The Program is based on 7 research lines that are developed mainly at the Faculty of Sciences of the University of Valparaíso. All of them have external funding and all are available for thesis work, laboratory internships and rotations.

**1.- Structure and Function of Ion Channels:** This line of research is interested in understanding the mechanisms that cause ion channels to open in response to diverse stimuli, including electrical potential, intracellular calcium, and temperature. Using electrophysiological, fluorescence, and structural modeling techniques, we investigate how voltage sensors work in proton channels (Hv), Ca2+- and voltage-activated K+ channels, voltage-dependent Ca2+ channels, and Connexins.

**2.- Neurosecretion and Cellular Communication:** This line studies the molecular mechanisms that allow cellular signaling. By combining molecular, electrophysiological, fluorescence, and molecular dynamics techniques, we study the mechanisms that regulate processes such as neurotransmitter and neurohormone release, vesicular recycling, intracellular communication via gap junctions, and the release of molecules through connexins and pannexins channels.

**3.- Synaptic Transmission and Plasticity:** This line of research seeks to understand the biological bases of communication and neuronal plasticity, as well as its regulation by neuromodulators, such as endocannabinoids and nitric oxide. Electrophysiological, biochemical, behavioral and genetic tools are used for this purpose.

**4.- Sensory Neurophysiology:** This line of research investigates sensory coding in the retina and in the olfactory and telencephalic bulb of vertebrates using electrophysiological techniques such as multielectrodes and patch clamp supplemented with histological and imaging techniques. It also seeks to understand the cellular and molecular events by which endogenous neuromodulators such as cannabinoids and nitric oxide modify sensory coding.

**5.- Genetics and Development of the Nervous System:** This line uses the animal models, zebrafish, Drosophila, and transgenic mice, in combination with genome analysis, to investigate the genetic bases of the development of the nervous system, behavior (such as olfactory behaviors and circadian rhythms), and psychiatric diseases (such as mood and anxiety disorders).

**6 System Neuroscience and Behavior:** This line of research uses electrophysiological, histological, and behavioral tests to understand the neurophysiological mechanisms involved in learning and memory, and how these can be affected by stress and diet. It studies the pathophysiology of depression using animal models and uses rodent models that naturally develop sporadic Alzheimer's disease to investigate the mechanisms responsible for this disease.

**7.- Bioinformatics and Biomathematics in Neuroscience:** In this line of research advanced methods of mathematical modeling and molecular simulation are used to study structure-function relationships of membrane proteins such as ion channels and connexins. With simulations and mathematical analysis we also study different aspects of the dynamics of neuronal excitability, neural networks, and biological systems.