Spring 2025

PRO LOEWE NEWS

The LOEWE research initiatives report

EXCELLENT HESSE

SPECIAL EDITION

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THE EXCELLENCE STRATEGY: STRENGTHENING CUTTING-EDGE RESEARCH IN GERMANY AND HESSE – ALSO THANKS TO LOEWE RESEARCH FUNDING

The Excellence Strategy is an important agreement between the federal and state governments that aims to sustainably promote cutting-edge research and strengthen the international competitiveness of German universities - and thus also of Germany as a business location. It is the successor to the Excellence Initiative and is divided into two central funding lines: clusters of Excellence and Universities of Excellence.

Clusters of Excellence funding line. Clusters of Excellence are selected and assessed on the basis of scientific selection procedures. These procedures are carried out by the German Research Foundation (DFG) and the German Council of Science and Humanities on behalf of the federal and state governments. The aim is to promote internationally competitive research fields at universities and in university consortia, whereby up to 70 clusters can be funded with between 3 and 10 million euros per year. For the first funding phase of initially seven years (starting in 2019), a total of a total of 57 clusters of excellence were selected.

Hessian successes. "CPI", a Hessian project, and "POLiS", a project with Hessian participation, are also among the clusters of excellence in the first funding phase!

Future prospects: On February 1, 2024, the panel of experts selected 41 outlines to submit for the second funding phase from 2026. Five more projects qualified here: "RAI", "TAM", "CoM2Life", "MC4" and "SCALE". Together with "CPI" and "POLiS", this makes seven Hessian projects or projects with Hessian participation that are already excellent or have a good chance of becoming excellent.

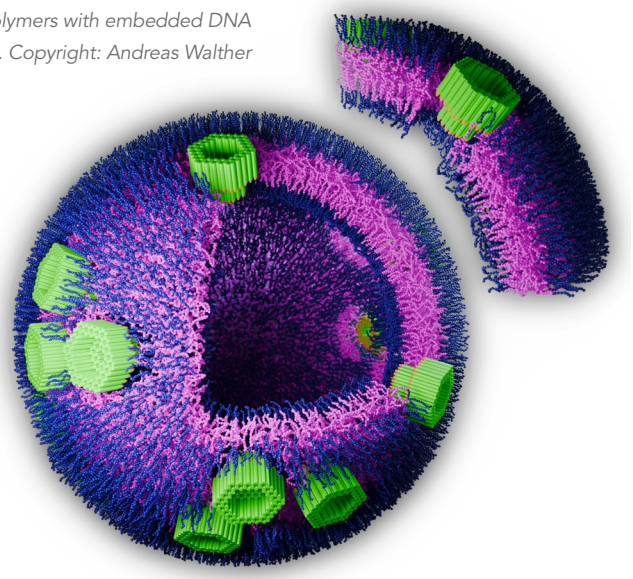
The long road to a cluster of excellence – LOEWE provides support. Clusters of excellence are an important part of the long-term strategic and thematic planning of universities. The last call for clusters of excellence took place in December 2022. From the very beginning, promising Hessian initiatives were supported by the state of Hesse with additional funding for the development of cluster projects. The draft proposals for the first selection round of new clusters of excellence were submitted to the DFG in May 2023 and the results of the review were announced in February 2024. The selected projects in the second round had a good six months to prepare a full proposal. Existing clusters of excellence submitted a follow-up application at the same time. The work on the full proposals is characterized by intensive professional and very close cooperation in the consortia, each supported by 20-25 high-rankings researchers as well as the respective university management. The full proposals submitted by the cluster of Excellence candidates in August 2024 were reviewed in detail by the DFG in Bonn between October 2024 and February 2025. To this end, the clusters and the participating university management teams faced international expert groups in presentations and interviews lasting several hours. The decision on funding as a cluster of Excellence will be made in May 2025; the actual funding of the selected projects will then start on January 1, 2026 for a period of seven years.

What comes next: University of Excellence. In addition to the clusters of Excellence, the Universities of Excellence funding line enables individual universities or consortia to be strengthened. The prerequisite for this is to have successfully acquired at least two clusters of excellence (three in the case of consortia). The Rhine-Main Universities of Frankfurt, Mainz (in Rhineland-Palatinate, however, part of the Rhine-Main Network) and Darmstadt as well as the Universities of Marburg and Giessen have promising chances of applying – whether individually or jointly.

