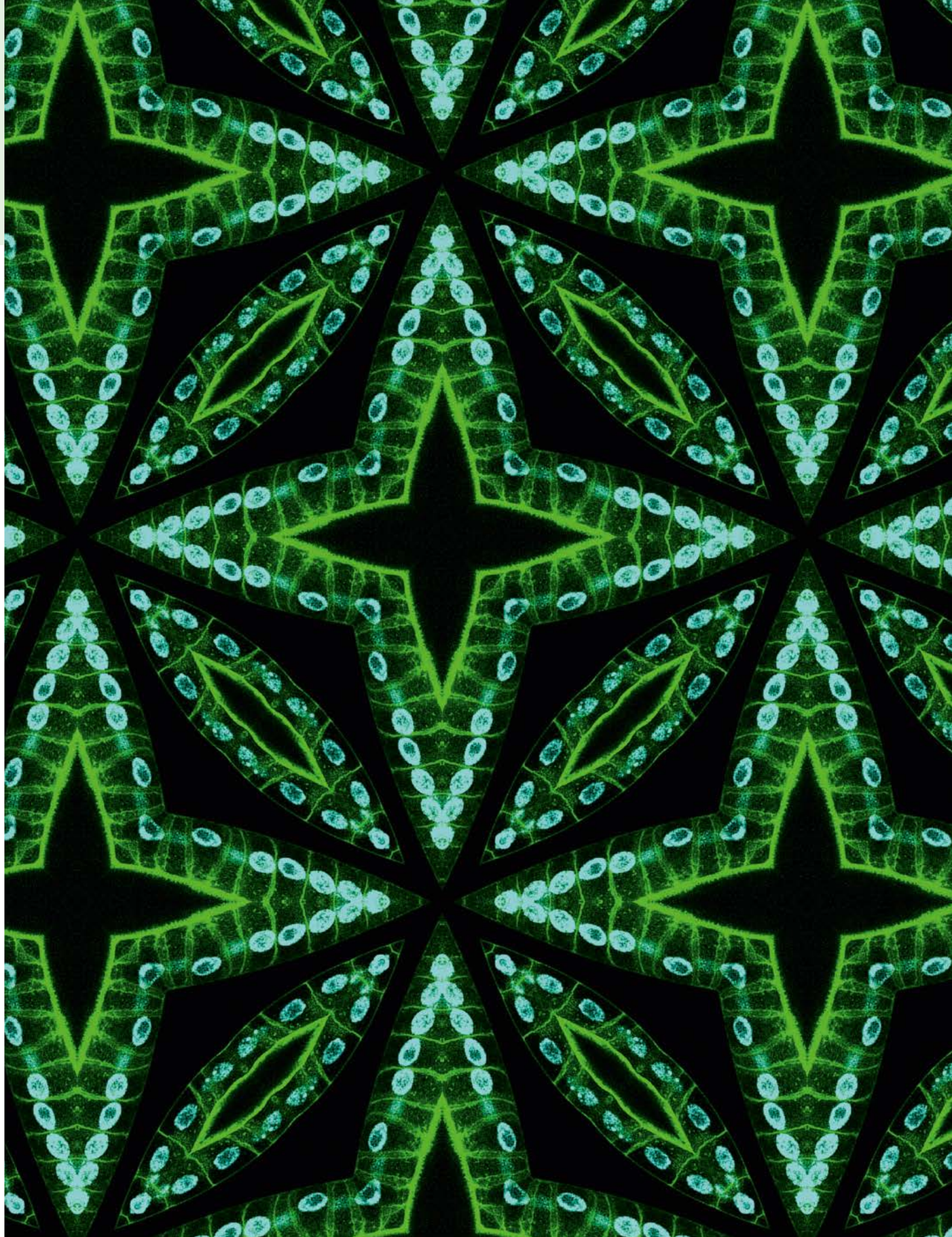
Gabarró-Solanas R, Davaatseren A, Kleifeld J, Kepčija T, Köcher T, Giralt A, Crespo-Enríquez I, Urbán N. (2023). **Adult neural stem cells and neurogenesis are resilient to intermittent fasting.** EMBO Reports, 24(12):e57268

Gabarró-Solanas, R., Urbán, N. (2023). **It takes two to untangle: Combined stimulation of adult neurogenesis reverts AD symptoms.** Cell Stem Cell, 30(4), 333–334

TEAM IN 2023

**Group Leader:** Noelia Urbán
**Postdoc:** Gabriele Colozza, Ivan Crespo Enriquez
**Senior Research Assistant:** Lilian Kirwan
**Research Assistants:** Amarbayasgalan Davaatseren, Tatjana Kepcija
**PhD Students:** Rut Gabarro Solanas, Justus Kleifeld, Lidija Milojkovic, Greeshma Pushpa Bose, Katherina Tavernini
**Master's Student:** Lucia Ruiz-Salinas Rivas





INTERVIEW

# Challenging, yet *rewarding*

## Catarina Martins Costa, a recent PhD graduate, shares an inside view on doing a PhD at IMBA.

Catarina Martins Costa completed her PhD at IMBA in 2023. In the lab of Jürgen Knoblich, she developed human brain organoids to study corpus callosum agenesis. In this rare and understudied disease, the millions of long-range axonal projections that would normally connect the two brain hemispheres are not formed, leading to severe defects as the two hemispheres no longer communicate with each other. During her PhD, Catarina Martins Costa used patient-derived brain organoids to gain insights into the molecular mechanisms involved in corpus callosum agenesis, including the affected gene regulatory network and the resulting defects in neuronal development, maturation, and function. In 2023, Catarina's PhD thesis was recognized with the City of Vienna's Impact Award and the Vienna BioCenter PhD Award.

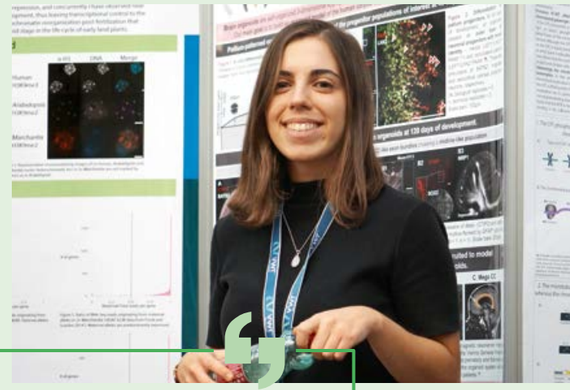
Catarina Martins Costa told us about her PhD experience at IMBA and how it helped shape her career.

**Why did you decide to do a PhD at IMBA?**
Before I got my master's degree in 2017, I had been working on fundamental stem cell and developmental biology, and I wanted to keep studying these topics with a more translational approach. I applied for several PhD programs but felt that IMBA and the Knoblich lab were the best fit. Not only because they are leading experts in organoid technologies, but also because I anticipated a high degree of scientific independence and collaborative opportunities, which are two very important aspects for me.

**What unique opportunities did IMBA provide for your development as a PhD student?**
IMBA and the Vienna BioCenter provide a lot of learning opportunities for PhD students like the "Prime your PhD" seminar series, which lays a great foundation for understanding the ongoing research on campus. In addition, during my first year, I had the opportunity to go to Bologna, Italy, to attend a Summer School about neural stem cells, brain organoids and brain repair. The following year, I was also able to attend the Hydra Summer School on Stem Cell Biology, in Greece. These early experiences, which are not commonplace during a PhD, were very positive for developing my knowledge and skills outside of the lab.

**What was your PhD experience like?**
My PhD experience at IMBA has been the most challenging yet rewarding professional experience of my career. The dynamic scientific environment allowed me to do creative science, explore several projects in parallel, and collaborate on campus and internationally. While that involved a lot of work, it helped me grow as a scientist, which in my view is the ultimate goal of any PhD. Overall, it was a very good experience.

**What was the most challenging part of your PhD?**
My project addressed a rare disease about which very little was known, and my project was hence very ambitious from the beginning. IMBA researchers are not only at the technological forefront, but they also lead the way in asking and answering complex biological questions. Figuring out how to approach this project involved a lot of trial and error until we found the correct angle, but it made the whole process even more rewarding.



*The dynamic scientific environment allowed me to do creative science, explore several projects in parallel, and collaborate on campus and internationally.*

**What was your biggest "Eureka" moment during your PhD?**
Near the end of my project, I was doing a crucial experiment that would inform whether my findings were meaningful. This experiment was the final piece missing for me to finish my PhD, so it was a big deal. Between the experimental part and the data analysis, the whole experiment took close to a year to complete. To maintain the highest scientific rigor, the entire process had been blinded so that I didn't know which samples were from affected patients and which were not. After the data analysis was done, I hit the button that would unmask the samples and allow me to see the results for the first time. When, finally, the plot appeared on the screen, I could at once see that my experiment had uncovered a central piece of the puzzle, allowing us to understand the disease mechanism better. It was an amazing feeling!

**How did your PhD journey at IMBA help you develop as a scientist?**
At IMBA, I was able to access and learn state-of-the-art techniques like stem cell and organoid culture that are essential for the type of research I'm interested in. But, most importantly, I learned how to do good science, by asking the right questions and keeping the upmost scientific rigor. I learned how to meticulously plan experiments and analyze my results in an unbiased and thorough way. These transversal skills will be applicable to any future scientific endeavors.

**What was the best part of doing your PhD at IMBA?**
During my scientific journey at IMBA, I was able to do any experiment that I wanted. This unlimited support for creativity and curiosity is not common elsewhere. In addition, collaborating with the Vienna BioCenter Core Facilities meant having access to incredible technological resources, as well as expert personnel that were able to teach me how to use these resources. This significantly improved the quality of the science I was able to perform and allowed me to focus on the questions I wanted to answer.

**How did the environment at IMBA and the Vienna BioCenter contribute to your success?**
The collaborative environment in the lab, where everyone pitched in with ideas or advice, was essential for my success. In addition, being part of a scientific hub like the Vienna BioCenter opens a lot of collaboration opportunities, both on campus and outside. For my project, I collaborated with the Vienna General Hospital and with bioengineering experts in Japan, which added a lot of value to my research.

**What are your plans after IMBA?**
I would like to continue using the knowledge I acquired during my PhD regarding human biology, mostly in the perspective of finding new disease mechanisms, improving diagnosis, or developing novel therapies. Hopefully, the hard and soft skills I have learned here will help me bridge the gap between fundamental biology and clinical research and make a meaningful contribution to patients.

INTERVIEW

# A journey, *not* a destination

## Two IMBA alumni explain how working at IMBA shaped their scientific careers.

Postdoctoral research is a critical period for a scientist's academic career. Producing quality science and developing an independent research project are essential steps towards establishing an independent research team or transitioning to a position in industry. IMBA is home to many postdoctoral researchers, who take advantage of the resources and facilities to develop new research avenues and lead some of the institute's most important discoveries. When postdocs move on to the next steps in their career, what they have learned during their journey at IMBA shapes the scientists they will become.

Peter Ebert Andersen and Matthias Samwer are among the long list of IMBA alumni – in the past ten years, more than 110 postdocs pursued research at IMBA. They both participated in this year's IMBA anniversary symposium, where they spoke about the impact IMBA had in their scientific careers.

Andersen was a member of the Brennecke group from 2013 to 2019, where he uncovered how animal germline cells, which carry DNA from generation to generation, manage to stay immortal. His research revealed a surprising and unorthodox gene regulation mechanism underlying small RNA-based genome defense in *Drosophila*. Andersen is now a tenure-track group leader at Aarhus University, in Denmark.

Samwer was a member of Daniel Gerlich's group from 2013–2017, where he studied how the set of chromosomes that forms separate bodies in dividing cells is packaged into a single cell nucleus after the completion of cell division. Samwer is currently a Scientific Director in the Cancer Cell Signaling Department at Boehringer Ingelheim in Vienna, where he works on target identification and validation in the early oncology pipeline.

We sat down with Matthias Samwer and Peter Ebert Andersen to talk about their experience at IMBA and how the institute contributed to their successful scientific careers.

Peter Ebert Andersen, a postdoc at IMBA from 2013 to 2019, is now a tenure-track group leader at Aarhus University, Denmark.

### How did you experience being a postdoc at IMBA?

**Peter Ebert Andersen:** Being a postdoc at IMBA gives you a fantastic scientific environment which surrounds you with lots of really smart people and provides access to amazing resources like the Vienna BioCenter Core Facilities. This creates a research opportunity extravaganza to a degree that is found in few places around the world.

**Matthias Samwer:** Given the large degree of research freedom I enjoyed, it felt like the only limits to making discoveries were time and my own abilities. During my stay at IMBA I also connected with a lot of great scientists at IMBA and IMP, a few of which became colleagues in my new position at Boehringer Ingelheim. This highlights the kind of powerful network that you can build at IMBA.

### What was your favorite aspect of working at IMBA?

**Peter Ebert Andersen:** My favorite aspects were the scientific freedom as well as feeling that scientific spark when attending lab meetings or the wonderful RNA club seminars. It was great to see that people were excited about and motivated to engage in each other's research.



Matthias Samwer, a member of the Gerlich group from 2013 to 2017, is now a Scientific Director in the Cancer Cell Signaling Department at Boehringer Ingelheim in Vienna.


**Matthias Samwer:** The team spirit in the Gerlich lab, which was strongly fostered by Claudia, our lab manager. We would have a coffee round every morning at 10 a.m., which built a great sense of community.

### What is your best memory from your time at IMBA?

**Peter Ebert Andersen:** A few fellow Vienna BioCenter postdocs and I started a cross-team peer group where we worked to improve our manuscripts and ideas in a critical but informal and very constructive manner. We gave input and feedback on each other's projects and paper drafts, and it was exciting and very fun to interact with such brilliant, generous and funny people and help each other make our science better.

**Matthias Samwer:** My best memory is from when I was writing my manuscript and teamed up with other postdocs that were at a similar stage in their projects. We discussed our data and several storylines back and forth until we found something that worked for each of us. It was a very rewarding experience.

### Which learnings from your research environment at IMBA do you apply in your current position?

**Matthias Samwer:** I learned a lot about stringent scientific thinking from the discussions with other scientists. Also, I learned how to present a project in a crisp and comprehensive way so that other scientists can relate to it and get engaged in a discussion. Both skills help me in my current position, where I also regularly present projects from various areas of cancer biology to audiences with very divergent levels of background knowledge.

**Peter Ebert Andersen:** I learned a lot of things that I apply in my own research group, including the importance of developing presentation skills and the inspiring realization that everyone, regardless of their position, can be a role model you can learn something from.

### How did your experience at IMBA shape your ongoing scientific career?

**Peter Ebert Andersen:** It takes a delicate balance to build a research environment that is both ambitious, with spark and nerve, and at the same time kind and inclusive. The diversity of research leaders at IMBA and the Vienna BioCenter and their approaches to find this balance was an important eye-opener to me. I realized how different the approaches to building a research group are, and that I needed to find my own path.

**Matthias Samwer:** IMBA taught me that a group of talented researchers can get a project further than any individual alone ever could. And while a postdoctoral researcher is still highly responsible for driving their own project, at IMBA there are numerous people that can and will help you to get further. In drug discovery, where I'm working now, this is even more important. Assembly and leadership of a highly functional team is one of the key skills to make any project progress.

### How was your "life at IMBA"? What social events, clubs or extra-curricular activities did you participate in while on campus?

**Matthias Samwer:** The Friday afternoon social hours were a great experience. This kind of weekly event is really something special about IMBA and the Vienna BioCenter, where you can just informally connect with great minds, pitch them some of your science and just get into a great conversation. Many times, I would walk away with great new ideas.

**Peter Ebert Andersen:** For a good while during my postdoc, I was lucky to be part of a fantastic group of people from campus playing badminton every week. One Friday social hour also led to the formation of a band called "Navlefnuller" – Danish for belly button fluff – with which I rehearsed every week for two years, had immense amounts of fun, and never played a single concert. Altogether, doing a postdoc was about the journey, not the destination.

