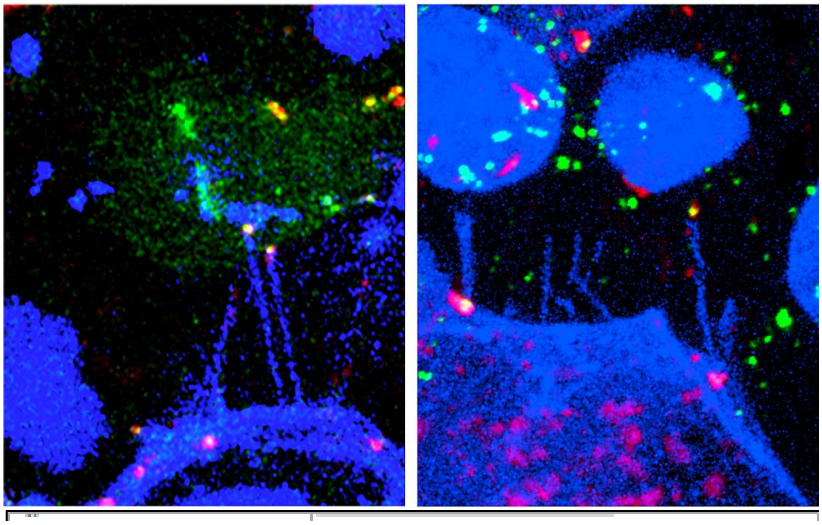
How Cells Communicate

Research of the European Zebrafish Resource Center of KIT Provides Insight into the Development of the Central Nervous System of Vertebrates – Publication in Nature Communications



Control of cell differentiation in the central nervous system: Long, blue-colored cytoplasmic projections, so-called filopodia, carry the red-colored signaling protein Wnt at the tip. As soon as neighboring cells are activated by the Wnt filopodia, the contact points are colored yellow. (Photos: Eliana Stanganello and Steffen Scholpp)

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During embryonal development of vertebrates, signaling molecules inform each cell at which position it is located. In this way, the cell can develop its special structure and function. For the first time now, researchers of Karlsruhe Institute of Technology (KIT) have shown that these signaling molecules are transmitted in bundles via long filamentary cell projections. Studies of zebrafish of the scientists of the European Zebrafish Resource Center (EZRC) of KIT revealed how the transport of the signaling molecules influences signaling properties. A publication in the Nature Communications journal presents the results.

Organisms, organs, and tissues are complex three-dimensional systems that consist of thousands of cells of various types. During embryonal development of vertebrates, each cell requires information on the position at which it is located in the tissue. This position information enables the cell to develop a certain cell type for

later execution of the correct function. This information is transmitted via signal molecules, so-called morphogenes. These morphogenes are not homogenously distributed in the tissue, their concentration varies. Various concentrations activate various genes in the target cell.

The cells in the developing central nervous system receive their position information from signal molecules belonging to the family of Wnt proteins. The concentration of Wnt proteins determines whether a cell differentiates to a cell of the forebrain or of the afterbrain. “Distribution of these signal molecules has to be controlled precisely,” Dr. Steffen Scholpp, head of a research group of the KIT Institute of Toxicology and Genetics (ITG), explains. “Smallest changes of the concentration or the transport direction may cause severe damage, such as massive malformations during embryonal development or formation of cancer.”

For the first time now, the working group of Dr. Steffen Scholpp has shown that the Wnt proteins are transmitted specifically via long cell projections, so-called filopodia. In the Nature Communications journal, the scientists report that the signaling factors are loaded on the tips of the filopodia only. In this way, signaling can start immediately upon contacting. The signaling factors bind to the corresponding receptors of the target cell and induce the correct cell response. “Now, the source cell can decide precisely which target cell receives how much signaling protein at which time,” Scholpp explains. The KIT researchers study zebrafish and human cell lines and succeeded in reproducing or reducing the filopodia and analyzing the resulting changes of signaling properties of the Wnt morphogenes.

Eliana Stanganello, Anja I.H. Hagemann, Benjamin Mattes, Claude Sinner, Dana Meyen, Sabrina Weber, Alexander Schug, Erez Raz & Steffen Scholpp: Filopodia-based Wnt transport during vertebrate tissue patterning. Nature Communications, published 5 January 2015. DOI: 10.1038/ncomms6846

About the EZRC

The European Zebrafish Resource Center (EZRC) of KIT accommodates a central archive for the cultivation and distribution of zebrafish stems for research. Zebrafishes are ideal model organisms for studying the causes of cancer or cardiac diseases or the effects of medical substances. Most organ systems of these vertebrates correspond to the organ systems of human beings. Moreover, zebrafish eggs are transparent and develop outside of the mother’s body. In this way, the development of organs or even of individual cells can be observed in the embryo or the also transparent larva.

The EZRC also is a screening center that offers innovative technologies, such as high-throughput synthesis of medical substances, genome sequencing, robotics and software for sample handling, microscopy, and image analysis.

Karlsruhe Institute of Technology (KIT) is a public corporation pursuing the tasks of a university of the state of Baden-Württemberg and of a national research center of the Helmholtz Association. The KIT mission combines the three strategic lines of activity of research, teaching, and innovation. With about 9,400 employees and 24,500 students, KIT is one of the big institutions of research and education in natural sciences and engineering in Europe.

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