The importance of LOEWE for the Excellence Strategy. For the Hessian initiatives, the support of the state government within the framework of the LOEWE program is a decisive start-up aid. On the one hand, the start-up funding for the promising initiatives enables the consolidation of scientific integration within the respective consortia beyond the existing equipment of the participating institutes, thereby further increasing the scientific weight of the initiatives. On the other hand, they also create a framework for developing the formal and structural success factors of long-term research initiatives, which are not easy to organize in the day-to-day business of universities. Finally, the awarding of LOEWE professorships substantially improves the structural set-up of the initiatives and thus in turn increases the overall chances of the respective applications. But the influence of LOEWE funding on the clusters begins even before this. As can be clearly seen on the following pages, the proportion of scientists who have already conducted research in LOEWE projects is high. Overall, the importance of the LOEWE program on the path to research excellence in Hesse cannot be overestimated.

The significance for Hesse. With the Excellence Strategy and successfully acquired clusters of Excellence, Hesse is becoming a central player in top-level research in Germany. The combination of innovative projects and strategic partnerships lays the foundation for forward-looking scientific development.

Artificial cell based on block copolymers with embedded DNA origami nanopores for permeability control. Copyright: Andreas Walther



CoM2Life

TU Darmstadt, Johannes Gutenberg University Mainz, Max Planck Institute for Polymer Research in Mainz

The vision of the *Convergence Center for Life-Like Soft Materials and Biological Systems, "CoM2Life" – Communicating Biomaterials* is to revolutionize the field of soft biomaterials by integrating principles from living systems into synthetic materials to enable bidirectional communication and continuous interaction with living biological systems. Our approach combines chemistry-centered biomaterials design and synthetic biology-centered design of regulatory circuits, resulting in biomaterials that exhibit life-like properties such as signal sensing, processing, and actuation. This breakthrough towards biomaterials with an 'embodied intelligence' unlocks new possibilities for interactive crossregulation and adaptive co-development in future generations of biomaterials systems.

These advancements are expected to drive breakthroughs in medical research and personalized healthcare in the coming decades. Examples include feedback-regulated drug delivery, tissue models that can replace animal testing, metabolic regulation systems for tumor immunotherapy, tissue repair, and the engineering of artificial organs.

Communication sciences are also involved to foster trust and understanding in this highly interdisciplinary environment and develop effective communication strategies to address the challenges of misinformation in the world today.

Spokespersons: Prof. Dr. Andreas Walther, Prof. Dr. Tanja Weil and Prof. Dr. Heinz Koeppl
LOEWE contribution: LOEWE-CompuGene, LOEWE-FLOW FOR LIFE, LOEWE-iNAPO and LOEWE-Whitebox, Prof. Dr. Iryna Gurevych (LOEWE top professorship)

POLiS

Karlsruhe Institute of Technology (KIT), Ulm University with the Center for Solar Energy and Hydrogen Research for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW), Justus Liebig University Giessen

Batteries are what made the technological "revolution" of mobile devices possible in the first place. Batteries also play a central role in the energy and transportation transition. The scientists at "POLiS" (Post-Lithium Storage) have identified sustainable alternatives that do not require lithium and other critical materials. Although lithium occurs frequently, it is only found in low concentrations and is one of the most expensive raw materials to extract. POLiS Karlsruhe Institute of Technology (KIT), Ulm University with the Center for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW) and Justus Liebig University Giessen (JLU).

The "POLiS" cluster is now conducting research into batteries based on mobile sodium, magnesium, calcium, aluminum and chloride ions. These so-called post-lithium batteries could store energy more sustainably, be safer and offer a more cost-effective, long-term option for mass applications such as stationary and mobile energy storage.

With this concept, the Karlsruhe Institute of Technology and the Ulm University, together with the Center for Solar Energy and Hydrogen Research Baden-Württemberg and Justus Liebig University Giessen, won the 2018 Excellence Strategy of the German federal and state governments – as the only cluster of Excellence for battery research.

The Justus Liebig University Giessen is involved in the current cluster of Excellence at the Universities of Ulm and Karlsruhe, and the research results of the LOEWE focus area STORE-E, which was funded from 2013-2016, are being incorporated. JLU is now a co-applicant in the planned continuation of the cluster.