# A foundation for *excellent* research

## The scientific facilities available to IMBA researchers are the backbone for excellent science.

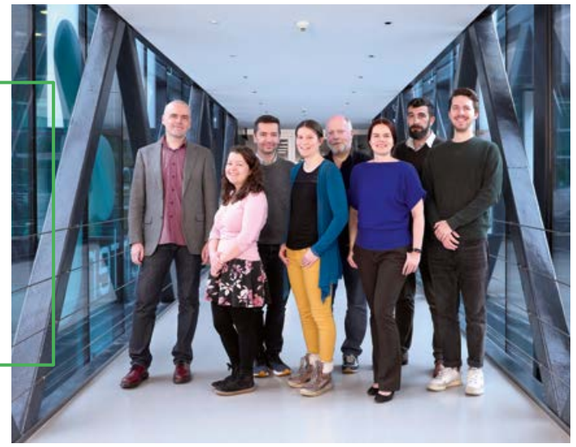
The impact scientific facilities have on research at IMBA was exemplified by the development of heart organoids, described in a study published in Cell in 2023. A collaborative effort between Sasha Mendjan's team at IMBA, researchers at the Vienna BioCenter, and the campus' scientific facilities resulted in the development of a multi-chambered heart organoid that mirrors the heart's intricate structure and function. This finding addresses a critical gap in cardiac research, as until now, no physiological model of the human heart was available.

Scientific facilities were the essential technological and infrastructural backbone for the study's advanced experiments and played an important role throughout the entire research journey. "Watching the initially separate organoids coalesce into a working heart model was truly impressive," Tobias Ilmer, research assistant and co-author of the paper, recalls. Alison Deyett, PhD student and co-first author, added, "The development of different electrical signaling pathways and connections was remarkable." To reach this milestone, a diverse array of technologies and areas of expertise were brought together. "This achievement was only possible due to the immense collaborative effort and the exceptional resources provided by research facilities; the expertise and support were outstanding," Sasha Mendjan, corresponding author of the study, affirmed.

The Molecular Biology Services unit, particularly Robert Heinen, optimized high-throughput sample preparation methods for RNA extraction to prepare samples for sequencing, which was crucial for achieving the required sample size. The sequencing data were generated at the Next Generation Sequencing facility, where Thomas Grentzinger implemented a new single-cell RNA sequencing technique for this publication. Those sequencing data are included in most of the publication's figures.

The Histology facility, notably Tamara Engelmaier and Agnieszka Piszczek, optimized RNAscope, a molecular technique that allowed the researchers to precisely visualize and study specific RNA molecules within cells and tissues at the single-cell level. The BioOptics facility, particularly with the contributions of Pawel Pasierbek, Alberto Moreno Cencerrado, and Tobias Müller, provided essential training in advanced microscopy techniques and offered invaluable feedback in selecting the most suitable microscope for the researcher's questions. Finally, Maria Novatchkova, a co-author from the Bioinformatics Facility, contributed significantly by conducting single-cell analysis and developing necessary bioinformatic pipelines.

The development of the first multi-chamber cardioids reflects the essence of collaborative research at IMBA, as the convergence of knowledge, resources, and dedication led to a deeper understanding of cardiac biology and its potential applications in healthcare.



Sasha Mendjan's team at IMBA, researchers at the Vienna BioCenter, and the campus' scientific facilities developed a multi-chambered heart organoid, mirroring the heart's intricate structure and function.

Pictured from left to right: Sasha Mendjan, Alison Deyett, Pawel Pasierbek, Tamara Engelmaier, Robert Heinen, Agnieszka Piszczek, Thomas Grentzinger, and Tobias Ilmer.





# *Core* Facilities

## Scientists at IMBA make use of core facilities, shared with the IMP and the GMI.

Researchers at IMBA benefit from scientific core facilities on campus, jointly utilized with the IMP and the GMI, and from the resources provided by the Vienna BioCenter Core Facilities (VBCF). Together, these scientific facilities form the backbone of a dynamic research ecosystem, offering access to advanced equipment and expert knowledge. Expert teams support experimental design, instrument operation, and data analysis, ultimately elevating research standards and promoting collaboration and innovation within the scientific community.

**Bioinformatics** offers a wide range of support to molecular biology research groups, including data analysis, software, training, and assistance with experimental design for high-throughput biological datasets.

**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.

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.

The **Transgenic Service Department** assists in-house investigators by offering services for the creation and preservation of genetically engineered laboratory animal strains.

**IMBA also benefits from access to dedicated facilities that cater exclusively to the needs of IMBA researchers.**

**⊳ Fly and Worm Facility** provides micro-injections to generate transgenic animals and offers a CRISPR genome engineering service for precise knock-out and knock-in projects in *Drosophila* as well as several nematode species, including *C. elegans*.

**The Stem Cell Core Facility** offers key services like human iPS reprogramming, genome targeting in mouse and human stem cells, quality control of cell lines and biobanking, which is enabled by established collaborations with research institutions. In addition, the facility offers hands-on training to individual and/or groups of scientists who want to advance their skills and knowledge in the field of stem cell research.

**Organoid Research Facility** is a specialized IMBA center focused on advancing organoid-based research.

# Vienna BioCenter *Core* Facilities

## The Vienna BioCenter Core Facilities provides access to cutting-edge scientific infrastructure in biomedical research to all researchers at the Vienna BioCenter.

**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.

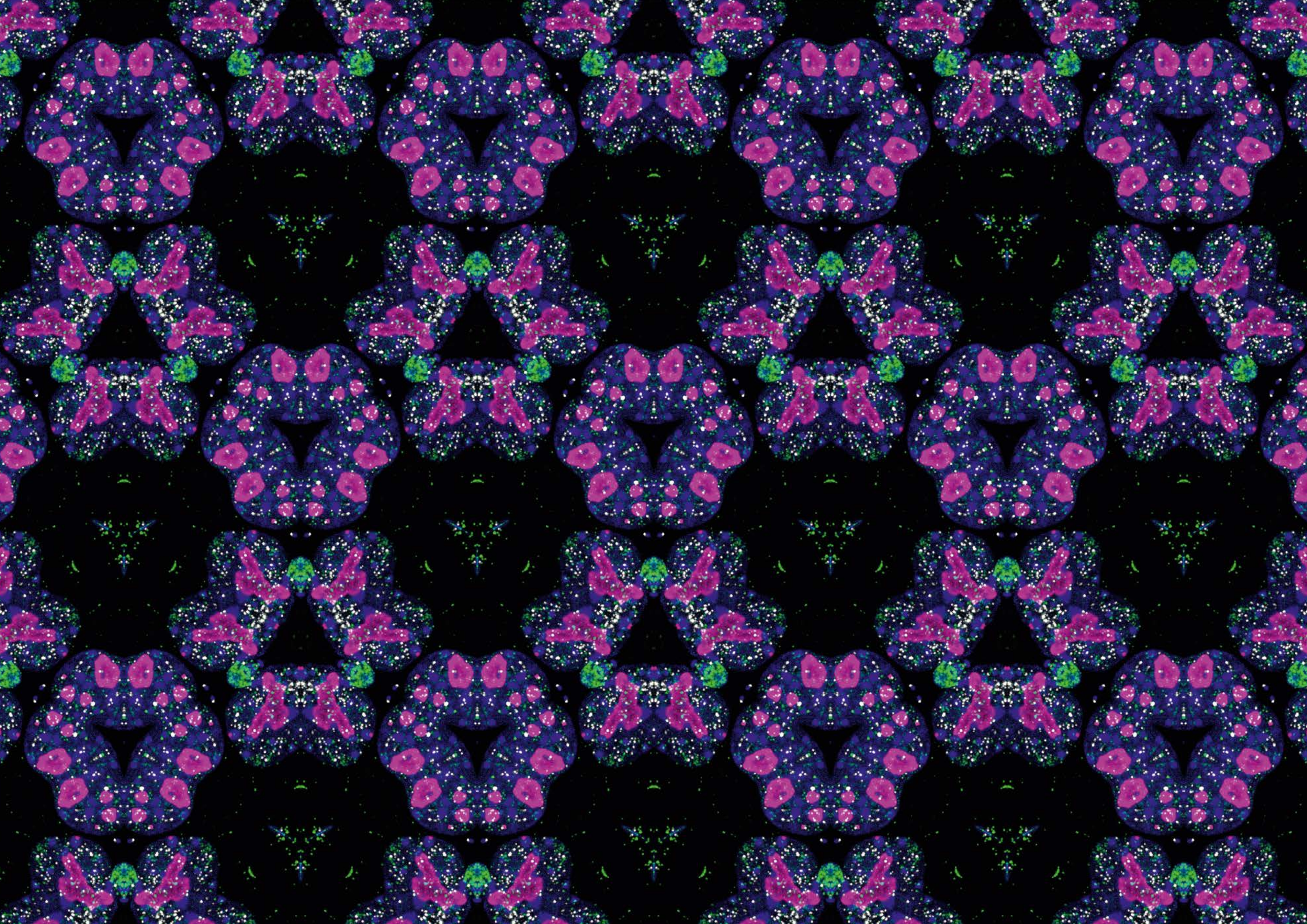
**Plant Sciences** (PlantS) operates a state-of-the-art, high-throughput, multi-sensor plant phenotyping research infrastructure (PHENOPlant) and 23 highly specialized phytotrons. We offer expertise and service in high-throughput plant phenotyping, dynamic environmental simulations, soft- and hardware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

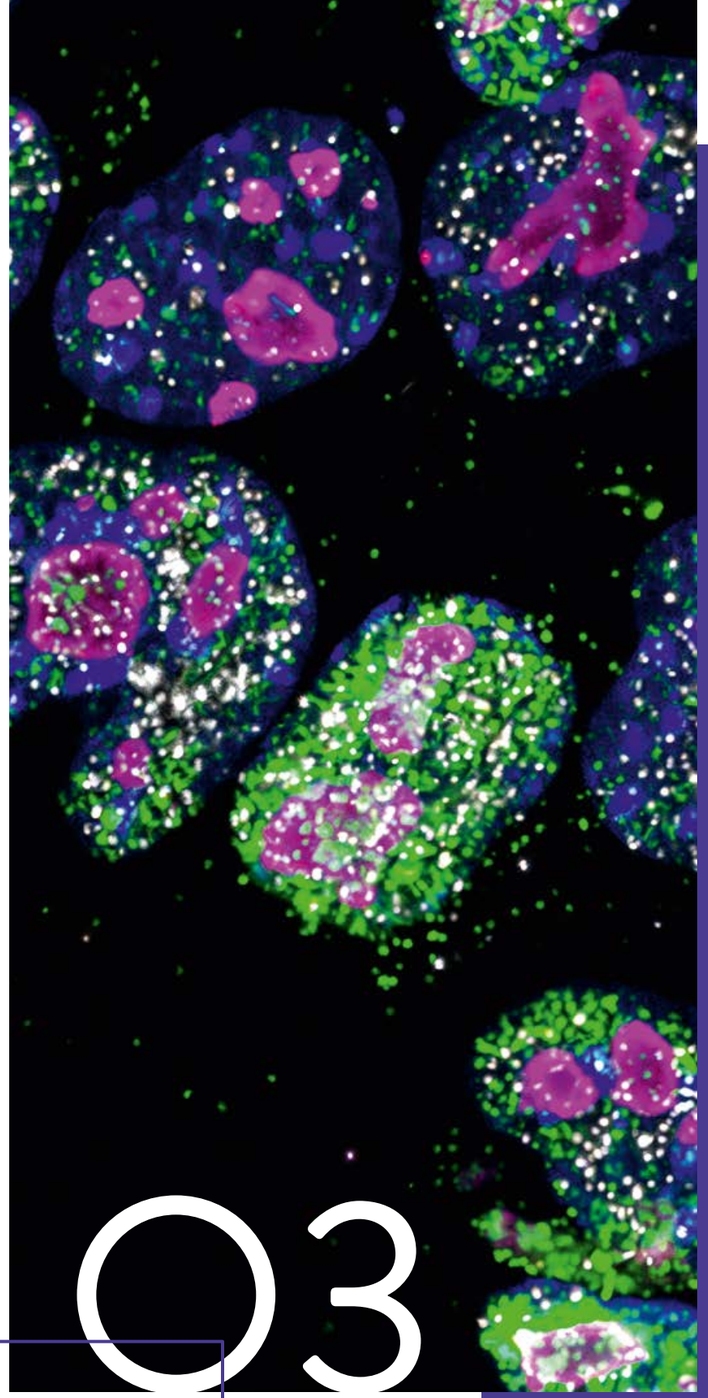
**Preclinical Phenotyping** (pcPHENO) specializes in advanced mouse *in vivo* studies covering behavior tests, metabolic and cardiovascular measurements, as well as surgical services.

**∇ 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.

Heads of scientific facilities available to IMBA research groups.





03

DNA and RNA from the “dark” genome – expressed here in stem cells – can affect genome organization and may act as driving force during early development.

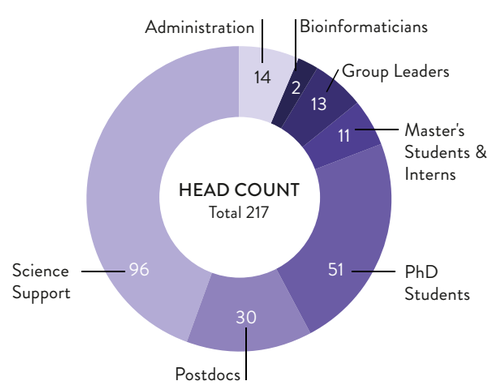
# 2023 *in* REVIEW

KEY FACTS

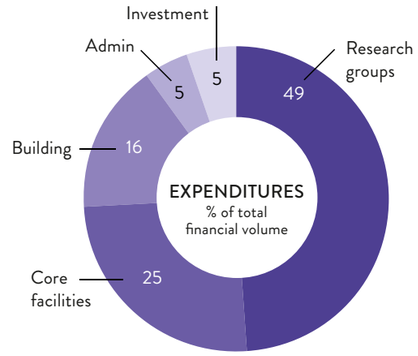
# Key numbers in 2023

Across 2023, IMBA's international team brought together expertise across various fields and successfully acquired funding from national, European and international sources.

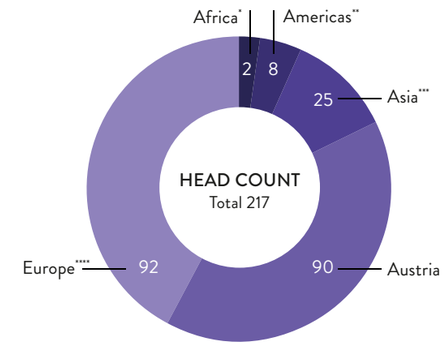
## Staff by function




## Expenditures




## Staff by nationality



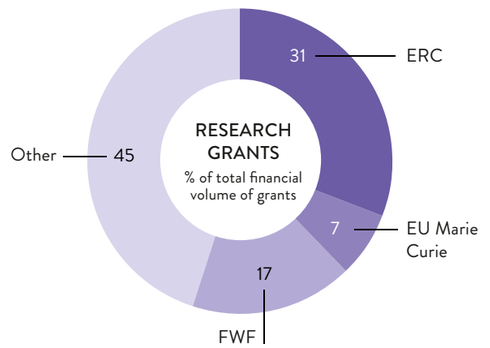

**Africa*** Ghana, Tunisia

**Americas**** Canada, Chile, Costa Rica, Ecuador, United States

**Asia***** Australia, China, Israel, India, Iran, Japan, South Korea, Mongolia, Philippines, Singapore, Thailand, Turkey

**Europe****** Bosnia and Herzegovina, Bulgaria, Switzerland, Czech Republic, Germany, Spain, France, Greece, Croatia, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Serbia, Russia, Slovenia, Slovakia, Ukraine

## Research grants




Data as of December 31, 2023.

