Laboratory for Molecular and Developmental Biology

Institute for Protein Research

Professor Takahisa FURUKAWA takahisa.furukawa @protein.osaka-u.ac.jp
Associate Professor Taro CHAYA taro.chaya @protein.osaka-u.ac.jp
Assistant Professor Hung-Ya TU hung-ya.tu @protein.osaka-u.ac.jp

URL: http://www.protein.osaka-u.ac.jp/furukawa_lab/

Using the mouse as a model organism, our laboratory aims to elucidate the molecular mechanisms of vertebrate central nervous system development using a wide range of methodologies, including molecular biology, developmental engineering, histology, and physiology, to elucidate the principles underlying the construction and functional expression of the nervous system. Using the retinal visual system as a model system, we are studying how the genetic program inscribed in the chromosomal genome produces a variety of neurons, forms precise neural circuits, and leads to neurophysiological functions in vivo. Furthermore, we are actively contributing to medical problems such as how abnormalities in each step from genes to physiological functions lead to human diseases and how they can be solved. Our goal is to "integrate the understanding of central nervous system development from genes to individual physiological functions and human diseases.

Analysis of molecular mechanisms of synapse formation

The retina is the tissue of the central nervous system and forms a beautiful layered structure with morphologically simple and distinct neuron morphology. Synaptic sites are well defined and synaptic terminals can be precisely verified by electron microscopy. Although we have made relative progress in understanding the mechanisms of how axons stretch toward their targets in recent years, the molecular mechanisms of specific synaptic connections to create precise circuits are still poorly understood. We have isolated a novel extracellular matrix protein, picatulin, and found that picatulin functions as a specific synapse-forming molecule between photoreceptor and bipolar cells by binding to dystroglycan. We are now working to elucidate the molecular mechanisms of retinal synaptogenesis and neural circuit formation.

Analysis of the regulatory mechanism of development and function of the central nervous system by non-coding RNAs (non-coding RNAs)

In recent years, it has become clear that microRNAs (miRNAs), small RNAs of 18-25 nucleotides, are transcribed in large numbers in various species. MicroRNAs suppress the expression of target genes with complementary sequences and are thought to be involved in various biological phenomena such as development, differentiation, metabolism, neurology, and carcinogenesis. We have shown that microRNA-124a, which is expressed specifically in the central nervous system, is essential for normal neural circuit formation in the hippocampus and for the survival of retinal pyramidal cells. We are focusing on microRNAs and long noncoding RNAs expressed in the central nervous system, as they play important roles. We aim to elucidate the biological functions and mechanisms of action of noncoding RNAs to reveal new mechanisms of gene regulation in the central nervous system.

Analysis of molecular systems involved in neuronal differentiation

How is the cell fate of the 100 billion neurons in the human brain correctly determined? How much do epigenetic factors come into play? We have focused on photoreceptor cells, the light-receiving neurons of the retina, to understand how their fate is determined from the perspective of transcriptional regulation. We have discovered that photoreceptor fate is determined by "chain activation of transcription factors. We are also investigating gene regulation of retinal neuron development, and using retinal neurons as a model, we aim to elucidate the entire mechanism from neuron fate determination to final differentiation at the in vivo level.

There are several other projects in progress. Please contact us if you are interested.

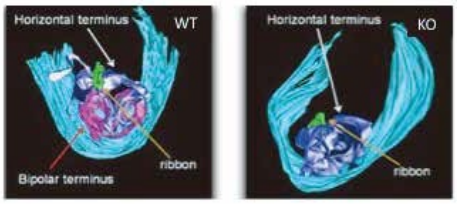

Figure 1 Three-dimensional tomographic analysis of retinal ribbon synapses using an ultra-high-voltage electron microscope. No bipolar cell nerve endings enter the ribbon synapses of the retina in picatulin KO.

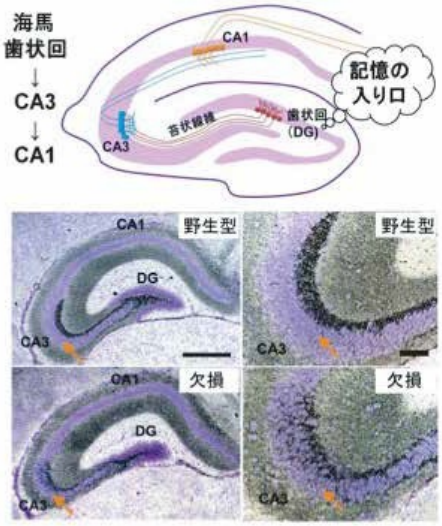

Figure 2. miR-124a-deficient (KO) mice brains show abnormal invasion of lichen fibers into the CA3 region, with failure of circuit formation of lichen fibers and CA3 pyramidal cells in the hippocampal dentate gyrus in the correct location.

The more I study, the more I am amazed at the incredibly sophisticated and profound mechanisms of living organisms! Why don't you join us in uncovering the wonders of life?

Institute for Protein Research, Osaka University
3-2 Yamadaoka, Suita, Osaka 565-0871, Japan
TEL: +81-6-6879-8631
FAX : +81-6-6879-8633

Scan here for the lab's website >>