Spokespersons: Prof. Dr. Maximilian Fichtner, Prof. Dr. Helmut Ehrenberg and Prof. Dr. Axel Groß
LOEWE contribution: LOEWE-STORE-E

Battery research at JLU – Investigating the material structure of a battery with the help of X-rays. Copyright: JLU/Rolf K. Wegst

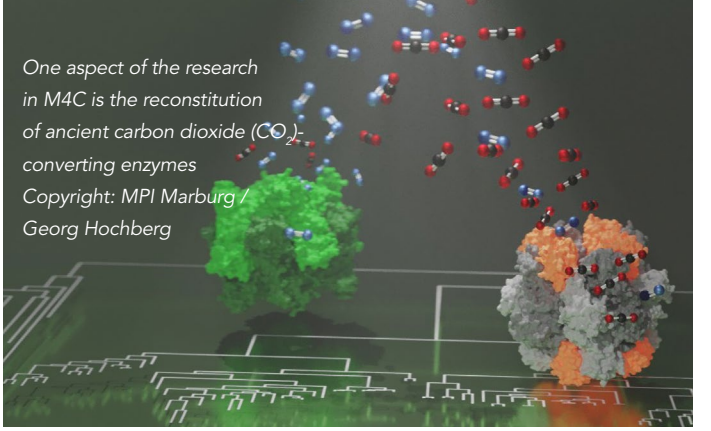
RAI

TU Darmstadt, Goethe University Frankfurt, University of Tübingen, Saarland University, Bremen University and Julius-Maximilians-Universität Würzburg

Over the past decade, deep learning (DL) has led to groundbreaking advances in artificial intelligence, and yet current AI systems still have notable weaknesses. For example, current AI systems lack logical reasoning, have difficulty dealing with new situations, need to be continuously adapted and require extensive resources. They are developed and used in an "unreasonable" way and require unreasonably large models, data, calculations and infrastructures, so that ultimately a few large companies with the necessary resources occupy a monopoly position.

The planned cluster of Excellence "RAI" (Reasonable Artificial Intelligence) under the leadership of TU Darmstadt in collaboration with researchers from the universities of Frankfurt, Tübingen, Saarland, Bremen and Würzburg aims to develop the next generation of artificial intelligence: AI systems that learn with a "reasonable" amount of resources based on "reasonable" data quality and "reasonable" data protection. They are equipped with "common sense" and the ability to deal with new situations and contexts, they are trained decentrally and are based on training paradigms that enable continuous improvement, interaction and adaptation.

Spokespersons: Prof. Dr. Kristian Kersting, Prof. Dr. Mira Mezini and Prof. Dr. Marcus Rohrbach
LOEWE contribution: LOEWE-CompuGene, LOEWE-DYNAMIC, LOEWE-emergenCITY, LOEWE-FLOW FOR LIFE, LOEWE-iNAPO and LOEWE-WhiteBox, Prof. Dr. Anna Rohrbach (LOEWE start professorships), Prof. Dr. Carsten Binning, Prof. Dr. Iryna Gurevych, Prof. Dr. Marcus Rohrbach, Prof. Dr. Mira Mezini (each LOEWE top professorships)



One aspect of the research in M4C is the reconstitution of ancient carbon dioxide (CO_2)-converting enzymes Copyright: MPI Marburg / Georg Hochberg

M4C

Marburg University, Max Planck Institute for Terrestrial Microbiology Marburg, Giessen University, University of Münster

A key driver of the climate crisis is the man-made imbalance in the carbon cycle. Microorganisms play a key role in the biological carbon cycle because they invented the conversion of CO_2 billions of years ago and made our planet a life-friendly world. Today, they convert about as much CO_2 globally as plants do. The aim of the Cluster of Excellence initiative "Microbes for Climate" (M4C) is to generate the knowledge base for a future balanced carbon cycle. "M4C" is dedicated to microbes that are still actively shaping our world and the carbon cycle and that have the potential to enable new biotechnological solutions for the conversion of CO_2. M4C researchers elucidate the basic mechanisms of microbial contributions to climate change, reconstruct how these mechanisms have evolved over Earth's history, and use synthetic biology to develop more efficient ways to sustainably convert the greenhouse gas CO_2. "M4C" is driven by Marburg University and the Max Planck Institute for Terrestrial Microbiology through two joint research centers, the Center for Synthetic Microbiology (SYNMIKRO) and the Microcosm Earth Center. In addition, researchers from Giessen University and the University of Münster contribute to the cluster.