PUBLICATIONS

# IMBA Publications in *2023*

## JULIUS BRENNECKE

Baumgartner, L., Ipsaro, J. J., Hohmann, U., Handler, D., Schleiffer, A., Duchek, P., Brennecke, J. (2023). **Evolutionary adaptation of the chromodomain of the HP1-protein Rhino allows the integration of chromatin and DNA sequence signals** (p. 2023.09.29.560096). bioRxiv

Obergfell, E., Hohmann, U., Moretti, A., Hothorn, M. (2023). **Mechanistic insights into the function of 14-3-3 proteins as negative regulators of brassinosteroid signaling in *Arabidopsis*** (p. 2023.10.13.562204). bioRxiv

Pinheiro, A. S., Tsarouhas, V., Senti, K. A., Arefin, B., Samakovlis, C. (2023). **Scavenger receptor endocytosis controls apical membrane morphogenesis in the *Drosophila* airways.** eLife, 12, e84974

Senti, K.-A., Handler, D., Rafanel, B., Kosiol, C., Schloetterer, C., Brennecke, J. (2023). **Functional Adaptations of Endogenous Retroviruses to the *Drosophila* Host Underlie their Evolutionary Diversification** (p. 2023.08.03.551782). bioRxiv

Yelagandula, R., Stecher, K., Novatchkova, M., Michetti, L., Michlits, G., Wang, J., Hofbauer, P., Vainorius, G., Pribitzer, C., Isbel, L., Mendjan, S., Schübeler, D., Elling, U., Brennecke, J., Bell, O. (2023). **ZFP462 safeguards neural lineage specification by targeting G9A/GLP-mediated heterochromatin to silence enhancers.** Nature Cell Biology, 25(1), 42–55

## ALEJANDRO BURGA

Widen, S. A., Bes, I. C., Koreshova, A., Pliota, P., Krogull, D., Burga, A. (2023). **Virus-like transposons cross the species barrier and drive the evolution of genetic incompatibilities.** Science (New York, N.Y.), 380(6652), eade0705

## ULRICH ELLING

Bsteh, D., Moussa, H. F., Michlits, G., Yelagandula, R., Wang, J., Elling, U., Bell, O. (2023). **Loss of cohesin regulator PDS5A reveals repressive role of Polycomb loops.** Nature Communications, 14(1), 8160

Li, C., Fleck, J. S., Martins-Costa, C., Burkard, T. R., Themann, J., Stuempflen, M., Peer, A. M., Vertesy, Á., Littleboy, J. B., Esk, C., Elling, U., Kasprian, G., Corsini, N. S., Treutlein, B., Knoblich, J. A. (2023). **Single-cell brain organoid screening identifies developmental defects in autism.** Nature, 621(7978), 373–380

Malik, B., Vokic, I., Mohr, T., Poppelaars, M., Holcmann, M., Novoszel, P., Timelthaler, G., Lendl, T., Krauss, D., Elling, U., Mildner, M., Penninger, J. M., Petzelbauer, P., Sibilia, M., Csiszar, A. (2023). **FAM3C/ILEI protein is elevated in psoriatic lesions and triggers psoriasiform hyperproliferation in mice.** EMBO Molecular Medicine, e16758

Monteil, V., Kwon, H., John, L., Salata, C., Jonsson, G., Vorrink, S. U., Appelberg, S., Youhanna, S., Dyczynski, M., Leopoldi, A., Leeb, N., Volz, J., Hagelkruys, A., Kellner, M. J., Devignot, S., Michlits, G., Foong-Sobis, M., Weber, F., Lauschke, V. M., Horn, M., Feldmann, H., Elling. U., Penninger, J., Mirazimi, A. (2023). **Identification of CCZ1 as an essential lysosomal trafficking regulator in Marburg and Ebola virus infections.** Nature Communications, 14(1), 6785

Taubenschmid-Stowers J, Orthofer M, Laemmerer A, Krauditsch C, Rózsová M, Studer C, Lötsch D, Gojo J, Gabler L, Dyczynski M, Efferth T, Hagelkruys A, Widhalm G, Peyrl A, Spiegl-Kreinecker S, Hoepfner D, Bian S, Berger W, Knoblich JA, Elling U, Horn M, Penninger JM. (2023) **A whole-genome scan for Artemisinin cytotoxicity reveals a novel therapy for human brain tumors.** EMBO Molecular Medicine, e16959.

Vainorius, G., Novatchkova, M., Michlits, G., Baar, J. C., Raupach, C., Lee, J., Yelagandula, R., Wernig, M., Elling, U. (2023). **Ascl1 and Ngn2 convert mouse embryonic stem cells to neurons via functionally distinct paths.** Nature Communications, 14(1), 5341

Yelagandula, R., Stecher, K., Novatchkova, M., Michetti, L., Michlits, G., Wang, J., Hofbauer, P., Vainorius, G., Pribitzer, C., Isbel, L., Mendjan, S., Schübeler, D., Elling, U., Brennecke, J., Bell, O. (2023). **ZFP462 safeguards neural lineage specification by targeting G9A/GLP-mediated heterochromatin to silence enhancers.** Nature Cell Biology, 25(1), 42–55

## DANIEL GERLICH

Batty, P., Langer, C. C., Takács, Z., Tang, W., Blaukopf, C., Peters, J.-M., Gerlich, D. W. (2023). **Cohesin-mediated DNA loop extrusion resolves sister chromatids in G2 phase.** The EMBO Journal, e113475.

Gibson, B. A., Blaukopf, C., Lou, T., Chen, L., Doolittle, L. K., Finkelstein, I., Narlikar, G. J., Gerlich, D. W., Rosen, M. K. (2023). **In diverse conditions, intrinsic chromatin condensates have liquid-like material properties.** Proceedings of the National Academy of Sciences of the United States of America, 120(18), e2218085120

Langer, C. C. H., Mitter, M., Stocsits, R. R., Gerlich, D. W. (2023). **HiCognition: a visual exploration and hypothesis testing tool for 3D genomics.** Genome Biology, 24(1), 158

Nagasaka, K., Davidson, I. F., Stocsits, R. R., Tang, W., Wutz, G., Batty, P., Panarotto, M., Litos, G., Schleiffer, A., Gerlich, D. W., Peters, J.-M. (2023). **Cohesin mediates DNA loop extrusion and sister chromatid cohesion by distinct mechanisms.** Molecular Cell, S1097-2765(23)00567-1.

Roudot, P., Legant, W. R., Zou, Q., Dean, K. M., Isogai, T., Welf, E. S., David, A. F., Gerlich, D. W., Fiolka, R., Betzig, E., Danuser, G. (2023). **u-track3D: Measuring, navigating, and validating dense particle trajectories in three dimensions.** Cell Reports Methods, 100655.

Sanz-Flores, M., Ruiz-Torres, M., Aguirre-Portolés, C., Bakkali, A. E., Salvador-Barberó, B., Villarroya-Beltri, C., Ortega, S., Megías, D., Gerlich, D. W., Álvarez-Fernández, M., Malumbres, M. (2023). **PP2A-B55α,δ phosphatase counteracts Ki67-dependent chromosome individualization during mitosis** (p. 2023.11.30.569375). bioRxiv

Spicer, M. F. D., Gerlich, D. W. (2023). **The material properties of mitotic chromosomes.** Current Opinion in Structural Biology, 81, 102617.

## ANTON GOLOBORODKO

Corsi, F., Rusch, E., Goloborodko, A. (2023). **Loop extrusion rules: the next generation.** Current Opinion in Genetics Development, 81, 102061.

Costea, J., Schoeberl, U. E., Malzl, D., von der Linde, M., Fitz, J., Gupta, A., Makharova, M., Goloborodko, A., Pavri, R. (2023). **A *de novo* transcription-dependent TAD boundary underpins critical multiway interactions during antibody class switch recombination.** Molecular Cell, S1097-2765(23)00037-0.

Hill, L., Wutz, G., Jaritz, M., Tagoh, H., Calderón, L., Peters, J.-M., Goloborodko, A., Busslinger, M. (2023). **Igh and Igk loci use different folding principles for V gene recombination due to distinct chromosomal architectures of pro-B and pre-B cells.** Nature Communications, 14(1), 2316

Open2C, Abdennur, N., Fudenberg, G., Flyamer, I. M., Galitsyna, A. A., Goloborodko, A., Imakaev, M., Venev, S. V. (2023). **Pairtools: from sequencing data to chromosome contacts** (p. 2023.02.13.528389). bioRxiv.

## JOANNA JACHOWICZ

Jachowicz, J. W. (2023). **A fine balancing act: how epitranscriptome regulates dosage compensation in mammals.** Nature Structural Molecular Biology, 30(8), 1057–1059

## JÜRGEN KNOBLICH

Beirute-Herrera, J., López-Amo Calvo, B., Edenhofer, F., Esk, C. (2023). **The promise of genetic screens in human *in vitro* brain models.** Biological Chemistry

Boogerd, C. J., Lacraz, G. P. A., Vértesy, Á., van Kampen, S. J., Perini, I., de Ruiter, H., Versteeg, D., Brodehl, A., van der Kraak, P., Giacca, M., de Jonge, N., Junker, J. P., van Oudenaarden, A., Vink, A., van Rooij, E. (2023). **Spatial transcriptomics unveils ZBTB11 as a regulator of cardiomyocyte degeneration in arrhythmogenic cardiomyopathy.** Cardiovascular Research, 119(2), 477–491

Daniel, R., Christian, K., Maria, N., Edoardo, S., Sakurako Nagumo, W., Michael, Z., Marthe, P., Balint, D., Kaja I., R.-R., Marielle, P., Ilaria, M., Charles, F., Alessandro, F., Molly M., S., Manuel, Z., Cedric, B., Malin, P., Juergen A., K. (2023). ***In vitro* modeling of the human dopaminergic system using spatially arranged ventral midbrain-striatum-cortex assembloids.** Nature Methods, 20(12)

Li, C., Fleck, J. S., Martins-Costa, C., Burkard, T. R., Themann, J., Stuempflen, M., Peer, A. M., Vertesy, Á., Littleboy, J. B., Esk, C., Elling, U., Kasprian, G., Corsini, N. S., Treutlein, B., Knoblich, J. A. (2023). **Single-cell brain organoid screening identifies developmental defects in autism.** Nature, 621(7978), 373–380

Martins-Costa, C., Pham, V. A., Sidhaye, J., Novatchkova, M., Wiegers, A., Peer, A., Möseneder, P., Corsini, N. S., Knoblich, J. A. (2023). **Morphogenesis and development of human telencephalic organoids in the absence and presence of exogenous extracellular matrix.** The EMBO Journal, e113213

Martins-Costa, C., Pham, V. A., Wiegers, A., Sidhaye, J., Doleschall, B., Novatchkova, M., Lendl, T., Piber, M., Peer, A., Möseneder, P., Stuempflen, M., Chow, S. Y. A., Seidl, R., Prayer, D., Höftberger, R., Kasprian, G., Ikeuchi, Y., Corsini, N. S., Knoblich, J. A. (2023). **ARID1B controls transcriptional programs of axon projection in the human corpus callosum.** (p. 2023.05.04.539362). bioRxiv

Pflug, F. G., Haendeler, S., Esk, C., Lindenhofer, D., Knoblich, J. A., Haeseler, A. von. (2023). **Neutral competition explains the clonal composition of neural organoids.** (p. 2021.10.06.463206). bioRxiv

Ritzau-Reid, K. I., Callens, S. J. P., Xie, R., Cihova, M., Reumann, D., Grigsby, C. L., Prados-Martin, L., Wang, R., Moore, A. C., Armstrong, J. P. K., Knoblich, J. A., Stevens, M. M. (2023). **Microfibrous Scaffolds Guide Stem Cell Lumenogenesis and Brain Organoid Engineering.** Advanced Materials (Deerfield Beach, Fla.), e2300305

Sidhaye, J., Trepte, P., Sepke, N., Novatchkova, M., Schutzbier, M., Dürnberger, G., Mechtler, K., Knoblich, J. A. (2023). **Integrated transcriptome and proteome analysis reveals posttranscriptional regulation of ribosomal genes in human brain organoids.** eLife, 12, e85135

Taubenschmid-Stowers, J., Orthofer, M., Laemmerer, A., Krauditsch, C., Rózsová, M., Studer, C., Lötsch, D., Gojo, J., Gabler, L., Dyczynski, M., Efferth, T., Hagelkruys, A., Widhalm, G., Peyrl, A., Spiegl-Kreinecker, S., Hoepfner, D., Bian, S., Berger, W., Knoblich, J. A., … Penninger, J. M. (2023). **A whole-genome scan for Artemisinin cytotoxicity reveals a novel therapy for human brain tumors.** EMBO Molecular Medicine, e16959

Trepte, P., Secker, C., Kostova, S., Maseko, S. B., Choi, S. G., Blavier, J., Minia, I., Ramos, E. S., Cassonnet, P., Golusik, S., Zenkner, M., Beetz, S., Liebich, M. J., Scharek, N., Schütz, A., Sperling, M., Lisurek, M., Wang, Y., Spirohn, K., … Wanker, E. E. (2023). **AI-guided pipeline for protein-protein interaction drug discovery identifies a SARS-CoV-2 inhibitor.** (p. 2023.06.14.544560). bioRxiv

Winter, N., Marchand, R., Lehmann, C., Nehlin, L., Trapannone, R., Rović, D., Dobbelaere, J. (2023). **The paradox of the life sciences: How to address climate change in the lab:** EMBO Reports, e56683

## BON-KYOUNG KOO

Chatzeli, L., Bordeu, I., Han, S., Bisetto, S., Waheed, Z., Koo, B.-K., Alcolea, M. P., Simons, B. D. (2023). **A cellular hierarchy of Notch and Kras signaling controls cell fate specification in the developing mouse salivary gland.** Developmental Cell, 58(2), 94-109.e6

Colozza, G., Lee, H., Merenda, A., Wu, S.-H. S., Català-Bordes, A., Radaszkiewicz, T. W., Jordens, I., Lee, J.-H., Bamford, A.-D., Farnhammer, F., Low, T. Y., Maurice, M. M., Bryja, V., Kim, J., Koo, B.-K. (2023). **Intestinal Paneth cell differentiation relies on asymmetric regulation of Wnt signaling by Daam1/2.** (p. 2023.01.24.525366). bioRxiv

Dietrich, B., Victoria, K., Lackner, A. I., Meinhardt, G., Koo, B.-K., Pollheimer, J., Haider, S., Knöfler, M. (2023). **NOTCH3 signalling controls human trophoblast stem cell expansion and differentiation** (p. 2023.07.03.547490). bioRxiv.

Farnhammer, F., Colozza, G., Kim, J. (2023). **RNF43 and ZNRF3 in Wnt Signaling - A Master Regulator at the Membrane.** International Journal of Stem Cells

Kim, J., Kim, S., Lee, S.-Y., Jo, B.-K., Oh, J.-Y., Kwon, E.-J., Kim, K.-T., Adpaikar, A. A., Kim, E.-J., Jung, H.-S., Kim, H.-R., Roe, J.-S., Hong, C. P., Kim, J. K., Koo, B.-K., Cha, H.-J. (2023). **Partial *in vivo* reprogramming enables injury-free intestinal regeneration via autonomous Ptgs1 induction.** Science Advances, 9(47), eadi8454

Meyenberg, M., Hakobyan, A., Papac-Milicevic, N., Göderle, L., Langner, F. L., Markovic, M., Lee, J.-H., Koo, B.-K., Busslinger, G. A., da Silva, I. T., Binder, C. J., Menche, J., Loizou, J. I. (2023). **Mutational landscape of intestinal crypt cells after long-term *in vivo* exposure to high fat diet.** Scientific Reports, 13(1), 13964.

