TRA

Transdisciplinary Research Area

LIFE AND HEALTH

UNIVERSITÄT BONN

“As an academic institution at the interface between the life and medical sciences, the **TRA LIFE AND HEALTH** is focusing on the understanding of life at the systems level, and the reciprocal interactions of these systems with the environment.”

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In a nutshell

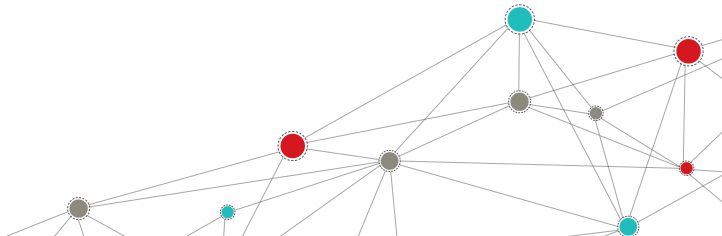
With the research program *Construction and Deconstruction of Life*, scientists at the TRA Life and Health aim to decipher the mechanisms underlying life and to provide the basis for a better understanding of diseases and the development of new therapies. The TRA Life and Health is represented mainly by members from the Faculty of Medicine, the sections of Molecular Biomedicine, Biology, and Pharmacy of the Faculty of Mathematics and Natural Sciences, the section of Psychology of the Faculty of Arts, and the section of Nutrition in the Faculty of Agricultural, Nutritional and Engineering Sciences, respectively. As an academic institution at the interface between the life and medical sciences, the TRA, together with the Cluster of Excellence „ImmunoSensation²“, is focusing on the understanding of life at the systems level, and the reciprocal interactions of these systems with the environment, as well as the development of new strategies for improving and sustaining health. This will be achieved by educating a new generation of students in an interdisciplinary setting including life, medical, computational, biological, pharmaceutical, physics and chemical sciences and by an accelerated transfer of knowledge and expertise to society and the private sector. To integrate these views, we have developed a “leitmotif”-narrative termed *Construction* and *Deconstruction of Life* which integrates our views into a coherent conceptual framework.

Furthermore, linking of TRA Life and Health efforts with other Uni Bonn TRAs, will progressively yield novel approaches that will improve basic understanding, diagnostics and treatment of common human disorders.

Deconstruction of Life

Applying Novel Mathematical Tools to Arrive at Predicitive Models and Theories

TRA scientists apply cutting-edge tools to the analysis of complex biological systems such as the immune and nervous systems, in a range of organisms ranging from simple model organisms to the human. To link high-dimensional datasets at different scales of complexity to behavior, or disease phenotypes the TRA increasingly employs expertise in Mathematics and Computational Biology to establish a close link between Biology and theory. Moreover, novel intelligent and machine learning systems will be extremely useful for understanding complex disorders of e.g. the immune system and the brain.



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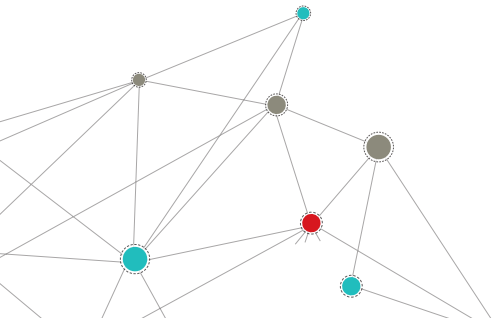
Construction of Life

Multiscale Analysis, Modeling and Engineering

We propose implementing a complementary strategy aimed at constructing reductionist systems of living matter. This novel strategy will leverage recent breakthroughs in stem cell technology, gene editing, nano-engineering of biomaterials or semi-synthetic biohybrids towards the generation of deterministic or self-organizing models of development and disease. Ranging from complex 2D cell cultures via 3D systems and organoids to chimeric tissues and in vivo models, this line of research is expected to provide unprecedented insight into the mechanisms underlying tissue development and disease in a human-specific context.



TRA spokespersons

TRA Life and Health is represented by the spokespersons Prof. Dr. Heinz Beck (Institute of Experimental Epileptology and Cognition Research) and Prof. Dr. Elvira Mass (LIMES-Institute). Elvira Mass took over the mission from Prof. Dr. Waldemar Kolanus (LIMES-Institute) in Nov. 2024.