Spokespersons: Prof. Dr. Anke Becker and Prof. Dr. Tobias Erb
LOEWE contribution: LOEWE RobuCop, LOEWE SYNMIKRO and LOEWE Tree-M, Prof. Dr. Katharina Höfer and Prof. Dr. Georg Hochberg (both LOEWE top professors)

TAM

Justus Liebig University Giessen, Philipps University Marburg, TU Darmstadt

One of the greatest challenges for any organism is to maintain stability in the face of a dynamic and uncertain world. At the same time, successful behavior also depends crucially on the ability to adapt when circumstances change fundamentally.

The aim of "TAM" (The Adaptive Mind) is, therefore, to understand the fundamental processes of human perception, thought, and behavior that enable us to adapt to constantly changing conditions.

The collaboration between Justus Liebig University Giessen, Philipps University Marburg, and TU Darmstadt brings together researchers from psychology, cognitive science, and neuroscience with experts in artificial intelligence, machine learning, and robotics to decode universal principles of the human mind and its adaptability, but also to understand what happens when these adaptive processes fail.

These findings from basic research are instantiated in computational models that can reproduce, predict, and explain both the successes and limitations of the human mind. Looking to the future, they play a crucial role in mental health and the development of safe AI and robotics technology.

Spokespersons: Prof. Roland Fleming, PhD and Prof. Dr. Katja Fiehler
LOEWE contribution: LOEWE-Dynamic, LOEWE-emergenCITY, LOEWE-FLOW FOR LIFE and LOEWE-WhiteBox, Prof. Dr. Stefan G. Hofmann (LOEWE top professorship)

Visualization of a cell with different compartments such as the cell nucleus and the endoplasmic reticulum (blue), mitochondria (orange-yellow) or the Golgi apparatus (pink). Copyright: Shau Chung Shin & Louise Düver

SCALE

**Goethe University Frankfurt,
Max Planck Institute of Biophysics,
Max Planck Institute for Brain Research
and Institute for Advanced Studies (FIAS)
all Frankfurt Main,
Johannes Gutenberg University Mainz,
Saarland University,
European Molecular Biology Laboratory**

The human body consists of trillions of cells. To perform their diverse functions, these cells are subdivided into specialized compartments, such as the cell nucleus, which protects genetic information, or the mitochondria, which are the cell's power plants. To form these compartments, the molecules of the cell must follow a complex self-organizing choreography that has thus far remained largely elusive. It is therefore also impossible to predict how the subcellular architecture changes under cellular stress, for example, during neurodegenerative diseases or ageing, when nuclear proteins mislocalize and aggregate in the cytosol or mitochondria develop abnormal substructures.

In the cluster of Excellence "SCALE" (SubCellular Architecture of Life), scientists are dedicated to studying cell compartmentalization. One of the main objectives of SCALE is to establish so-called digital twins, based on the integration of findings from various experimental approaches. Digital twins are created in high-performance computers through computer-aided modeling and machine learning. Once precisely developed, they allow the simulation of the function and malfunction of subcellular structures, enabling, as an example, the testing of therapeutic approaches in the computer.

Participants in the "SCALE" cluster of Excellence are the MPI for Biophysics, MPI for Brain Research, Frankfurt Institute for Advanced Studies (FIAS), Johannes Gutenberg University Mainz, Saarland University, European Molecular Biology Laboratory and Goethe University Frankfurt as the leading partner.

Spokespersons: Prof. Dr. Martin Beck, Prof. Dr. Inga Hänelt and Prof. Dr. Michaela Müller-McNicoll
LOEWE contribution: LOEWE-CMMS, LOEWE-DynaMem, LOEWE-MegaSyn and LOEWE-TBG, Prof. Dr. Christian Münch (LOEWE top professorship)

CPI

**Justus Liebig University Giessen,
Goethe University Frankfurt,
Max Planck Institute for Heart and Lung Research in Bad Nauheim**

Diseases of the lungs and the cardiovascular system are among the most common causes of death worldwide. They often go hand in hand. Chronic heart or lung diseases, but also acute processes such as respiratory infections with their short and long-term effects on the lungs and the cardiovascular system, play a role. The aim of the cluster of Excellence "Cardio-Pulmonary Institute" (CPI) is to understand which molecular biological processes underlie the functioning of these organs and their failure. The Hessian cluster of Excellence "CPI" was already funded as part of the Excellence Initiative from 2006-2018. In 2019, it was successful with a new approach as a separate institute, the CPI, and is now entering the race for the second funding period.