Teriyapirom, I., Kim, J., Lee, H., Merker, S. R., Andersson-Rolf, A., Jahn, S. R., Ada, A.-M., Kim, S.-M., Lim, J. Y., Schmäche, T., Wetterling, N., Stegert, S., Park, J.-Y., Cheong, J.-H., Kim, H., Stange, D. E., Koo, B.-K. (2023). **Acquired epithelial WNT secretion drives niche independence of developing gastric cancer.** (p. 2023.02.24.529854). bioRxiv

Wu, S.-H. S., Kim, S., Lee, H., Lee, J.-H., Colozza, G., Park, S.-Y., Bakonyi, R., Teriyapirom, I., Hallay, N., Pilat-Carrota, S., Theussl, H.-C., Kim, J., Lee, J.-H., Simons, B. D., Kim, J. K., Koo, B.-K. (2023). **Red2Flpe-SCON: A Versatile, Multicolor Strategy for Generating Mosaic Conditional Knockout Mice.**(p. 2023.02.09.527641). bioRxiv

## SASHA MENDJAN

Bartsch, D., Kalamkar, K., Ahuja, G., Lackmann, J.-W., Hescheler, J., Weber, T., Bazzi, H., Clamer, M., Mendjan, S., Papantonis, A., Kurian, L. (2023). **mRNA translational specialization by RBPMS presets the competence for cardiac commitment in hESCs.** Science Advances, 9(13), eade1792

Cole, A. G., Jahnel, S. M., Kaul, S., Steger, J., Hagauer, J., Denner, A., Murguia, P. F., Taudes, E., Zimmermann, B., Reischl, R., Steinmetz, P. R. H., Technau, U. (2023). **Muscle cell-type diversification is driven by bHLH transcription factor expansion and extensive effector gene duplications.** Nature Communications, 14(1), 1747

Ctortecka, C., Hartlmayr, D., Seth, A., Mendjan, S., Tourniaire, G., Udeshi, N. D., Carr, S. A., Mechtler, K. (2023). **An automated nanowell-array workflow for quantitative multiplexed single-cell proteomics sample preparation at high sensitivity.** Molecular Cellular Proteomics: MCP, 100665.

Schmidt, C., Deyett, A., Ilmer, T., Haendeler, S., Torres Caballero, A., Novatchkova, M., Netzer, M. A., Ceci Ginistrelli, L., Mancheno Juncosa, E., Bhattacharya, T., Mujadzic, A., Pimpale, L., Jahnel, S. M., Cirigliano, M., Reumann, D., Tavernini, K., Papai, N., Hering, S., Hofbauer, P., Mendjan, S. (2023). **Multi-chamber cardioids unravel human heart development and cardiac defects.** Cell, 186(25), 5587-5605.e27

Yelagandula, R., Stecher, K., Novatchkova, M., Michetti, L., Michlits, G., Wang, J., Hofbauer, P., Vainorius, G., Pribitzer, C., Isbel, L., Mendjan, S., Schübeler, D., Elling, U., Brennecke, J., Bell, O. (2023). **ZFP462 safeguards neural lineage specification by targeting G9A/GLP-mediated heterochromatin to silence enhancers.** Nature Cell Biology, 25(1), 42–55

PUBLICATIONS

# IMBA Publications in *2023*

## JOSEF PENNINGER

Cikes, D., Elsayad, K., Sezgin, E., Koitai, E., Ferenc, T., Orthofer, M., Yarwood, R., Heinz, L. X., Sedlyarov, V., Miranda, N. D., Taylor, A., Grapentine, S., Al-Murshedi, F., Abot, A., Weidinger, A., Kutchukian, C., Sanchez, C., Cronin, S. J. F., Novatchkova, M., … Penninger, J. M. (2023). **PCYT2-regulated lipid biosynthesis is critical to muscle health and ageing.** Nature Metabolism, 5(3), 495–515

Cronin, S. J. F., Andrews, N. A., Latremoliere, A. (2023). **Peripheralized sepiapterin reductase inhibition as a safe analgesic therapy.** Frontiers in Pharmacology, 14, 1173599

Cronin, S. J. F., Davidow, L. S., Arvanites, A. C., Rubin, L. L., Penninger, J. M., Woolf, C. J. (2023). **Implementation of a Drug Screening Platform to TargetGch1 Expression in Injured Mouse Dorsal Root Ganglion Neurons.** Bio-Protocol, 13(9), e4666

Cronin, S. J. F., Tejada, M. A., Song, R., Laval, K., Cikes, D., Ji, M., Brai, A., Stadlmann, J., Novatchikova, M., Perlot, T., Ali, O. H., Botta, L., Decker, T., Lazovic, J., Hagelkruys, A., Enquist, L., Rao, S., Koyuncu, O. O., Penninger, J. M. (2023). **Pseudorabies virus hijacks DDX3X, initiating an addictive "mad itch" and immune suppression, to facilitate viral spread.** (p. 2023.05.09.539956). bioRxiv

Cronin, S. J. F., Yu, W., Hale, A., Licht-Mayer, S., Crabtree, M. J., Korecka, J. A., Tretiakov, E. O., Sealey-Cardona, M., Somlyay, M., Onji, M., An, M., Fox, J. D., Turnes, B. L., Gomez-Diaz, C., da Luz Scheffer, D., Cikes, D., Nagy, V., Weidinger, A., Wolf, A., … Penninger, J. M. (2023). **Crucial neuroprotective roles of the metabolite BH4 in dopaminergic neurons.** (p. 2023.05.08.539795). bioRxiv

Devignot, S., Sha, T. W., Burkard, T. R., Schmerer, P., Hagelkruys, A., Mirazimi, A., Elling, U., Penninger, J. M., Weber, F. (2023a). **Low Density Lipoprotein Receptor-Related Protein 1 (LRP1) as an auxiliary host factor for RNA viruses including SARS-CoV-2.** (p. 2022.02.17.480904). bioRxiv

Devignot, S., Sha, T. W., Burkard, T. R., Schmerer, P., Hagelkruys, A., Mirazimi, A., Elling, U., Penninger, J. M., Weber, F. (2023b). **Low-density lipoprotein receptor-related protein 1 (LRP1) as an auxiliary host factor for RNA viruses.** Life Science Alliance, 6(7), e202302005

Keshmiri, H., Cikes, D., Samalova, M., Schindler, L., Appel, L.-M., Urbanek, M., Yudushkin, I., Slade, D., Weninger, W. J., Peaucelle, A., Penninger, J., Elsayad, K. (2023). **Imaging the microscopic viscoelastic anisotropy in living cells** (p. 2023.05.28.542585). bioRxiv

Kondegowda, N. G., Filipowska, J., Do, J.-S., Leon-Rivera, N., Li, R., Hampton, R., Ogyaadu, S., Levister, C., Penninger, J. M., Reijonen, H., Levy, C. J., Vasavada, R. C. (2023). **RANKL/RANK is required for cytokine-induced beta cell death; osteoprotegerin, a RANKL inhibitor, reverses rodent type 1 diabetes.** Science Advances, 9(44), eadf5238

Liu, Q., Telezhkin, V., Jiang, W., Gu, Y., Wang, Y., Hong, W., Tian, W., Yarova, P., Zhang, G., Lee, S. M.-Y., Zhang, P., Zhao, M., Allen, N. D., Hirsch, E., Penninger, J., Song, B. (2023). **Electric field stimulation boosts neuronal differentiation of neural stem cells for spinal cord injury treatment via PI3K/Akt/GSK-3β/β-catenin activation.** Cell Bioscience, 13(1), 4

Malik, B., Vokic, I., Mohr, T., Poppelaars, M., Holcmann, M., Novoszel, P., Timelthaler, G., Lendl, T., Krauss, D., Elling, U., Mildner, M., Penninger, J. M., Petzelbauer, P., Sibilia, M., Csiszar, A. (2023). **FAM3C/ILEI protein is elevated in psoriatic lesions and triggers psoriasiform hyperproliferation in mice.** EMBO Molecular Medicine, e16758

Mereiter, S., Jonsson, G., Oliveira, T., Helm, J., Hoffmann, D., Abeln, M., Jochum, A.-K., Jochum, W., Kellner, M. J., Feith, M., Tkalec, V., Wasilewska, K., Jiao, J., Emsenhuber, L., Holstein, F., Obenauf, A. C., Lordello, L., Scoazec, J.-Y., Kroemer, G., … Penninger, J. M. (2023). **Tumor sialylation is a barrier against CD8 T cell-mediated anti-tumor responses and anti-PD-1 resistance in breast cancer.** (p. 2023.09.20.558571). bioRxiv.

Monteil, V., Kwon, H., John, L., Salata, C., Jonsson, G., Vorrink, S. U., Appelberg, S., Youhanna, S., Dyczynski, M., Leopoldi, A., Leeb, N., Volz, J., Hagelkruys, A., Kellner, M. J., Devignot, S., Michlits, G., Foong-Sobis, M., Weber, F., Lauschke, V. M., Horn, M., Feldmann, H., Elling. U., Penninger, J., Mirazimi, A. (2023). **Identification of CCZ1 as an essential lysosomal trafficking regulator in Marburg and Ebola virus infections.** Nature Communications, 14(1), 6785

Onji, M., Penninger, J. M. (2023). **RANKL and RANK in Cancer Therapy.** Physiology (Bethesda, Md.), 38(3), 0

Onodera, Y., Liang, J., Li, Y., Griffin, B., Thanabalasingam, T., Lu, C., Zhu, J., Liu, M., Moraes, T., Zheng, W., Khateeb, J., Khang, J., Huang, Y., Jerkic, M., Nakane, M., Baker, A., Orser, B., Chen, Y.-W., Wirnsberger, G., … Zhang, H. (2023). **Inhalation of ACE2 as a therapeutic target on sex-bias differences in SARS-CoV-2 infection and variant of concern.** iScience, 26(8), 107470

Oudit, G. Y., Wang, K., Viveiros, A., Kellner, M. J., Penninger, J. M. (2023). **Angiotensin-converting enzyme 2-at the heart of the COVID-19 pandemic**. Cell, 186(5), 906–922

Salewskij, K., Penninger, J. M. (2023). **Blood Vessel Organoids for Development and Disease.** Circulation Research, 132(4), 498–510

Starkl, P., Jonsson, G., Artner, T., Turnes, B. L., Serhan, N., Oliveira, T., Gail, L.-M., Stejskal, K., Channon, K. M., Köcher, T., Stary, G., Klang, V., Gaudenzio, N., Knapp, S., Woolf, C. J., Penninger, J. M., Cronin, S. J. F. (2023). **Mast cell-derived BH4 is a critical mediator of postoperative pain** (p. 2023.01.24.525378). bioRxiv

Starzonek, S., Maar, H., Mereiter, S., Freytag, V., Haider, M.-T., Riecken, K., Huang, Y.-L., Jacob, F., Wicklein, D., Schumacher, U., Lange, T. (2023). **Identification of potential classes of glycoligands mediating dynamic endothelial adhesion of human tumor cells.** Glycobiology, 33(8), 637–650

Taubenschmid-Stowers, J., Orthofer, M., Laemmerer, A., Krauditsch, C., Rózsová, M., Studer, C., Lötsch, D., Gojo, J., Gabler, L., Dyczynski, M., Efferth, T., Hagelkruys, A., Widhalm, G., Peyrl, A., Spiegl-Kreinecker, S., Hoepfner, D., Bian, S., Berger, W., Knoblich, J. A., … Penninger, J. M. (2023). **A whole-genome scan for Artemisinin cytotoxicity reveals a novel therapy for human brain tumors.** EMBO Molecular Medicine, e16959

Turgu, B., El-Naggar, A., Kogler, M., Tortola, L., Zhang, H.-F., Hassan, M., Lizardo, M. M., Kung, S. H., Lam, W., Penninger, J. M., Sorensen, P. H. (2023). **The HACE1 E3 ligase mediates RAC1-dependent control of mTOR signaling complexes.** EMBO Reports, e56815

Vietor, I., Cikes, D., Piironen, K., Vasakou, T., Heimdörfer, D., Gstir, R., Erlacher, M. D., Tancevski, I., Eller, P., Demetz, E., Hess, M., Kuhn, V., Degenhart, G., Rozman, J., Klingenspor, M., Angelis, M. H. de, Valovka, T., Huber, L. A. (2023). **The negative adipogenesis regulator DLK1 is transcriptionally regulated by TIS7 (IFRD1) and translationally by its orthologue SKMc15** (IFRD2).(p. 719922). bioRxiv

Vietor, I., Cikes, D., Piironen, K., Vasakou, T., Heimdörfer, D., Gstir, R., Erlacher, M. D., Tancevski, I., Eller, P., Demetz, E., Hess, M. W., Kuhn, V., Degenhart, G., Rozman, J., Klingenspor, M., Hrabe de Angelis, M., Valovka, T., Huber, L. A. (2023). **The negative adipogenesis regulator Dlk1 is transcriptionally regulated by Ifrd1 (TIS7) and translationally by its orthologue Ifrd2 (SKMc15).** eLife, 12, e88350

Vitale, I., Pietrocola, F., Guilbaud, E., Aaronson, S. A., Abrams, J. M., Adam, D., Agostini, M., Agostinis, P., Alnemri, E. S., Altucci, L., Amelio, I., Andrews, D. W., Aqeilan, R. I., Arama, E., Baehrecke, E. H., Balachandran, S., Bano, D., Barlev, N. A., Bartek, J., … Penninger, J. … Galluzzi, L. (2023). **Apoptotic cell death in disease-Current understanding of the NCCD 2023.** Cell Death and Differentiation, 30(5), 1097–1154

Wang, K., Khoramjoo, M., Srinivasan, K., Gordon, P. M. K., Mandal, R., Jackson, D., Sligl, W., Grant, M. B., Penninger, J. M., Borchers, C. H., Wishart, D. S., Prasad, V., Oudit, G. Y. (2023). **Sequential multi-omics analysis identifies clinical phenotypes and predictive biomarkers for long COVID.** Cell Reports. Medicine, 101254

Werschler, N., Penninger, J. (2023). **Generation of Human Blood Vessel Organoids from Pluripotent Stem Cells.** Journal of Visualized Experiments: JoVE, 191

Yamada, D., Kojima, Y., Hosoya, A., Suzuki, M., Watabe, T., Inoue, T., Tsugawa, N., Asakawa, T., Yonemoto, Y., Onizawa, M., Nemoto, Y., Oshima, S., Shimonaka, M., Kuba, K., Ishida, J., Fukamizu, A., Penninger, J. M., Watanabe, M., Okamoto, R., Nagaishi, T. (2023). **Apelin expression is downregulated in T cells in a murine model of chronic colitis.** Biochemical and Biophysical Research Communications, 647, 72–79

Zhu, C., Stolz, V., Simonovic, N., Al-Rubaye, O., Vcelkova, T., Moos, V., Hess, L., Hagelkruys, A., Madern, M., Reiter, W., Meixner, A., Bock, C., Hartl, M., Ellmeier, W., Seiser, C. (2023). **Targeting the catalytic activity of HDAC1 in T cells protects against experimental autoimmune encephalomyelitis.** (p. 2023.04.14.536700). bioRxiv

## NICOLAS RIVRON

David, L., Bruneau, A., Fréour, T., Rivron, N., Van de Velde, H. (2023). **An update on human pre- and peri-implantation development: a blueprint for blastoids**. Current Opinion in Genetics Development, 83, 102125

Heidari Khoei, H., Javali, A., Kagawa, H., Sommer, T. M., Sestini, G., David, L., Slovakova, J., Novatchkova, M., Scholte Op Reimer, Y., Rivron, N. (2023). **Generating human blastoids modeling blastocyst-stage embryos and implantation.** Nature Protocols

Iyer, D. P., Weijden, V. A. van der, Khoei, H. H., McCarthy, A., Rayon, T., Simon, C. S., Dunkel, I., Wamaitha, S. E., Elder, K., Snell, P., Christie, L., Schulz, E. G., Niakan, K. K., Rivron, N., Bulut-Karslioglu, A. (2023). **Delay of human early development via *in vitro* diapause.** (p. 2023.05.29.541316). bioRxiv

Okubo, T., Rivron, N., Kabata, M., Masaki, H., Kishimoto, K., Semi, K., Nakajima-Koyama, M., Kunitomi, H., Kaswandy, B., Sato, H., Nakauchi, H., Woltjen, K., Saitou, M., Sasaki, E., Yamamoto, T., Takashima, Y. (2023). **Hypoblast from human pluripotent stem cells regulates epiblast development.** Nature [epub]

Rivron, N. C., Martinez Arias, A., Pera, M. F., Moris, N., M'hamdi, H. I. (2023). **An ethical framework for human embryology with embryo models.** Cell, 186(17), 3548–3557

Rivron, N. C., Martinez-Arias, A., Sermon, K., Mummery, C., Schöler, H. R., Wells, J., Nichols, J., Hadjantonakis, A.-K., Lancaster, M. A., Moris, N., Fu, J., Sturmey, R. G., Niakan, K., Rossant, J., Kato, K. (2023). **Changing the public perception of human embryology.** Nature Cell Biology, 25(12), 1717–1719.