Why am I a spokesperson in the TRA?

Prof. Dr. Heinz Beck
"One of the challenges in science in general is the creation of truly new and innovative thoughts, and to develop them to theories and successful experiments. I believe that new connections between branches of science that have not previously interacted much is a breeding ground for such developments, and I was excited to participate in the TRA concept."

heinz.beck@ukbonn.de

Why am I a spokesperson in the TRA?

Prof. Dr. Elvira Mass
"I believe that the most transformative discoveries arise when researchers step beyond disciplinary boundaries to collaborate and tackle complex questions. With my experience in fostering interdisciplinary dialogue and connecting diverse perspectives, I aim to actively contribute to shaping innovative ideas and driving the TRA's vision forward."

elvira.mass@uni-bonn.de

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TRA manager

Dr. Meike Brömer

The TRA management team has several important functions. It serves as an interface between scientists, Rectorate and administration. The TRA managers act as a „transmission belt“ to implement the strategic goals of the Rectorate, interconnect the TRAs, and administer all TRA functions in close cooperation with the spokespersons and the TRA's governing bodies. They take a major role in developing and coordinating TRA activities as well as reporting and presenting the TRAs to different target groups. As a key area of work, the TRA managers provide administrative and strategic advice to (future) TRA projects, and foster inter- and transdisciplinary networking of scientists from all career levels. Furthermore, TRA managers were closely involved in the recruitment of the high-profile professorships.

m.broemer@uni-bonn.de

life-and-health@uni-bonn.de

+49 228 73 54470

Hertz Chair

Hertz Chair for
Artificial Intelligence and Neuroscience

Prof. Dr. Dr.
Dominik Bach

In Bonn, Dominik Bach was the responsible spokesperson for an excellence cluster initiative seeking to integrate between Circuit, Clinical and Cognitive Neuroscience, and Computer Science, in order to understand naturalistic behavior across species boundaries and in clinical conditions.

Dominik Bach joined the University of Bonn in April 2022.

@ d.bach@uni-bonn.de

Understanding the brain with Artificial Intelligence

How do people behave in extreme situations?

Dominik Bach uses models and methods from Theoretical Neuroscience and Artificial Intelligence to decipher the function of the human brain. The brain uses mathematical operations to control its actions. Bach's research aim is to characterize these operations on an abstract level. He and his team analyze human behavior and neural population activity in extreme situations to investigate the limitations – and thus the functioning – of these mechanisms. The research team simulates critical danger in in virtual reality, allowing them to record how humans make rapid critical decisions. Using wearable magnetoencephalography, they track neural activity from deep brain sources at mesoscopic level.

Argelander Professor for
Organoids and Chemical Biology

Jun.-Prof. Dr. **Elena Reckzeh**

Being at the interface of multiple disciplines (Chemical Biology, Pharmacology, Medicine and Biology), Elena Reckzeh strengthens cross-disciplinary research efforts within the University of Bonn and beyond (Bonn-Melbourne Research Excellence Fund). Furthermore, Elena Reckzeh joined the steering committee of the Women in Science (LIMES-Institute) and the organoid club (TRA).

Elena Reckzeh joined the University of Bonn in April 2023.

ereckzeh@uni-bonn.de

Finding new biologically active substances to study metabolic phenomen

Elena Reckzeh uses stem cell-derived model systems of the gut (organoids, mini-organs) and colon tumors (tumor organoids) to study extrinsic and intrinsic influences on nutrient uptake, dependence and flexibility. She is especially interested in key regulators mediating metabolic adaptation. Her group has established organoid models to find new biologically active substances (compounds) to study metabolic phenomena.

Elena Reckzeh contributes to the *Construction* arm of the TRA research profile. Providing the knowledge on cutting-edge organoid models significantly expands the range of technologies available within TRA Life and Health.

Argelander Professorship

Using "mini-organs" to study disease

Argelander Professor for
Organoid Biology

Jun.-Prof. Dr. **Ana Ivonne Vazquez-Armendariz**

Ana Ivonne Vazquez-Armendariz is an active member of the Organoid community in Bonn including the organoid club and the "3R Competence Network NRW". Ultimately, her research goal is to dissect the cellular and molecular crosstalk between lung epithelium and immune cells occurring during lung development, injury, and repair.