The funding of the "CPI" would make it possible to further expand a globally unique center for heart and lung diseases with the aim of better understanding them and identifying new therapeutic options. The consortium of basic, translational and clinical scientists has already made fundamental contributions to therapy development with the mission of translating precision biology into precision medicine.

The universities of Giessen and Frankfurt and the Max Planck Institute for Heart and Lung Research in Bad Nauheim are cooperating in "CPI".

Spokespersons: Prof. Dr. Susanne Herold and Prof. Dr. Stefanie Dimmeler
LOEWE contribution: LOEWE-CGT, LOEWE-FCI and LOEWE-iCANx Prof. Dr. Susanne Herold (LOEWE top professorship)

LOEWE CONTRIBUTIONS

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LOEWE-CGT
Center for Cell and Gene Therapy Frankfurt

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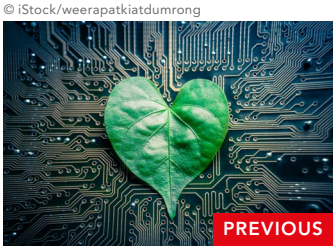

LOEWE-CMMS
Center for Multiscale Modelling in Life Sciences

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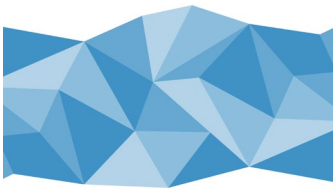
LOEWE-CompuGene
Computer-assisted processes for generating complex genetic circuits

© Achilleas Frangakis, Goethe Universität Frankfurt

LOEWE-DynaMem
Dynamics of cell membranes

© Alexander Henß



LOEWE-DYNAMIC
The Dynamic Network Approach of Mental Health to Stimulate Innovations for Interventions and Change

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LOEWE-emergenCITY
Resilience for Digital Cities

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LOEWE-FCI
Frankfurt Cancer Institute
Molecular Mechanisms of Therapeutic Responses in Tumors and Development of Individual Tumor Therapies

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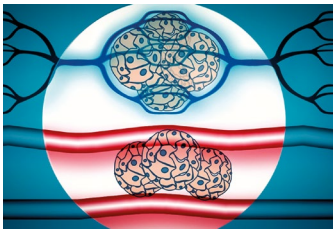

LOEWE-FLOW FOR LIFE
An artificial network for organ-like 3D cell aggregates

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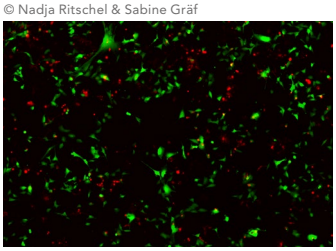

LOEWE-iCANx
Cancer – Lung (Disease) Crosstalk: Tumor and Organ Microenvironment

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LOEWE-iNAPO
Ion-conducting nanopores

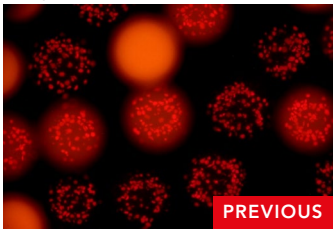
© Uwe Dettmar

LOEWE-MegaSyn
Control and design of multifunctional metasynthases

© Justus-Liebig-Universität Gießen

LOEWE-STORE-E
Storage in Boundary Layers

© Tarryn Miller & Thomas Benoit



LOEWE-SYNMIKRO
LOEWE Research Centre for Synthetic Microbiology

© Florian Schulz

LOEWE-TBG
Translational Biodiversity Genomics
Genomic Biodiversity Research

© Steffen Böttcher / Hessen schafft Wissen

LOEWE-Tree-M
Mechanisms of resilience and environmental impact of the leaf microbiome of trees

© Unsplash

LOEWE-WhiteBox
Explainable models for human and artificial intelligence

In addition, the LOEWE focus area Robucop, which has been funded since January 2025

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