Neuronal correlates of long-term fear memory and its extinction

One of the main challenges in neurobiology is to understand the cellular and molecular basis of memory: how the memory is formed, how it is stored, processed and recalled. It is known that memory formation is accompanied by the changes of synapses (connections between the neurons) in the brain regions involved in coding and storing the memory. Surprisingly, most of these changes are very transient. Therefore, it is still poorly understood how the remote memory is stored. We know, however, that the brain regions involved in memory storage change in time. In particular, recall of the remote memory activates some parts of the brain cortex. We will focus on the retrosplenial cortex, which is involved in the spatial memory formation and its connections with thalamus which is deep brain structure also involved in learning processes. Our previous studies showed that both of these structures are activated during remote memory formation.

In our research we will use transgenic mice with mutation in one of the most abundant regulatory protein it the brain, calcium/calmodulin-dependent protein kinase II. Mice with such mutation show many disorders in the memory formation. Our experiments showed that remote memory is also impaired in these mice. We plan to image their retrosplenial cortex while mice are awake and performing memory tasks. For this purpose we need to construct new device compatible with special microscope (two-photon microscope) for living animals. Observation of the neuronal morphology and connections in both control and mutant mice during memory formation could lead us to better understanding of the molecular basis of memory. This is crucial for the development of new therapies of cognitive disorders observed in many neurological and psychiatric diseases as well as during healthy aging.