Ana Ivonne Vazquez-Armendariz joined the University of Bonn in April 2023.

@ vazquez@uni-bonn.de

Ana Ivonne Vazquez-Armendariz focuses on the use of complex three-dimensional lung organoid systems from murine and human adult somatic stem cells and human induced pluripotent stem cells (iPSCs) to model lung development and disease. Particularly, her lab will invest major efforts towards the vascularization of human lung organoids (LIMES, ImmunoSensation^2, TRA connections).

In addition, she will employ immune-competent fat organoids from mouse and human sources to model white adipose tissue macrophages-adipocytes interactions regulating lipid metabolism including triglyceride cycling during metaflammation (CRC1454).

TRA key figures 2020 – 2024

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158

members

31

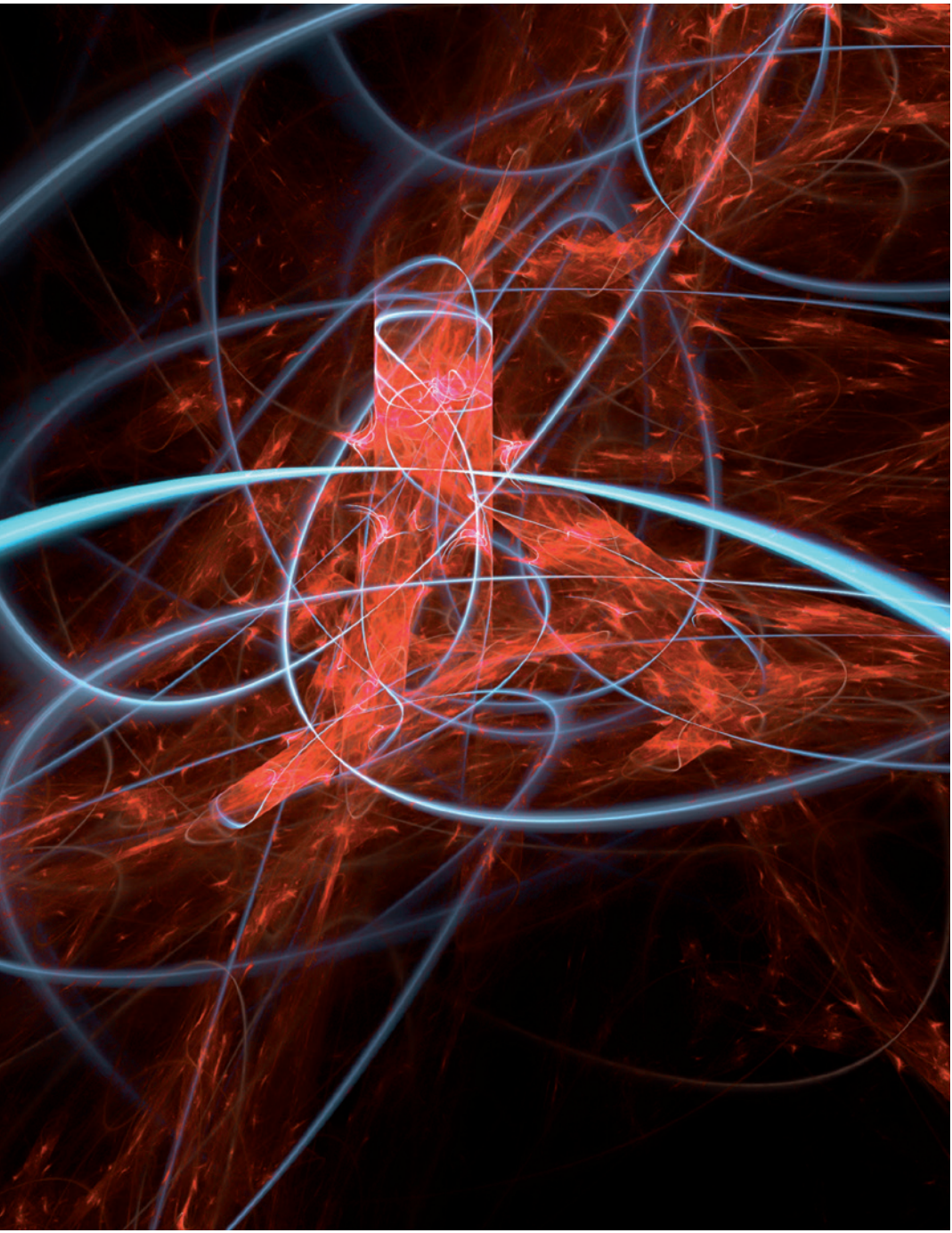
funded projects

22

networking events

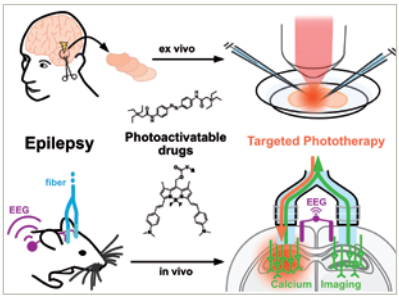
€ 895,045

money spent



Antiepileptic Drugs with Light Switch

Pharmacist Prof. Dr. Christa Müller and neurologist PD Dr. Michael Wenzel have worked together in this project – awarded with the Life and Health Research Prize 2020 – to develop a pharmacological approach that may in future be used to treat epilepsy patients. To this end, the researchers develop so-called photo-activatable agents. The special feature of this type of drugs is that they only have an effect when they are illuminated with light. This allows doctors to „switch them on" at exactly the place and time in the body where they are needed, a concept that may result in considerably fewer side effects. In their project, the researchers are working on chemically modifying the substances phenytoin, propofol and others in such a way that they only become active when exposed to light of a certain wavelength. To make these substances light-switchable, the pharmacists around Christa Müller have first created the corresponding compounds and characterized them.



Model systems for testing photo-activatable anti-epileptic drugs.

In the further course of the project, the biomedical researchers around Michael Wenzel are now testing how they can use optical fiber implants to „switch on" the active ingredients in the brains of mice in a targeted manner to combat epileptic seizures. Alongside a substantial reduction of medical adverse effects, this project might pave the way for novel, highly efficacious antiepileptic drugs. Importantly, the preliminary work funded by the TRA Research Prize has provided the basis for M. Wenzel's successful subsequent ERC Starting Grant application to continue working on this promising project.