Seong, J., Rivron, N. C. (2023). **Protocol for capturing trophectoderm stem cells reflecting the blastocyst stage.** STAR Protocols, 4(2), 102151.

Suresh, V., Bhattacharya, B., Tshuva, R. Y., Gotthold, M. D., Olender, T., Bose, M., Pradhan, S. J., Zeev, B. B., Smith, R. S., Tole, S., Galande, S., Harwell, C., Baizabal, J.-M., Reiner, O. (2023). **PRDM16 co-operates with LHX2 to shape the human brain.**(p. 2023.08.12.553065). bioRxiv

## NOELIA URBÁN

Gabarró-Solanas, R., Urbán, N. (2023). **It takes two to untangle: Combined stimulation of adult neurogenesis reverts AD symptoms**. Cell Stem Cell, 30(4), 333–334

Gabarró-Solanas R, Davaatseren A, Kleifeld J, Kepčija T, Köcher T, Giralt A, Crespo-Enríquez I, Urbán N. (2023). **Adult neural stem cells and neurogenesis are resilient to intermittent fasting.** EMBO Rep, 24(12):e57268.

## SCIENTIFIC SERVICES

Appel, L.-M., Benedum, J., Engl, M., Platzer, S., Schleiffer, A., Strobl, X., Slade, D. (2023). **SPOC domain proteins in health and disease.** Genes Development, 37(5–6), 140–170

Birklbauer, M. J., Matzinger, M., Müller, F., Mechtler, K., Dorfer, V. (2023). **MS Annika 2.0 Identifies Cross-Linked Peptides in MS2-MS3-Based Workflows at High Sensitivity and Specificity.** Journal of Proteome Research, 22(9), 3009–3021

Ceppi, M., Smolkova, B., Staruchova, M., Kazimirova, A., Barancokova, M., Volkovova, K., Collins, A., Kocan, A., Dzupinkova, Z., Horska, A., Buocikova, V., Tulinska, J., Liskova, A., Mikusova, M. L., Krivosikova, Z., Wsolova, L., Kuba, D., Rundén-Pran, E., El Yamani, N., … Dusinska, M. (2023). **Genotoxic effects of occupational exposure to glass fibres - A human biomonitoring study.** Mutation Research. Genetic Toxicology and Environmental Mutagenesis, 885, 503572.

Dorl, S., Winkler, S., Mechtler, K., Dorfer, V. (2023). **MS Ana: Improving Sensitivity in Peptide Identification with Spectral Library Search.** Journal of Proteome Research

Feng, C., Roitinger, E., Hudecz, O., Cuacos, M., Lorenz, J., Schubert, V., Wang, B., Wang, R., Mechtler, K., Heckmann, S. (2023). **TurboID-based proteomic profiling of meiotic chromosome axes in *Arabidopsis thaliana*.** Nature Plants, 9(4), 616–630

Link, O., Jahnel, S. M., Janicek, K., Kraus, J., Montenegro, J. D., Zimmerman, B., Cole, A. G., Technau, U. (2023). **A cell-type atlas from a scyphozoan jellyfish *Aurelia coerulea* (formerly sp.1) provides insights into changes of cell-type diversity in the transition from polyps to medusae.** (p. 2023.08.24.554571). bioRxiv

Matzinger, M., Mayer, R. L., Mechtler, K. (2023). **Label-free single cell proteomics utilizing ultrafast LC and MS instrumentation: A valuable complementary technique to multiplexing.** Proteomics, e2200162

Matzinger, M., Mechtler, K. (2023). **Improving single cell proteomics experiments: how can we best utilize latest-generation data acquisition and MS instrument architecture?** Expert Review of Proteomics, 1–3.

Matzinger, M., Müller, E., Dürnberger, G., Pichler, P., Mechtler, K. (2023). **Robust and Easy-to-Use One-Pot Workflow for Label-Free Single-Cell Proteomics.** Analytical Chemistry, 95(9), 4435–4445.

Zheng, R., Matzinger, M., Mayer, R., Valenta, A., Sun, X., Mechtler, K. (2023). **A high-sensitivity low-nanoflow LC-MS configuration for high-throughput sample-limited proteomics.** (p. 2023.04.27.538542). bioRxiv

# Grants active or acquired in *2023*

## BRENNECKE GROUP

**Adaptation of a retroviral family to its host** *(Kirsten Senti)*
FWF (Austrian Science Fund): P 33715-B
**€ 407,284.42**
July 2021 – June 2024

**Dissecting the molecular principles of piRNA homeostasis**
FWF (Austrian Science Fund): P 36970
**€ 414,112.50**
November 2023 – October 2026

**RNA@core: "Molecular mechanisms in RNA biology"**
FWF (Austrian Science Fund): DOC 177-B
**€ 407,284.42**
September 2023 – August 2027

**RNA Smuggling** *(Ulrich Hohmann)*
H2020-MSCA-IF-2019: 896416
**€ 174,167.04**
January 2022 – December 2023

**VIP² Fellowship** *(Maya Voichek)*
H2020-MSCA-COFUND-2018: 847548
**€ 145,220**
January 2021 – December 2025

**VIP² Fellowship** *(Changwei Yu)*
H2020-MSCA-COFUND-2018: 847548
**€ 147,960**
July 2021 – December 2025

**EMBO Postdoctoral Fellowship** *(Maja Gehre)*
EMBO (European Molecular Biology Organization): ALTF 900-2020
**107,666.73**
August 2021 – February 2023

**BIF Fellowship** *(Julia Portell I De Montserrat)*
BIF Boehringer Ingelheim Fonds
**€ 78,400**
August 2021 – March 2024

## BURGA GROUP

**TOX-ANT: Toxin-antidote selfish elements in animals: from gene drive to speciation**
ERC (European Research Council) Starting Grant: 851470
**€ 1,498,428.00**
March 2020 – February 2025

**Structural basis of tRNA synthetase-based selfish killer**
FWF (Austrian Science Fund): P 34372-B
**€ 308,612.83**
July 2021 – June 2025

**VIP² Fellowship** *(Sonya Widen)*
H2020-MSCA-COFUND-2018: 847548
**€ 147,960**
July 2021 – December 2025

**DOC Fellowship Programme** *(Florian Pühringer)*
ÖAW (Austrian Academy of Sciences): 26441
**€ 85,025**
August 2022 – July 2024

**BIF Fellowship** *(Alevtina Koreshova)*
BIF Boehringer Ingelheim Fonds
**€ 75,950.00**
October 2020 – April 2023

## ELLING GROUP

**Talente: FEMtech Praktika für Studentinnen 2023:** ***in vivo*** **screening**
FFG (Oesterr. Forschungsförderungsgesellschaft mbH): FO999902764:
**€ 7,120**
June 2022 – May 2026

## GERLICH GROUP

**TopoGenomics: Topological interactions as functional regulators of the eukaryotic genome: moving beyond intramolecular looping**
ERC (European Research Council) Advanced Grant: 101019039
**€ 2,792,500**
September 2021 – August 2026

**Elucidating sister chromatid structure by chemical DNA labeling and conformation capture**
WWTF (Wiener Wissenschafts-, Forschungs- und Technologiefonds): LS17-003
**€ 492,108.85**
June 2018 – June 2023

**Elucidating the mechanics of mitotic chromosome assembly by light-, electron-, and atomic force microscopy**
WWTF (Wiener Wissenschafts-, Forschungs- und Technologiefonds): LS19-001
**€ 499,600**
June 2020 – May 2025

**Organization of sister chromatids in replicated chromosomes** *(Zsuszanna Takacs)*
FWF (Austrian Science Fund): T 1246
**€ 244,906.43**
January 2021 – December 2023

**EMBO Postdoctoral Fellowship** *(Thomas Steinacker)*
EMBO (European Molecular Biology Organization): ALTF 866-2022
**€ 72,000**
July 2023 – June 2024

**VIP² Fellowship** *(Thomas Steinacker)*
H2020-MSCA-COFUND-2018: 847548
**€ 19,180**
January 2023 – July 2023

**DSB Architect: The role of chromosome conformation in DNA double-strand break repair** *(Federico Teloni)*
H2020-MSCA-IF-2020: 101022896
**€ 174,167.04**
September 2022 – August 2024

**MicroChrom: Revealing the architecture of replicated human chromosomes by sister-chromatid-sensitive fluorescence in situ hybridisation** *(Thomas Steinacker)*
HORIZON-MSCA-2022-PF-01: 101103258
**€199,440.96**
August 2024 – July 2026

**BIF Fellowship** *(Emoke Gerocz)*
BIF Boehringer Ingelheim Fonds
**€ 24,500**
April 2022 – January 2023

## GOLOBORODKO GROUP

**Polymer models of homolog pairing in meiosis**
FWF (Austrian Science Fund): SFB F8804-B
**€ 325,967.73**
March 2022 – February 2026

**Elucidating the mechanics of mitotic chromosome assembly by light-, electron-, and atomic force microscopy**
WWTF (Wiener Wissenschafts-, Forschungs- und Technologiefonds): LS19-001
**€ 69,280**
May 2020 – April 2024

**MisterCHROM: Modelling sister chromatids cohesion** *(Flavia Corsi)*
H2020-MSCA-IF-2020: 101033347
**€ 174,167.04**
September 2022 – August 2024

## GRADE GROUP

***In vivo*** **reprogramming to rescue alterations in Huntington's disease**
La Caixa Banking Foundation
**€ 145,696.10**
November 2021 – October 2024

**VIP² Fellowship** *(Maria Nazareth Gonzalez Alvarado)*
H2020-MSCA-COFUND-2018: 847548
**€ 115,080**
July 2022 – February 2025

**EMBO Scientific Exchange Grant**
EMBO (European Molecular Biology Organization)
EMBO Scientific Exchange Grant 10278
**€ 8,720**
May 2023 – July 2023

## JACHOWICZ GROUP

**DarkCellFader: Uncovering the role and regulation of 3D DNA-RNA nuclear dynamics in controlling cell fate decisions**
ERC (European Research Council) Starting Grant: 101077048
**€ 1,500,000**
June 2023 – May 2028

## KNOBLICH GROUP

**Stem cell modulation in neural development and regeneration** *(Coordination/Partner)*
FWF (Austrian Science Fund): SFB F7801-B/ F7804_B
**€413,180.46 / € 366,980.46**
March 2020 – February 2023

**Developmental and cell type-specific origin of ASD pathology at single-cell resolution**
Simons Foundation, SFARI: 724430
**$ 480,000**
February 2021 – July 2023

***In vitro*** **modelling of dopamine pathways in fused organoids**
FWF (Austrian Science Fund): P 35369
**€ 393,554.70**
January 2022 – December 2025

**Molecular mechanisms of copy-neutral loss of heterozygosity**
FWF (Austrian Science Fund): P 35680
**€ 399,416.23**
April 2022 – March 2025

**The regulatory machinery of tubulin detyrosination** *(Lisa Landskron)*
FWF (Austrian Science Fund): J 4448-B
**€ 72,322.50**
August 2023 – April 2024





**Modeling connectomic deficits in TSC with cerebral organoids** *(Ramsey Najm)*
FWF (Austrian Science Fund): M 3303-B
**€ 179,021**
January 2022 – December 2023

**SCORPION: Bioengineered scaffolds for patterning of cerebral organoids**
FWF (Austrian Science Fund): DOC 72-B7
**€ 195,631.75**
October 2019 – March 2024

**PhenoConnectomics: Pheno-connectomics of human neurodevelopmental diseases** *(Abel Vertesy)*
H2020-MSCA-IF-2019: 898231
**€ 174,167.04**
September 2021 – August 2023

**EMBO Postdoctoral Fellowship** *(Laura Kracht)*
EMBO (European Molecular Biology Organization): ALTF 45-2023
**€ 144,000**
July 2023 – June 2025

**DOC Fellowship Programme** *(Ana Štravs)*
ÖAW (Austrian Academy of Sciences): 26729
**€ 116,897.5**
September 2023 – February 2026

**BIF Fellowship** *(Jamie Littleboy)*
BIF Boehringer Ingelheim Fonds
**€ 58,800**
April 2022 – March 2024

**Infrastructure for whole cell electrophysiology and Patch-seq**
ÖAW (Austrian Academy of Sciences): F_2023-05
**€ 204,000**
September 2023 – December 2023

**Next-Generation Preclinical Models of NF1 Brain Tumors**
Gilbert Family Foundation: 923017
**$1,294,348.00**
January 2024 – December 2026

## KOO GROUP

**Treatment decision based on organoids in gastric cancer**
FWF (Austrian Science Fund): I 5900-B
**€ 248,507.44**
April 2022 – June 2023

**SCORPION: Bioengineered scaffolds for patterning of cerebral organoids**
FWF (Austrian Science Fund): DOC 72-B7
**€ 163,202**
October 2019 – March 2024

**A Role for MEK1 in WNT and TGFß Signaling**
FWF (Austrian Science Fund): P 35694
**€ 51,134.06**
October 2022 – September 2025

**Treatment decision based on organoids in gastric cancer** *(Gabriele Colozza)*
FWF (Austrian Science Fund): I 5900-B
**€ 50,403.44**
July 2023 – March 2025

## MENDJAN GROUP

**Deciphering BMP signaling in human lateral plate mesoderm**
FWF (Austrian Science Fund): PAT 4435223
**€ 399,816.36**
April 2022 – June 2023

**SCORPION: Bioengineered scaffolds for patterning of cerebral organoids**
FWF (Austrian Science Fund): DOC 72-B7
**€ 195,631.75**
October 2019 – March 2024

**Human 3D disease models for cardiac drug discovery**
Wirtschaftsagentur Wien
**€ 131,109.74**
February 2022 – July 2024

**Transcriptional and morphogenic signatures of congenital heart disease pathways**
Additional Ventures, Single Ventricle Research Fund
**$ 330,000**
February 2022 – February 2025

**RECREATE: non-coding RNA therapeutics to elicit cardiac regeneration in ischemic heart disease**
FWF (Austrian Science Fund): I 6934-B
**€ 374,052.00**
March 2024 – February 2027

## PENNINGER GROUP

**Breast Cancer Research**
Zastrow Foundation
**€ 1,600,000**
January 2018 – December 2023

**MAD-CoV 2: Modern approaches for developing antivirals against SARS-CoV 2**
H2020-JTI-IMI2-2020-21: 101005026
**€ 1,100,000**
August 2020 – July 2024

**Developing a unique high throughput platform for identification of essential cellular factor for of virus replication**
The Swedish Research Council: 2018-05766_3
**SEK 4,500,000**
January 2019 – December 2024

**Exploiting organoid model systems to explore systemic conditions worsening COVID19: merging cellular and genetic engineering**
Fundacio La Marato de TV3: 202125-31
**€ 133,000**
September 2021 – September 2024

**Sialoproteome driven immune response in breast cancer** *(Stefan Mereiter)*
FWF (Austrian Science Fund): ESP 166
**€ 294,015.98**
September 2022 – August 2025

**DOC Fellowship Programme** *(Gustav Jonsson)*
ÖAW (Austrian Academy of Sciences): 26316
**€ 84,550**
July 2022 – June 2024

**SWEEPICS: Swept Lasers For Non-Invasive Diagnostics**
HORIZON-CL4-2023-DIGITAL-EMERGING-01: 101135053
**€ 313,550**
December 2023 - November 2026

**Diamond Blackfan Anemia**
Project supported by donations

## RIVRON GROUP

**BLASTOID: A drug discovery platform for early human embryogenesis.**
ERC-2020-COG: 101002317
**€ 2,000,000**
July 2021 – June 2026

**BLASTOID-DISCOVERY: Human blastoids: a drug discovery platform for women's reproductive health**
ERC-2022-POC2: 101082147
**€ 150,000**
November 2023 – March 2025

**The black box of pregnancy first steps**
FWF (Austrian Science Fund): I 6392-B
**€ 419,958.00**
December 2023 – November 2027

