One of the most important feature of the brain is the ability to acquire, interpret and store the information. These processes are assured by the modifications in the number and/or strength of the contacts between the neurons called synapses. Synapse modifications are thought to underlie brain's learning capability and they are called synaptic plasticity. The modern definition of a synapse indicates that it consists of pre- and postsynaptic site of a neuron, extracellular matrix and glial cells invaginations. The postsynaptic part is frequently localized at the membranous protrusion extending from a neurons' dendrite called dendritic spine. Enhanced network activity (e. g. during memory acquisition) often results in alterations of structure/number of these structures, which are believed to accompany modifications in synapse strength. Since dendritic spines are tightly surrounded by the extracellular matrix (ECM), changes in their shape can be caused by interactions with the ECM components. In our research project, we decided to focus on a protein called matrix metalloproteinase-9, MMP-9. This ECM modifier has been shown repeatedly to be a key player in synaptic plasticity, able to induce dendritic spine maturation. Proteolytic activity of MMP-9 allows it to cleave different ECM components. Such enzymatic activity at the synapse controls synaptic changes, thus affects memory formation and storage. Interestingly, we have recently shown that the time window of proteolytic MMP-9 activity, is strictly regulated in order to assure proper changes in dendritic spine structure during activity of neurons. The immediate enzyme inactivation is controlled by its endogenous inhibitor, TIMP-1.

The plasticity of the nervous system is one of the most intriguing aspects in the contemporary neuroscience. However, the knowledge on how the brain is processing and storing the information is still inadequate. In the research project we will explore the relationship between proteolytic activity that is subsequently inhibited and dendritic spines structural plasticity. We will use an experimental approach that will help to directly answer the above questions –*in vivo* brain imaging.

Dendritic spines are considered to be the locus of plastic changes in the nervous system, thus we decided to perform the research allowing to understand the molecular mechanisms of spine formation and its long-lasting stabilization, which not only underlay physiological plasticity of the synapse, but they are also engaged in different pathological conditions. We think that studying, the dynamics of dendritic spines in vivo will substantially expand the knowledge of such complex process as neuronal synaptic plasticity.