Life and Health Matter(s)

Networking Event

TRA scientists are listening to the guide's explanation of an artistic brain model.

Chemistry and Physics play an important role in many areas of the life sciences – and vice versa. For example, when it comes to developing new detectors for diagnostic imaging or developing chemical compounds so that they can be used in imaging or drug development.

But how do researchers from these different fields get to know each other? To stimulate an exchange between members of the TRAs Building Blocks of Matter and Fundamental Interactions (TRA Matter) and Life and Health, we invited scientists to an extraordinary networking event entitled "Life and Health Matter(s)" on May 31, 2022. A special location, the Bundeskunsthalle in Bonn, an inspiring guided tour through the exhibition "The Brain in Art and Science", short presentations in "FlashTalks" and exchange in randomly arranged small groups – for all participants this event was a complete success. In addition to an exchange with scientists from the other TRA, there was also the opportunity to establish new contacts between researchers within each TRA. Due to the pandemic, networking had come up far too short up to this point.

Remarkably, this event even led to an equally successful follow-up workshop: some TRA members identified issues with data science as shared topic in one of the randomly assembled groups and got motivated to organize the workshop "TeRAbytes - Strategies for Data Science and Data Management", which took place in January 2023.

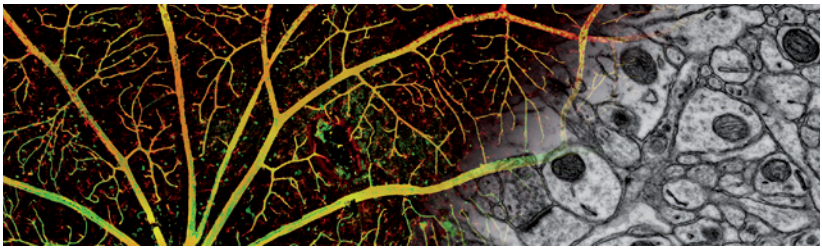
A Think Tank for Technologies

There are several instances in which the TRA Life and Health has been instrumental in placing new ideas, concepts and technologies center stage, and transforming them into actual structures and projects.
A large steering committee with representatives of all major scientific fields in the area of Life and Health in Bonn, as well as the deans of the three connected faculties, has served as a think tank and discussion forum to integrate views and ideas beyond disciplines, faculties and third-party funded consortia.