**HU_BLAST: Understanding human peri-implantation development**
FWF (Austrian Science Fund): I 6214
**€ 401,291.67**
January 2023 – December 2026

**Creating a symphony from noise: stochastic and coordinated regulation of stem cells in embryogenesis**
Human Frontier Science Program (HFSP): RGY0081_2019
**€ 346,723.59**
November 2019 – October 2024

**IMPLANTATION: A stem cell-based approach for modelling implantation** ***in vitro*** *(Heidar Heidari Khoei)*
H2020-MSCA-IF-2020: 101026451
**€ 174,167.04**
September 2022 – August 2024

**VIP² Fellowship** *(Saurabh Pradhan)*
H2020-MSCA-COFUND-2018: 847548
**€ 112,340**
August 2022 – December 2025

**JSPS Fellowship** *(Harunobu Kagawa)*
Japan Society for the Promotion of Science (JSPS)
**¥13,541,500.00**
April 2022 – March 2024

**NRF Fellowship** *(Jinwoo Seong)*
National Research Foundation of Korea (NRF): 300-20220052
**KRW 42,858,000**
September 2022 – August 2023

**BIF Fellowship** *(Viktoria Holzmann)*
BIF Boehringer Ingelheim Fonds
**€ 73,500**
December 2020 – May 2023

**EHMPLANT - Engineering a uteroid hydrogel platform for human implantation** *(Martina de Santis)*
ÖAW (Austrian Academy of Sciences) Seal of Excellence
**€ 200,000**
October 2022 – November 2023

## SAHA GROUP

**Role of nuage in germline cell fate**
FWF (Austrian Science Fund): P 34278
**€ 382,930.26**
June 2021 – May 2025

## URBÁN GROUP

**Stem cell modulation in neural development and regeneration**
FWF (Austrian Science Fund): SFB F 7808_B
**€ 442,279.41**
March 2020 – February 2023

**Targeted protein degradation – from small molecules to complex organelles**
FWF (Austrian Science Fund): SFB F7907-B
**€ 405,163.93**
March 2020 – February 2023

**SMICH: Extrinsic regulation of adult neural stem cell quiescence**
FWF (Austrian Science Fund): W 1261-B28
**€ 236,840.00**
May 2021 – April 2025

**Using activity-based probes to study the mechanism and regulation of the giant E3 ligase Huwe1**
WWTF (Wiener Wissenschafts-, Forschungs- und Technologiefonds): LS21-029
**€ 279,970.00**
June 2022 – May 2026

# Seminars and scientific events in *2023*

## Scientists at IMBA host internationally renowned speakers at campus-wide seminars and conferences.

### Speakers hosted by group leaders at IMBA

**Irina R. Arkhipova, Marine Biological Laboratory, United States**
How does horizontal transfer contribute to eukaryotic evolution?

**Thorsten Boroviak, University of Cambridge, United Kingdom**
How to build a primate: Modelling postimplantation development in a dish

**Daniele Canzio, University of California San Francisco, United States**
How chromosome architecture shapes brain architecture

**Silvia Cappello, Max Planck Institute of Psychiatry Munich, Germany**
Cellular crosstalk in neurodevelopmental disorders

**Luca Chiapperino,**
**Institute of Social Sciences, University of Lausanne, Switzerland**
The mirage of biosocial complexity: Critique and collaboration around the tools of epigenetics

**Antoine Coulon, Institut Curie, France**
Probing chromosome mechanics in the interphase nucleus

**Sven Diederichs, German Cancer Research Center, Germany**
From non-coding RNAs to non-canonical mutations in cancer

**Sevi Durdu,**
**Friedrich Miescher Institute for Biomedical Research, Switzerland**
CAGGTG/CAGATG, in other words a muscle or a neuron

**Nikolce Gjorevski,**
**Roche Institute for Translational Bioengineering, Switzerland**
Next-generation immunocompetent intestinal organoids capture drug-induced inflammation

**Martin Hetzer, Institute of Science and Technology Austria, Austria**
Protein homeostasis and lifelong cell maintenance

**Valérie Hilgers,**
**Max Planck Institute of Immunobiology and Epigenetics, Germany**
Non-coding RNAs drive cytoplasmic compartmentalization and neuronal function

**Christoph Huber,**
**Universitätsmedizin Mainz, TRON gGmbH, BioNTech, Germany**
Translating science into survival

**Lijian Hui, Shanghai Institute of Biochemistry and Cell Biology, China**
Cell identity conversion: Liver regeneration and cell therapy

**C. Justin Lee, Center for Cognition and Sociality at**
**the Institute for Basic Science, South Korea**
Reactive astrocytes as the cause of Alzheimer's disease

**Paul Lehner, Jeffrey Cheah Biomedical Centre, United Kingdom**
How HUSH protects your genome from reverse genetic flow

**Prisca Liberali,**
**Friedrich Miescher Institute for Biomedical Research, Switzerland**
Principles of tissue organization: Symmetry breaking in intestinal organoids

**Julia Maristany, University of Cambridge, United Kingdom**
Mechanical properties of DNA govern nucleosomal unwrapping

**Jacob Mueller, University of Michigan, United States**
Fruits of chromosomal conflict

**Laurent Nguyen, University of Liege, Belgium**
Regulation of cerebral cortex morphogenesis by migrating cells

**Ramesh Pillai, University of Geneva, Switzerland**
RNA modifications in control of mammalian gene expression

**Jens Puschhof, German Cancer Research Center - DKFZ, Germany**
Modelling cancer-microbiome interactions with organoids and organs-on-chips

**Teresa Rayon, Babraham Institute, United Kingdom**
Mechanistic control of timescales in development

**Peter Rugg-Gunn, Babraham Institute, United Kingdom**
Establishing the epigenome in human development and pluripotency

**Jesse Veenvliet, Max Planck Institute of**
**Molecular Cell Biology and Genetics, Germany**
Connecting spaces and scales in stembryos

**Ayaka Yanagida, The University of Tokyo, Japan**
Capturing early human embryonic development using naive pluripotent stem cells

**Jessica Zuin,**
**Friedrich Miescher Institute for Biomedical Research, Switzerland**
Nonlinear control of transcription through enhancer-promoter interactions

**Thomas Zwaka,**
**Icahn School of Medicine at Mount Sinai, United States**
Pluripotent stem cells provide a new framework for studying bat biology and viruses






SY-Stem 2023: Prisca Liberali delivers a keynote lecture at the SY-Stem 2023 conference.

### Conferences

**SY-Stem symposium**
In 2023, the annual SY-Stem symposium, jointly organized by IMBA, IMP, and the Max Perutz Labs, featured keynotes by Michele De Luca and Prisca Liberali. SY-Stem focuses on the next generation of stem cell researchers and fosters collaboration and discussions within stem cell biology.

**17th Microsymposium on RNA Biology**
The 17th Microsymposium on RNA Biology was co-organized by IMBA, IMP, GMI, Max Perutz Labs, and the Vienna BioCenter's RNA community. This international conference serves as a vital platform for young scientists, group leaders, and company representatives to exchange and discuss recent advancements in small RNA research and related fields.

**60th Birthday Symposium Jürgen Knoblich**
A symposium was held for the 60th birthday of IMBA director Jürgen Knoblich. More than 100 colleagues, past and present, as well as alumni and current lab members gathered to celebrate. The symposium highlighted the achievements of Knoblich Lab alumni who have excelled in academia and industry.

**LMB-VBC Graduate Life Sciences Symposium**
The Vienna BioCenter and the MRC Laboratory of Molecular Biology (LMB) in Cambridge partnered to host the LMB-VBC Graduate Life Sciences Symposium, a student-led event to foster scientific exchange and networking between the two institutions. This international symposium featured a keynote by Jennifer Lippincott-Schwartz and offered numerous networking opportunities.

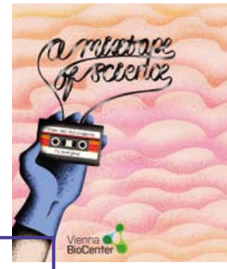

Participants at the Microsymposium on RNA Biology discuss recent research findings.

**20th Annual Vienna BioCenter PhD Symposium**
The Vienna BioCenter PhD Symposium, organized by PhD students and the Vienna BioCenter Scientific Training Unit, has been a cornerstone of scientific exchange, annually gathering a wide-ranging audience and distinguished speakers from Europe and beyond. Marking its 20th anniversary, the symposium, themed "A Mixtape of Science", sought to enhance this tradition by fostering a dynamic, collaborative environment that merged diverse expertise, methodologies, model organisms, disciplines, and research approaches.

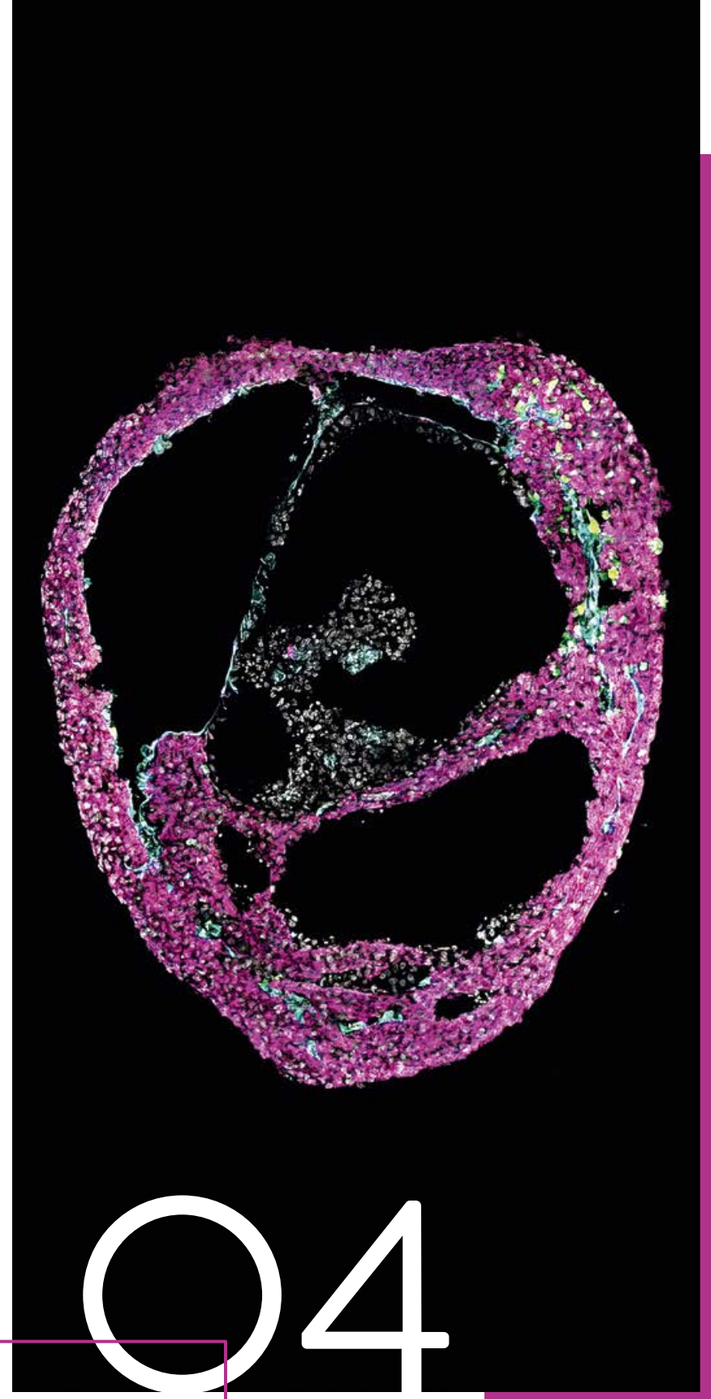
**DevStem - Development and Stem Cells**
DevStem, a regional meeting co-organized by IMBA, GMI, IMP, ISTA, Max Perutz Labs, the University of Vienna, and the Medical University of Vienna featured presentations by students and postdocs, poster sessions, and flash talks, with a keynote address by IMBA group leader Sofia Grade. This event served as a unique platform for developmental and stem cell biologists to exchange technologies, approaches, ideas, and establish new collaborations.

**1st VBC - Life Sciences Minisymposium**
The VBC-Life Sciences Minisymposium was initiated after part of the Faculty of Life Sciences moved to the new University of Vienna Biology Building at the Vienna BioCenter. The symposium united colleagues from all institutes at the Vienna BioCenter, providing talks from diverse fields within the life sciences and creating an ideal platform for networking.

**Young Investigator Symposium**
The Young Investigator Symposium, jointly organized by IMBA, IMP, and the Vienna BioCenter, is a bi-annual virtual event that showcases the work of emerging scientists across various disciplines such as gene expression, synthetic biology, machine learning, artificial intelligence and more. This meeting provides a platform for young researchers to present their findings and engage with peers from around the world.




The 20th Vienna BioCenter PhD Symposium delivered a mixtape of science to its audience.



# 04

Heart organoids developed at IMBA offer unprecedented opportunities to study heart development and disease.

# CAMPUS & COMMUNITY


THE VIENNA BIOCENTER

# IMBA – a part of the *Vienna BioCenter*

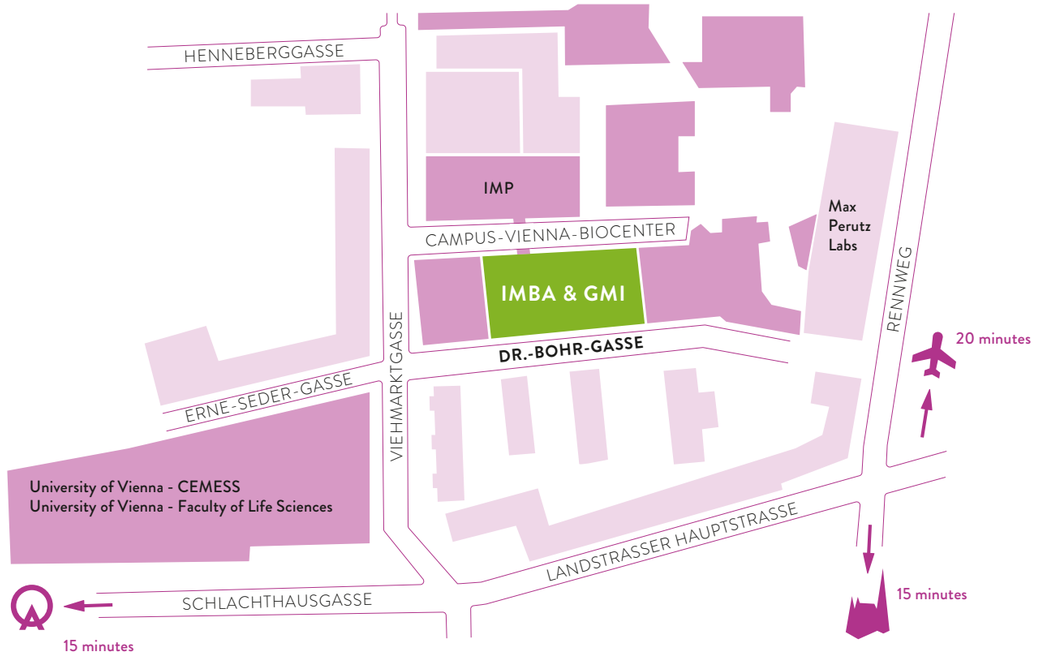
## IMBA is situated within the dynamic and interdisciplinary campus of the Vienna BioCenter.

IMBA is located at the Vienna BioCenter, one of Europe's leading life science locations, which is distinguished by its integration of research, education, and capacity for innovation.

In addition to IMBA, five other outstanding research institutes are located at the Vienna BioCenter: the Gregor Mendel Institute of Molecular Plant Biology (GMI), 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 at the University of Vienna. In 2023, 2,800 staff members from 85 countries worked at the Vienna BioCenter, including more than 2,000 scientists.

The Vienna BioCenter is more than just a place for research; it's a lively community. This welcoming atmosphere is interwoven with joint seminars and conferences, as well as social activities such as a drama club and sports activities. The Vienna BioCenter provides an environment where anything is possible: Spontaneous discussions and cross-disciplinary collaborations catalyze creative approaches to complex scientific questions.

