ERLANGEN,
16 JANUARY 2026

DFG funds brain development research at MPZPM with half a million euros

The process of "epigenetic memory" in nerve cells plays a key role in learning ability, memory function, and healthy brain development. Prof. Tomohisa Toda at the Max-Planck-Zentrum für Physik und Medizin (MPZPM) aims to investigate how nerve cells preserve a specific set of gene expressions via epigenetic regulation. The project, a collaboration with Prof. André Reis at the Uniklinikum Erlangen, has now been selected by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) and will receive approximately €500,000 in funding over a period of three years.

The new DFG priority project "Epigenomic adaptations of the developing neural chromatin" (EPIADAPT) funds projects, which aim to investigate the underlying epigenetic mechanisms at work during the development of the central nervous system (CNS). Epigenetic mechanisms are control systems that modulate when and how genes function, without changing genetic sequences. During brain development, we are exposed to numerous environmental stimuli, and CNS cells must modulate their gene expression in response to changes in their environment. In this way, our brain can develop robustly in different environments. However, it is still largely unknown how CNS cells control epigenetic regulation in response to environmental changes.
Furthermore, the project aims to investigate the deregulation of these mechanisms in developmental diseases. Many mutations in genes controlling epigenetic mechanisms are strongly linked to neurodevelopmental disorders and their underlying mechanisms are unclear. With this, the scientists aim to advance our knowledge of brain health and disease.

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Group picture from the kick-off meeting of EPIADAPT. Prof. Tomohisa Toda (third from right) and his project at MPZPM were selected for a funding.

Long-term maintenance of state dependent-neural epigenomics

Most nerve cells (neurons) in the human brain exist from birth and can only be replaced to a very limited extent throughout a lifetime. Since their plasticity and functioning are essential for proper brain function, they must be particularly robust. Otherwise, neurons will stop functioning in the middle of life. Therefore, it is important to understand how they develop such robust systems. While the importance of activity-dependent gene regulation has been intensively addressed in the context of neuronal plasticity, the mechanisms by which they maintain state-dependent neural epigenomes in the long-term, remain unclear. The scientists in the research group "Neural

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Epigenomics", led by Prof. Tomohisa Toda at MPZPM, aim to identify the molecular and structural mechanisms that underlie the long-term maintenance of the neural epigenome.

Neural Epigenomics

Toda and his research group have previously investigated the epigenetic mechanisms underlying the long-term function of nerve cells. Neurons respond to environmental cues such as learning a new language by changing their gene expression patterns, i.e. the specific activity profile of genes in a cell or tissue at a specific point in time. This activity-dependent gene regulation is a fundamental process underlying plasticity, learning and memory. Scientists around Toda, in collaboration with Prof. André Reis at the Uniklinikum Erlangen, investigate which epigenetic mechanisms enable neurons to maintain their activity-dependent gene expression programs. This regulates, for example, the processes of remembering and forgetting. Proper epigenetic regulation is also essential for controlling neuronal identity or states (e.g. active or basal). Depending on their states, neurons can respond differently to the same stimuli and perform different functions, making controlling neuronal states vital to brain function.

Prof. Tomohisa Toda

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About EPIADAPT: *The DFG Priority Program EPIADAPT brings together research on epigenetic adaptation in the central nervous system from across Germany. It focuses on transient cellular states during development and the question of how epigenetic regulation supports healthy brain function and can contribute to disorders. More information: https://uni-freiburg.de/spp2502/*

*The **Max-Planck-Zentrum für Physik und Medizin** is conceived as a joint effort between the Max-Planck-Institute for the Science of Light (MPL), the Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) and the Universitätsklinikum Erlangen (UKER). The new scientific center aims to apply advanced methods from experimental physics and mathematics to basic biomedical research with an emphasis on the intercellular microenvironment. Learn more at mpzpm.mpg.de.*

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