The Center for Brain Research of the Medical University of Vienna

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The Center for Brain Research (CBR) of the Medical University of Vienna, Austria, was founded in 1999. It is based in a historical building in the centre of Vienna.

The CBR is devoted to state-of-the-art translational research and teaching neurosciences.

Our research topics include Alzheimer's disease, anxiety, decision making, epilepsy, learning and memory, multiple sclerosis, myasthenia gravis, neuromyelitis optica, neurodegeneration, neuropathy, opioid-withdrawal syndrome, inflammatory and neuropathic pain, Parkinson's disease, Rasmussen's encephalitis, sleep disturbances, X-linked adrenoleukodystrophy, and Zellweger syndrome. Virtually all major technologies of modern neurosciences are currently employed at the Center covering aspects from the molecular- and cellular- all the way up to the systemic level. An increasing number of collaborations with clinical partners substantiate the relevance of our research for the patients' needs.

Signal processing in the central nervous system (CNS) is characterized by electrical nerve activity, chemical messengers and by a highly complex neuronal network. Consequently our research projects deal with the electrophysiological properties and functions of single nerve cells; the chemical information transfer at specialized contacts between nerve cells, i.e. the synapses; and with the roles of individual neurons and complex networks for behaviour.

The brain consists of about 100 billion neurons and 1 quadrillion synapses. Each neuron may receive up to ten thousand synaptic contacts from other neurons. Synaptic transmission involves the release of neurotransmitters and binding to receptor molecules. Several research projects deal with the structure, the pharmacology or the trafficking of important receptor molecules for γ-aminobuturic acid (GABA),

acetylcholine or glutamate. GABA is the major inhibitory neurotransmitter in the CNS. The properties and functions of GABAergic neurons are studied in various contexts including cognitive functions and pain.

The properties and functions of the electrical and chemical signalling machineries in the CNS are continuously modified, e.g. by experience, but also by age or disease. This is called "neuronal plasticity". Ongoing research at the Center relates to activity-dependent forms of synaptic plasticity such as synaptic long-term potentiation (LTP), which may, for example, underlie learning and memory formation. Our researchers use the neuromuscular junction as a model synapse to study the formation, maturation and maintenance of synapses. Translational control at synapses involves dendritic mRNA transport and subsequent activity-dependent local protein synthesis at the synapse that is studied in several other research projects at the Center.

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All cells, including neurons, need to metabolise lipids. Specialized cell organelles, the peroxisomes, fulfil this role and their dysfunction in neurons almost always leads to severe neurological abnormalities. Impaired cell metabolism and the production of reactive oxygen or nitrogen species may trigger nerve cell malfunction and degeneration. In Parkinson's disease, for example, degeneration leads to a progressive loss of the neurotransmitters dopamine and norepinephrine in the basal ganglia. All these topics are addressed in various research projects at our Center.

The CNS is viewed as an immune privileged site, since the blood brain barrier restricts the entry of immune cells and immunological mediators. The access of immune competent cells to the CNS is relevant under pathological conditions such as multiple sclerosis and neuromyelitis optica. Nerve cells are far outnumbered by non-neuronal glial cells in the CNS. They play important roles in health and disease. The mutual interactions of neurons and non-neuronal, immune competent cells are studied by different groups in the Center, e.g. in the context of multiple sclerosis or pain.

Visualization is a prerequisite for many scientific questions in life sciences. The complex three dimensional neuronal networks are rather inaccessible for visualization. This problem is now tackled down to the level of dendritic spines by a guest group at the Center for Brain Research. With the help of computational models and mathematical algorithms some of the present and former researchers at the Center are exploring the complexity of neurotransmitter receptors, individual neurons, neuronal networks and living organisms. Modelling and data analysis deal with receptor-binding pockets; spatio-temporal pattern recognition in neuronal networks; natural language processing and acquisition; EEG and related signals; and decision making.

Members of our Center are involved in a number of teaching activities covering the broad spectrum of neurosciences, medical education and state-of-the-art technologies in imaging, cellular and molecular biology, neuroimmunology and neurophysiology. We offer classes for students from our Medical University and from universities around the world. Our practical courses, lectures and seminars span basic neurosciences for the beginner and highly specialized topics for the advanced researcher.

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