Central to IMBA's research are the Vienna BioCenter Core Facilities (VBCF), which provide researchers at the Vienna BioCenter with access to advanced scientific infrastructure. More than 40 biotech companies and start-up labs within the campus create a space where fundamental research and market application co-exist.



# *Opportunities* for students at IMBA

## IMBA provides excellent education and training for undergraduate and graduate students.

At IMBA, life sciences education is offered through the Vienna BioCenter Summer School and the Vienna BioCenter PhD Program. These programs are distinguished by their rigorous academic standards and focus on investigative scientific research, offering students an invaluable opportunity to pursue answers to some of the most complex questions in molecular biology.

### Vienna BioCenter Summer School

Funded by the Max Birnstiel Foundation, the Vienna BioCenter Summer School is a key educational initiative for undergraduate students in the life sciences. The Summer School is a highly competitive nine-week program that annually welcomes 20 students from around the world. Participants engage in independent research projects under the guidance of scientists at the Vienna BioCenter's research institutes, including IMBA.

### Vienna BioCenter PhD Program

The Vienna BioCenter PhD Program, affiliated with the University of Vienna and the Medical University of Vienna, is one of Europe's leading doctoral programs in the life sciences. The PhD Program is a collaborative effort involving IMBA and other research institutes at the Vienna BioCenter, including the Gregor Mendel Institute of Molecular Plant Biology (GMI), the Research Institute of Molecular Pathology (IMP), and the Max Perutz Labs. Characterized by its international reach, the program is designed to train students from diverse backgrounds to become future scientific leaders by providing them with an interdisciplinary and world-class academic environment. Above all, students cultivate analytical skills, unconventional thinking, and creativity.

New PhD students engage in the "Prime Your PhD" series, a morning seminar series that serves as an introduction to the breadth of research and methodologies conducted on campus. The program also provides a platform for students to showcase their research during weekly Vienna BioCenter-wide seminars, as well as retreats and symposia. PhD students across the Vienna BioCenter PhD Program also organize the yearly PhD Symposium, giving students first-hand experience in organizing a scientific symposium. PhD candidates at IMBA contribute to the research landscape with work that often leads to high-interest publications, affirming the institute's commitment to advancing scientific knowledge.

**The Vienna BioCenter PhD program is designed to train students to become future scientific leaders.**

### IMBA graduates in 2023

**Catarina Da Cunha e Silva Martins Costa,** Knoblich group, From neuroepithelial morphogenesis to circuit formation: using organoid technologies to understand human brain development

**Johanna Gassler,** Tachibana group, Chromatin reorganization to totipotency during the mammalian oocyte-to-zygote transition

**Sofia Kolesnikova,** Gerlich group, Organization of sister chromatids in replicated chromosomes

**Isaree Teriyapirom,** Koo group, The role of MAPK and WNT in tumorigenesis of gastric and liver cancer

**Paul Daniel Batty,** Gerlich group, The mechanics of sister chromatid resolution

**Daniel Reumann,** Knoblich group, *In Vitro* Modeling of the Human Dopaminergic System

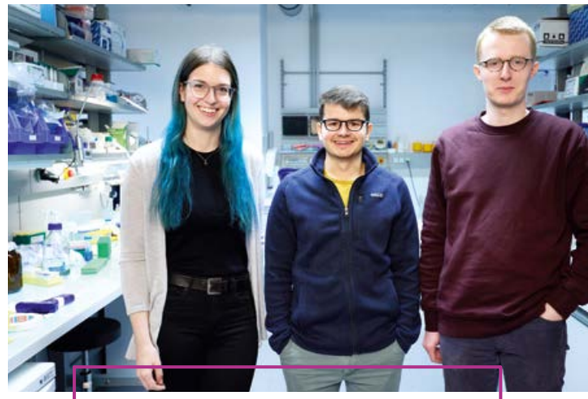




## PhD student representatives foster strong ties in the student community

PhD student representatives at IMBA take an active role in representing the PhD community within the institute. They organize events, raise common issues and are the first contact point for their peers.

The IMBA student representatives gave us an insight into their experience at IMBA and how they have supported their peers in the last year.



Marie-Christin Leitner from the Mendjan group, Christian Lehmann from the Knoblich group and Ralf Jansen from the Brennecke group represented the PhD students at IMBA in 2023.

**How has your experience at IMBA been so far?**

**Ralf Jansen:** IMBA as a part of the Vienna BioCenter is a great place to do research and develop as a scientist, because we can access world-class research infrastructure and are constantly exposed to an amazing diversity of research directions across all institutes. This provides a uniquely fertile foundation to grow new, often interdisciplinary collaborations within the campus.

**Marie-Christin Leitner:** IMBA is a creative hub that fosters cutting edge research in a highly collaborative environment.

**Christian Lehmann:** IMBA provides an ideal environment for PhD students to do scientific research, offering access to high-end facilities and fostering collaborations within the campus. This opens unique opportunities for students to mature and pursue their passion.

**What was your motivation for becoming PhD student representatives?**

**Christian Lehmann:** Pursuing a PhD can be a challenging, yet ultimately rewarding journey. My aim was to use my experience to help other PhD students and make their PhD adventure even more fulfilling.

**Ralf Jansen:** Doing your PhD in any high-level institution can be challenging because producing quality research requires a lot of dedication. I was interested in building on existing support systems and exploring new ones.

**Marie-Christin Leitner:** I think it's important to listen to the experiences of PhD students. It's essential to nurture a student community that supports each other and makes sure that concerns from PhD students are shared with management.

**What initiatives have you participated in?**

**Christian Lehmann:** We lead a successful yearly PhD student survey, in which 90-95% of students participate. This allows us to identify topics that are relevant to PhD students and tackle them before they can become an issue. The last example was mental health: we partnered with faculty and management to introduce positive change by giving PhD students more tools for managing stress.

**Marie-Christin Leitner:** We've set up office hours where students can drop by and share whatever's on their mind. And we also use town hall-style meetings where anyone can come and discuss these topics collectively.

**How has your work helped PhD students develop and learn?**

**Ralf Jansen:** We've identified that issues can stem from inefficient communication. The Vienna BioCenter Scientific Training Unit, which also organizes the Vienna BioCenter PhD Program, is developing leadership courses to address the topic of leadership in academia.

**Christian Lehmann:** We are also organizing debate courses that will help PhD students more effectively discuss their projects and concerns. These are essential skills that students will be able to apply in their professional future.

**Marie-Christin Leitner:** The PhD retreats, which are organized by us, have been a great resource to provide PhD students with experiences of what it's like to present their research in flash talks or in a poster format, and are a great platform for networking and sharing their passion.

# *Opportunities* for postdoctoral researchers at IMBA

## At IMBA, all researchers are supported to reach their full potential.

Postdocs at IMBA make the most of the many collaboration and networking possibilities at the Vienna BioCenter.

A comprehensive training program makes IMBA a destination for researchers at all levels of their careers. All researchers have access to the scientific facilities on campus and to training opportunities.

### Vienna International Postdoctoral (VIP²) Fellowship Program

IMBA is a member of the Vienna International Postdoctoral Program (VIP²), which offers a unique opportunity for postdoctoral researchers in the life sciences: Combining a three-year fellowship with a two-mentor scheme encourages interdisciplinary and inter-sectoral research. This innovative program, open to candidates with diverse scientific backgrounds, emphasizes scientific independence and the potential for establishing new research lines. Research topics range from structural biology to organismal biology, from gene expression to neurobiology, from microbiology to molecular medicine, and encompass the full range of model systems from microbes, stem cells, plants, invertebrates to vertebrates.

### The Vienna BioCenter Leadership Program – New in 2023

Academic leaders face a complex landscape of global competition and expanding responsibilities. At the Vienna BioCenter, the Training Unit runs a comprehensive leadership program that focuses on further developing key skills such as empathetic communication, effective delegation, and managing diverse team dynamics. Overall, this initiative is enhancing the organizational leadership landscape at the Vienna BioCenter and fostering a collaborative work environment that promotes innovative discovery.

### Expert-Led Research Training

While "Prime Your PhD" gives new students an overview of various research areas, the "How do you do it?" seminar series offered to all researchers focuses on detailed methodologies ranging from protein quality control, AI applications, to creating DNA nanostructures. These seminars, led by experts, provide hands-on experiences that enhance researchers' 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 and support. This approach ensures that researchers at IMBA are well-equipped with the necessary skills for conducting their research effectively.


The Postdoc Networking Day provides opportunities for postdocs across Vienna to network.





## Postdoc representatives foster collaboration and decision making.

Postdoctoral researchers (postdocs) are experienced scientists who act as mentors and role models for younger researchers and drive projects forward. At IMBA, postdoc representatives share their perspective on scientific and organizational matters, involving the institute community in the decision-making process. Four postdocs represented the postdoctoral community at IMBA in 2023.

Through new initiatives like the Postdoc Networking Day (PoND), postdoc representatives Federico Teloni, Laura Kracht, Shamsi Emtenani and Flavia Corsi spearheaded initiatives to strengthen campus community bonds and support systems. They told us about their experience at IMBA, their work as representatives and what drives them to contribute.

Shamsi Emtenani, Laura Kracht, Federico Teloni and Flavia Corsi represented the postdocs at IMBA in 2023.

**What is your experience as a postdoc at IMBA?**

**Laura Kracht:** I like to do research at IMBA because of the extraordinary facilities and infrastructure. We have access to multiple state-of-the-art techniques and equipment, as well as experienced staff who operate those systems and support us with data analysis. This takes a significant burden off the researchers and gives us freedom to answer our scientific questions with the best-fitting techniques available.

**Shamsi Emtenani:** I find great value in the supportive network at IMBA, where colleagues readily share knowledge and resources, fostering a collaborative spirit that propels our research forward with ingenuity and efficiency.

**What motivated you to become postdoc representatives?**

**Laura Kracht:** I value connecting with other people in similar roles, and knowing how other people think or feel about shared topics. Also, I was keen to understand the structure of the institute a bit better.

**Shamsi Emtenani:** I was eager to improve how I communicate with other, non-scientific staff of the institute. I also think it's crucial to amplify the voices of postdocs and increase their visibility. Lastly, seeing the institute structure from the other side was also important to me.

**Federico Teloni:** I wanted to gain a clearer understanding of the decision-making process at the institutional level, as this may not always be evident to postdocs. I also wanted to help the institute to develop an administrative framework that best supports the various needs of our postdoc community.

**What initiatives have you worked on?**

**Federico Teloni:** We are trying to connect postdocs all around the Vienna BioCenter through events like the Postdoc Networking Day (PoND), where they can all get together, share their research and network.

**Flavia Corsi:** Working at an academic institute can be very rewarding, but it can also create stress. We have collaborated in mental health awareness initiatives. Also, we want to make it easier for researchers from non-European countries to immigrate to Austria.

**What have you learned during your time as representatives?**

**Shamsi Emtenani:** As scientists, we're used to dealing with scientific problems, but we have learned that some problems are moral, political or artistic, and should be addressed differently. We've improved our communication with other members of our institute and are involved in transparent decision-making.

**Federico Teloni:** As a representative, I gained insights into the rationale behind certain decisions. We've been able to share that with our colleagues, improving communication within the institute. It has also helped our colleagues realize that our scientific interests and reasoning must be balanced with the administrative capabilities and requirements of the institute.

**Flavia Corsi:** We realized that leadership skills are not commonly part of academic training. The Vienna BioCenter has taken proactive steps by offering leadership courses, and we are optimistic that these initiatives will continue to strengthen cohesiveness at the institutes.

IMBA ANNIVERSARY

# *20* years of research at IMBA

**In June 2023, IMBA celebrated its 20th anniversary, bringing together the campus and alumni communities.**

2023 marked IMBA's 20th anniversary since the start of research operations. IMBA celebrated this milestone in the institute's history with a two-day event highlighting IMBA's commitment to research, discovery, and innovation. The celebrations brought together more than 400 guests from science, politics, and academia to recognize IMBA's scientific achievements over the past two decades.

### A festive ceremony reflected on IMBA's journey

On June 13, a festive ceremony highlighted IMBA's growth and scientific achievements. In a video message, the President of Austria, Alexander Van der Bellen, underscored the importance of academic freedom and basic research for the wider public. Josef Penninger, founding director of IMBA, and Jürgen Knoblich, scientific director, gave insights into the institute's development over the past 20 years. Maria Leptin, President of the European Research Council, and Tony Hyman, Director of the Max Planck Institute of Molecular Cell Biology and Genetics, who both have long-term ties to IMBA's scientific advisory board, stressed the significance of fundamental science and recalled IMBA's formative years. (Read excerpts from Maria Leptin's and Tony Hyman's speeches on page 18–19.)

Saxophonist Sebastian Grimus provided the background music for the festive ceremony.

Founding Director Josef Penninger and Jürgen Knoblich reflected on building a successful research institute.

The anniversary celebrations started with a ceremony, moderated by Ruth Hutsteiner.

The celebrations brought together guests from science, politics, and academia. From left to right: IMBA's directors Markus Kiess and Jürgen Knoblich, Mayor of the City of Vienna Michael Ludwig, and Heinz Faßmann, President of the Austrian Academy of Sciences, during the festive ceremony.


Elly Tanaka, group leader at the IMP, alumnus Peter Ebert Andersen, IMBA group leader Daniel Gerlich and Daniele Soroldoni, head of the Vienna BioCenter Core Facilities, raise a toast to IMBA.

Founding director Josef Penninger and IMBA's first business director, Michael Krebs, celebrated 20 years of IMBA.

IMBA alumna Veronika Krenn reflected on her journey at IMBA and its influence on her career development.

## Anniversary Symposium

On June 14, the scientific community celebrated IMBA's scientific breakthroughs in a symposium, held at the Vienna BioCenter to bring together the local scientific community. Under the tagline "Exploring the Unknown: Our Passion, our Future", the symposium built on the research of IMBA's groups in chromosome and RNA biology, stem cell and organoid research. The speakers – all former scientists at IMBA who have progressed to other positions in academia and industry – shared how their formative experiences at IMBA have shaped their further career paths. (Two alumni, Matthias Samwer and Peter Ebert Andersen, give an inside look at their time at IMBA in an interview on page 48–49.)

## Art and Science – a long tradition at IMBA

Following IMBA's tradition of engaging in a dialogue between art and science, the anniversary event included a salon with artists who created artworks at the institute. Scientists, including Josef Penninger, and artists engaged in a dialogue about the intersection of art and science, moderated by journalist Ruth Hutsteiner.

In the anniversary year, IMBA made additional commitments to science communication and community engagement.

The scientific community celebrated IMBA's scientific breakthroughs in a symposium with IMBA alumni.

Art and Science have a long tradition at IMBA. Josef Penninger and artists who have created artworks at IMBA engaged in a dialogue about the interaction of both.


## Research illuminated

Together with the design group dform, IMBA developed a stunning exhibition in the building foyer. The exhibition displays illuminated high-resolution images taken by IMBA research groups, offering an accessible and insightful look into research conducted at IMBA.

## Anniversary supplement in Der Standard

The Austrian newspaper Der Standard outlined IMBA's achievements in advancing our understanding of molecular biology, in particular the development of organoids to understand disease on a molecular level. Additionally, it reflected on the institute's growth, the training of new talents and their trajectories, and IMBA's success in securing 21 ERC Grants, underlining IMBA's significant contributions to basic research.

## IMBA @ Open house Vienna

IMBA's participation in Open House Vienna in 2023, as part of the anniversary celebrations, provided a unique opportunity for more than 500 visitors to explore both the architectural features of IMBA and the scientific research conducted by scientists at IMBA.

The anniversary celebrations culminated in a vibrant party, marking the major successes of the last 20 years with cheerful toasts.

OUTREACH

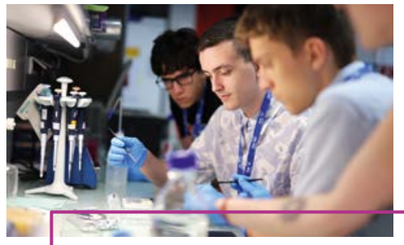
# Hands-on science for *everyone*

## IMBA's outreach programs connect basic research and the wider community.

IMBA researchers facilitate the translation of complex scientific ideas and new findings into various formats including lectures, workshops, lab visits, and exhibits, with the goal of making science accessible to audiences of diverse ages and backgrounds.