One important topic for this discussion forum over the past years has been to generate a university-wide technology support structure that supplies cutting-edge life science technologies, is available to all university members, and operates with harmonized standards.

TRA spokesperson Heinz Beck was the founder of the technology platform "Bonn Technology Campus Life Sciences" (founded 2016), originally carried by the Medical Faculty. This platform provides access to state-of-the art technologies and instruments which are operated as pay-for-service facilities with professional core facility managers and staff. These facilities are run and subsidized by the Medical Faculty but are open to all university members. Besides these, several other facilities and research infrastructures for the life sciences exist at the Mathematics and Natural Sciences Faculty or the Agricultural, Nutritional and Engineering Sciences Faculty with different organizational structures and conditions of use.

With the vision for a harmonized core facility structure for life science technologies at the University of Bonn, TRA Life and Health (represented by the two spokespersons Heinz Beck and Waldemar Kolanus) has initiated a process that has led



to an intense dialogue between the deans of the three faculties, the rectorate, Bonn Technology Campus and the university's Research and Innovation Service. The core facilities concept originally established at the Medical Faculty may serve as a best practice example also for university-wide research infrastructures. These coordinated efforts towards coherent and service-oriented core facility structures at the University of Bonn strongly demonstrate the added value of a Transdisciplinary Research Area for conceptualization and triggering of new structures and across the borders of faculties. As of 2025, a central Core Facilities and Technology Platforms Office at the Research and Innovation Services Department coordinates efforts across the rectorate, faculties, TRAs and administration.

"True innovation in understanding and treating human diseases has frequently relied on a cross-fertilization between Medicine and other disciplines, such as Mathematics, Computer Science, Physics and Chemistry. At the same time, establishing such new strategies has wide-ranging implications across disciplines, from Law, Economics, and Social Sciences to Ethics and Philosophy. In this sense, transdisciplinarity is a de-facto requirement for the medical science of the next decade. The TRA 'idea space' has been a perfect area to support conceptual development, which has already led to a number of important novel transdisciplinary projects and initiatives."

Prof. Dr. Bernd Weber, Dean, Medical Faculty

3 questions to ...

Prof. Dr. Jan Hasenauer

Schlegel Chair of the Faculty of Mathematics and Natural Sciences

The strategic requirement for education at the interface of Life Sciences and Mathematics, and discussions within the steering committee of the TRA, the TRA spokespersons with rectorate and TRA members has led to an initiative for a new Master's program "Biomedical Data Sciences", as a joint course of the Medical Faculty and the Mathematics and Natural Sciences Faculty. This initiative is headed by Prof. Dr. Jan Hasenauer, Schlegel Chair of the Mathematics and Natural Sciences Faculty.

Jan, what has motivated you to initiate the establishment of a new Master's course "Biomedical Data Sciences"?

The amount of biomedical data is rapidly increasing. To exploit this source of information for research, prevention and treatment, we need individuals familiar with advanced computational and mathematical approaches as well as Biology and Medicine. Currently, we do not have such an interdisciplinary training program. This is the reason why a group of about 30 professors, including me, decided to initiate the establishment of this new Master's program.

How has the field of Mathematical and Computational Life Sciences developed over the past years at the University of Bonn?

The development has been amazing, and I'm happy to be a part of it! The commitment of the two Custers of Excellence, "Hausdorff Center for Mathematics" and "ImmunoSensation^2", allowed the establishment of three new professorships. This sparked the establishment of an Interdisciplinary Research Unit with more than 40 PhD students and PostDocs, which is currently transformed into a new Center for Mathematical Life Sciences. Yet, beyond this, there have been various other hires and a massive development on a broad front. We see now an interconnection of Mathematics, Computer Sciences, Life Sciences and Medicine on an unprecedented level.