### Guiding teenagers toward science

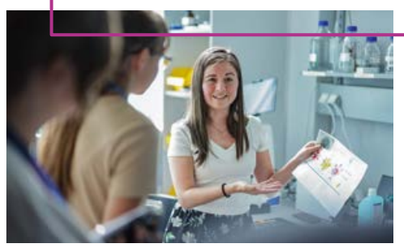
In 2023, IMBA researchers worked with aspiring young female scientists on Daughters' Day, participants of the Austrian Science Olympiads and the Kharkiv-Vienna International Science School. Interested teenagers were engaged in science topics ranging from cell fate in embryos to DNA organization in cell division and brain dysfunction. Besides hands-on learning about molecular biology, students had a chance to discover career paths in science.



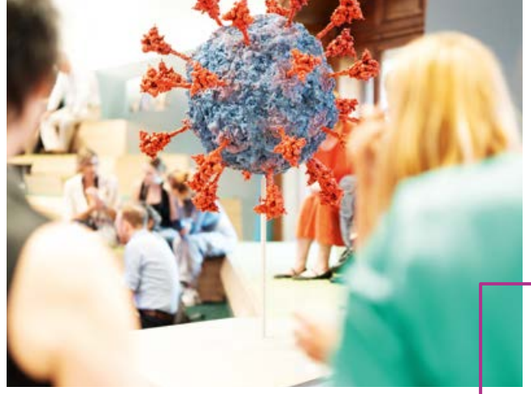
IMBA welcomed winners of the 2023 All-Ukrainian Science Olympiads. In workshops with the Gerlich and Grade labs, the students learned how researchers at IMBA make use of advanced technologies to explore fundamental biological processes.

On Daughters' Day, aimed at girls to discover careers in STEM, teenage visitors learned about early embryonic development and the technologies the Jachowicz lab uses. With the aid of microscopes, students viewed early mouse embryos and their derived stem cells.

IMBA hosted students who represented Austria at the International Science Olympiads. Visitors explored the Stem Cell Core Facility, where they observed how stem cells are cultured and used in research to understand development and disease.



Maria Nazareth Gonzalez Alvarado from the Grade group, explained the role of glial cells in the brain, and showed brain cells under the microscope.



A scientifically accurate model of SARS-CoV-2 is showcased at Deck 50 of the NHM. To put it in perspective, if a human were to be enlarged in the same manner as this virus model, the human would be larger than planet Earth.

### IMBA's cooperation with the Natural History Museum Vienna

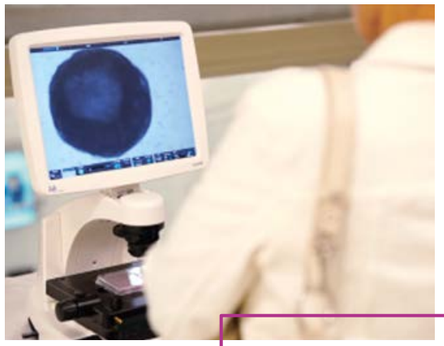
The Graphics Department and the Mechanical Engineering Center collaborated with the Natural History Museum Vienna to develop a realistic model of SARS-CoV-2 for the science communication space Deck50. In addition, IMBA scientists presented at science communication events held at the NHM, showcasing research on organoids and bat viruses.

### Organoid research at the European Researchers' Night

Among a crowd of 4,000 visitors at the European Researchers' Night, researchers from the Knoblich, Rivron, and Mendjan labs shared insights into organoid research. Visitors learned about the cultivation of organoids derived from human stem cells in laboratory settings and their crucial role in studying human development and disease mechanisms.

Theresa Sommer from the Rivron group shows children how to use pipettes, a fundamental tool in daily research activities.

Anna Bandura from the Mendjan group shows heart organoids to visitors, explaining how organoids are used to study the human heart.



Visitors observed beating heart organoids under the microscope.


## Health Science Forum Vienna II: Joint initiative of IMBA and Merck on personalized medicine

The 2nd edition of Health Science Forum Vienna, a joint initiative of IMBA and Merck, focused on advances in personalized medicine. The event offered a valuable platform for networking between researchers, representatives from the pharmaceutical industry, and policymakers.

HSFV II included keynote speeches and a panel discussion with Martin Moder, Stanley Sweeney-Lasch (Merck), Sashan Mendjan (IMBA), Jürgen Knoblich (IMBA), Leif Moll (Merck) and Herwig Ostermann, moderated by Ruth Hutsteiner.

## New in 2023 – Collaboration with KinderuniWien

IMBA and KinderuniWien engaged children in two hands-on workshops, exploring stem cells and how genetic information is used to construct proteins. Participants gained practical insights into fundamental biological processes and essential laboratory techniques.

Nina Malajner, (pictured), Theresa Sommer, Anna Bandura, and Sina Metzler introduced children to stem cells, microscopy and pipetting activities.


Uladzislava Khauratovich (pictured) and Emma Rusch from the Goloborodko group, along with Sina Metzler, explored how genetic information is converted into proteins. Participants constructed their own protein models.



## New in 2023 – Organoid workshop in the Vienna OpenLab

PhD student Christian Lehmann from the Knoblich group, in collaboration with the Vienna Open Lab, developed a special two-day workshop on organoid research to celebrate IMBA's and the Open Lab's 20th anniversary. Through hands-on experience in generating and examining embryonic bodies, participants deepened their understanding of stem cell research and laboratory practices, focusing on the application of brain organoids in medical research.

Christian Lehmann, PhD student in the Knoblich lab, showcases embryonic bodies under a microscope, broadening participants' understanding of stem cell research and lab practices.

VIENNA BIOCENTER CAMPUS

# Community *and* culture

## Activities and initiatives bring together the community at IMBA and the Vienna BioCenter.

**The Vienna BioCenter brings together individuals from a wide array of cultural backgrounds and nationalities. IMBA and the other research institutes on campus organize and support a range of initiatives that connect the community through networking events and activities.**

### 20th Vienna BioCenter PhD-Symposium – "A Mixtape of Science"

In 2023, the annual Vienna BioCenter PhD Symposium celebrated two decades of student-led scientific collaboration and networking. Organized by the PhD student community, research staff and the Scientific Training team, this year's program featured talks about stem cells, emerging technologies, genetics and epigenetics, biochemistry, and cancer and immunity from global experts.

### Industry Insights

The student-driven Vienna BioCenter Industry Insights (VBCII) initiative fosters connections between Vienna BioCenter scientists and the life sciences industry. This year, VBCII partnered with the venture capital enterprise Wilbe and the management consulting firm Kearney to organize two events where over 100 attendees could explore career options beyond academia.

### Equity, Diversity & Inclusion

The Equity, Diversity & Inclusion volunteer group is committed to promoting an even more inclusive and socially aware community. Initiatives in 2023 included seminars addressing culture shock in international teams, inequalities and leadership in science and the strengths and challenges of neurodiversity in academia.

### Mental Health Awareness Campaign 2023

The "MIND MATTERS" initiative focuses on elevating mental health awareness, destigmatizing seeking support, and promoting self-care practices within the academic sector.

### Vienna BioCenter Parents

The Vienna BioCenter provides a knowledge-sharing platform for all things coming up in family life, which supports those members of the community embarked in the journey of parenthood.

### Social hours

Each Friday evening one of the labs at IMBA, the GMI or the IMP organizes a social hour that expresses the unique identity of each research group through specially themed decoration, entertainment, and refreshments.

### Sports initiatives

The Vienna BioCenter provides a wide range of activities catering to all interests and fitness levels, including running, hiking and cycling clubs, outdoor bodyweight training and subsidized activities like CrossFit, paddle tennis, beach volleyball, yoga, and Tai-Chi.

### Amateur Dramatic Club

Since 2008, the Amateur Dramatic Club (ADC) presents three to four theatrical productions each year, including the Christmas Play: a pantomime that creatively parodies well-known movies or books, cleverly integrating familiar faces and locations from the Vienna BioCenter.

### Musicians @ VBC

A strong network makes it possible for musicians, vocalists, and music enthusiasts to work together to create, perform, and enjoy music of all kinds, and supports a range of musical events held on campus.

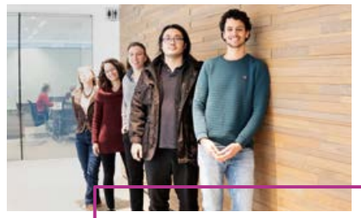
### Climate Initiative

The Vienna BioCenter is committed to reducing the environmental footprint of its research institutes by adopting new sustainable research procedures that reduce energy consumption and waste generation.

### Charity activities

Members of the Vienna BioCenter organize and engage in charity activities addressing various societal problems. In 2023, significant contributions have provided humanitarian aid and support for Ukrainian refugees in Vienna.


Sports activities unite individuals from a range of backgrounds and nationalities.

Researchers at the Vienna BioCenter spearhead several initiatives, including the EDI Group, the organization of the PhD Symposium, or the Industry Insights talk series.

The Amateur Dramatic Club presents several productions per year, each a highlight for the campus community.

# *Supporting* excellent science

## The administrative and infrastructure teams support researchers at IMBA with a range of expertise.

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


Administration & Infrastructure

### Administration

The **Scientific Office** organizes seminars, conferences, the annual recess and SAB meetings, and prepares scientific reports.

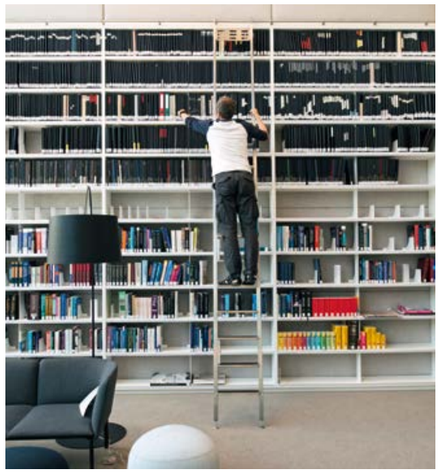
The **Finance Department** is responsible for accounting, financial controlling, and financial reporting.

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.

DONORS & SPONSORS

# Partners and donors *support* science at IMBA

## Project partners, sponsors and private donors provide vital support for research at IMBA.

Scientific excellence is strengthened by individual commitment. Since 2003, IMBA has thrived, also thanks to the support from dedicated individuals and stakeholders. IMBA would like to thank all its supporters, donors, and partners for their contributions to scientific progress.

A special note of appreciation is due to over 1000 donors who, since 2017, have generously funded research to understand the rare disease Diamond Blackfan Anaemia. This research is a collaborative effort between the Penninger lab at IMBA and the Martinez Lab at the Max Perutz Labs. Thanks to the initiative of Boris and Marianne Marte along with Josef Penninger and Javier Martinez, more than 1 million Euro has been raised for this significant project.

Boris Marte, Javier Martinez and Marianne Marte joined the 20th anniversary celebrations.

Research into Diamond Blackfan Anaemia has been supported by 1 million Euro in private donations.



## Sponsors in 2023

- Austrian Academy of Sciences
- Additional Ventures/Single Ventricle Research Fund
- BIF Boehringer Ingelheim Fonds
- European Molecular Biology Organization (EMBO)
- European Research Council
- FFG
- Federal Ministry of Education, Science and Research
- FWF-Österreichischer Wissenschaftsfonds
- Fundacio La Marato de TV3
- Human Frontier Science Program (HFSP)
- Japan Society for the Promotion of Science (JSPS)
- La Caixa Banking Foundation
- National Research Foundation of Korea (NRF)
- Simons Foundation
- Stadt Wien
- T. Zastrow Foundation
- The Swedish Research Council
- WWTF
- Wirtschaftsagentur Wien

## Partners in 2023

- Eppendorf
- feratel technologies AG
- IV Wien
- Kinderuni Wien
- LGT Private Banking
- Merck Austria
- NHM/Deck 50
- Open House Wien
- Open Science
- Österreichische Lotterien GmbH
- Stiftung Philanthropie Österreich
- Thermo Fisher
- Vienna Open Lab
- Wiener Städtische Versicherung
- Wiener Städtische Versicherungsverein

SCIENTIFIC ADVISORY BOARD

# Striving for *excellence*

## The scientific advisory board supports IMBA in conducting research at the highest level.

To maintain the highest standard of research, IMBA has installed a process of review and feedback: The Scientific Advisory Board (SAB), consisting of internationally recognized scientists, meets yearly at IMBA, and, together with IMBA researchers, evaluates the quality, significance, and focus of research conducted at IMBA.

### Elaine Fuchs, Chair

The Rockefeller University

### Gregory Hannan

Cancer Research UK Cambridge Institute (CRUK), University of Cambridge

### Eric Kandel

Columbia University in the City of New York

### Guido Kroemer

Paris Descartes University; INSERM; Institut Gustave Roussy

### Maria Leptin

European Research Council

### Gary Ruvkun

Massachusetts General Hospital; Harvard Medical School



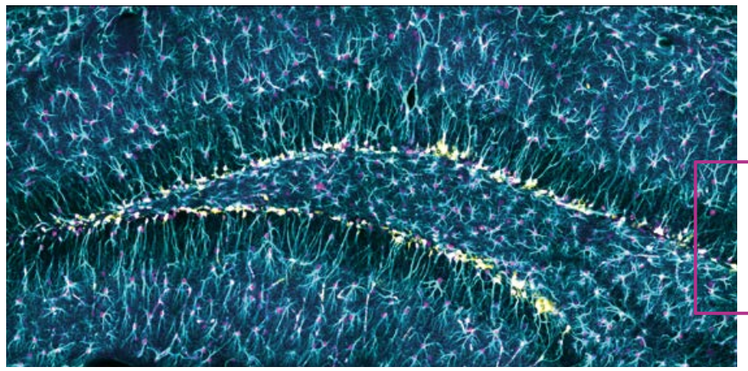
THE AUSTRIAN ACADEMY OF SCIENCES

# Strong *support*

## The Austrian Academy of Sciences, the leading non-university institution for research in Austria, funds and supports IMBA.

IMBA is the largest 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 fostering societal dialogue, disseminating new knowledge, and conducting foundational 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 IMBA.



Astrocytes and stem cells in the dentate gyrus, a part of the hippocampus.

## Imprint


**Published by**
IMBA - Institute of Molecular Biotechnology
of the Austrian Academy of Sciences
Dr-Bohr-Gasse 3
1030 Vienna, Austria
www.imba.oeaw.ac.at

**Editors**
IMBA Communications (Adam Cooper, Sophie Fessl, Manel Llado, Sina Metzler, Sylvia Weinzettl, Barbara Weigel)

**Graphic Concept & Design:**
The Gentlemen Creatives

**Printing house:**
Riedel Druck GmbH, 2214 Auersthal

**Photo & image credits:**
ATP Architekten
Astrid Bartl
Paul Batty/Daniel Gerlich/EMBO J
Lukas Beck
Julius Brennecke
Andreas Buchberger /LISAVienna
Domagoj Cikes
Adam Cooper
Joseph Cruz
Amarbayasgalan Davaatseren
Alison Deyett
Peter Duchek
Daniel Gerlich
Robert Herbst
Daniel Hinterramskogler
Johannes Hloch
Oliver Höller
IMBA-IMP Graphics
Joanna Jachowicz
Izabella Kaminski
Tatjana Kepcija
Mehdi Khadraoui
Chong Li
Manel Llado
Benedikt Mandl
feelimage / Matern
Lisa Meadows
Sasha Mendjan
Beata Mierzwa
Sina Metzler
Nadja Milivojev
Klaus Pichler
Luiza Puiu
Michael Sazel
Sandra Schartel
Ludwig Schedl
Moritz Schell
ÖAW




# Location


**IMBA**
INSTITUTE OF MOLECULAR BIOTECHNOLOGY
OF THE AUSTRIAN ACADEMY OF SCIENCES

Dr.-Bohr-Gasse 3
1030 Vienna, Austria

office@imba.oeaw.ac.at
www.imba.oeaw.ac.at