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Your research field lies at the interface of TRA Modelling and TRA Life and Health. How can the TRAs further support research between disciplines?

The continuous support from TRA Modelling and TRA Life and Health, as well as by the rectorate and the faculties, was instrumental for positive development. The start-up funding for exploring new research directions was particularly relevant. However, beyond this, it would be great if the TRAs could contribute to providing outstanding young scientists, for whom we are rather certain that they will succeed in their scientific careers and who come with innovative research ideas, with an early and clear perspective. We lose far too many bright minds, especially women, due to uncertainties along the career trajectory. Mitigating these uncertainties to some degree, for example, through a small pool of fixed positions that are very likely to be opened up again due to the selection of candidates, would, in my opinion, be very valuable.

“The amount of biomedical data is rapidly increasing. To exploit this source of information for research, prevention and treatment, we need individuals familiar with advanced computational and mathematical approaches as well as Biology and Medicine.”

TRA steering committee

TRA spokespersons

Prof. Dr. Heinz Beck,
Institute of Experimental Epileptology and Cognition Research

Prof. Dr. Elvira Mass, LIMES-Institute

TRA manager

Dr. Meike Brömer,
Staff Unit for Strategic Development and Quality Assurance

ex officio members

Prof. Dr. Dr. Dominik Bach,
Hertz Chair for Artificial Intelligence and Neuroscience

Jun.-Prof. Dr. Elena S. Reckzeh,
Argelander Professor for Organoids and Chemical Biology

Prof. Dr. Heiko Schoof,
Dean of the Faculty of Agricultural, Nutritional and Engineering Sciences

Jun.-Prof. Dr. Ana Ivonne Vazquez-Armendariz, Argelander Professor for Organoid Biology

Prof. Dr. Bernd Weber,
Dean of the Faculty of Medicine

Prof. Dr. Walter Witke,
Dean of the Faculty of Mathematics and Natural Sciences

Professorial members

Prof. Dr. Dirk Baumjohann,
Medical Clinic III for Oncology, Hematology, Immuno-Oncology and Rheumatology

Prof. Dr. Oliver Brüstle,
Institute of Reconstructive Neurobiology

Prof. Dr. Nicolas Gompel,
Bonn Institute for Organismic Biology

Prof. Dr. Jörg Höhfeld,
Institute for Cell Biology

Prof. Dr. Waldemar Kolanus,
LIMES-Institute

Prof. Dr. Christa Müller,
Pharmaceutical Institute

Prof. Dr. Markus Nöthen,
Institute of Human Genetics

Prof. Dr. Alexander Pfeifer,
Institute for Pharmacology and Toxicology

Prof. Dr. Florian I. Schmidt,
Institute of Innate Immunity

Prof. Dr. Anja Schneider,
DZNE and Clinic for Geriatric Psychiatry and Cognitive Disorders

Jun.-Prof. Dr. Marie-Christine Simon,
Institute of Nutritional and Food Sciences

Prof. Dr. Tatjana Tchumatchenko,
Institute of Experimental Epileptology and Cognition Research

Prof. Dr. Sebastian Zimmer,
Medical Clinic and Polyclinic II

Representation of university status groups

ACADEMIC STAFF

Annalena Liesen,
Department for Developmental Pathology

Katharina Sieckmann,
Institute of Innate Immunity

STUDENTS

Bianca Broske (Medicine)

Theresa Eulgem (Immunobiology)
Deputy

ADMINISTRATIVE AND TECHNICAL STAFF

Dr. Elmar Endl,
Core Facilites and Technology Platforms Office

TRA
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IMPRESSUM

Publisher
University of Bonn
Rectorate
Dechenstraße 3-11
53115 Bonn (Germany)

Editorial staff
Dr. Meike Brömer
Dr. Ines Heuer (resp.)
Dr. Katja Fels
Sandra Gelfert

Concept and design
Magdalena Franke, POLAR BLAU
Kathrin Strahl, STUDIO STRAHL

Date of issue
June 2025

Photo credits
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TRA Life and Health

life-and-health@uni-bonn.de,
uni-bonn.de/en/tra-lifeandhealth

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