Research plans

Personal profile and research history

I started my research activity by working on experimental techniques for the analysis of neuronal network activity. At the NTT in Japan, I worked on multi-electrode array recordings from neuronal cultures. In 1995, I worked under the supervision of Prof. V. Torre, on the analysis of electrical activity in the leech nervous system, using the optical technique of voltage sensitive dyes imaging. My PhD thesis at SISSA, under the supervision of Prof. E. Cherubini and Dr. A. Treves, was on short-term plasticity in hippocampal synapses. The project focussed on the understanding of the presynaptic mechanisms underlying facilitation and depression in the hippocampal CA3 area. During my PhD, I was also involved in the development of an imaging system for fast ion imaging in collaboration with Dr. F. Mammano. I used this imaging system to investigate calcium signals generated by GABAergic depolarisation in hippocampal pyramidal neurones of neonatal rats and by electrical activity in hypoglossal motoneurones. My postdoctoral research at NIMR with Dr. D. Ogden has focussed on the slow excitatory postsynaptic current evoked by metabotropic glutamate receptors (mGluR1) at parallel fibre synapses in cerebellar Purkinje neurones in acute brain slices.

I am using flash photolysis to rapidly release L-glutamate from novel caged compounds developed and characterised at the NIMR. My work has demonstrated that the mGluR1 current is mediated by a Ca^{2+} permeable cation conductance with low open probability and sub-pS single channel conductance. It was also found that the mGluR1 current is not mediated by Ca^{2+} release from stores, it is a G-protein dependent mechanism and it is regulated by a tyrosine phosphatase step that couples the mGluR1 to the cation conductance. The mGluR1 current is a putative source of localised Ca^{2+} entry that can play an important role in synaptic plasticity. This signal and Ca^{2+} release from intracellular stores via $InsP_3$ receptors can be observed in the same cell when mGluR1 are activated. I am now focussing on the characterisation of the interaction between these two signals using patch clamp recodings and simultaneous Ca^{2+} imaging. I also started a collaboration with Dr. Dejan Zecevic (Yale University) to do voltage imaging from individual Purkinje neurones.

Future plans

I would like in the near future to establish as an independent scientist and to continue my research activity on cerebellar studies. In mammals, the cerebellum plays and important role in motor coordination. The investigation of synaptic transmission at molecular/cellular/network level in the cerebellum is fundamental to understanding motor behaviours. Purkinje neurones (PN) provide the only output of the cerebellar cortex and synaptic integration occurring in these neurones is crucial in the cerebellar function. My will is to investigate the physiology of PN under two different directions.

1) Understanding of signal integration in PN. An extensive study of electrical activity in different subcellular compartments is possible with multi-site recording, such as optical imaging. I would like to investigate membrane potential distribution using intracellularly-loaded voltage sensitive dyes. Several aspects of subcellular compartmentalisation of electrical activity and of the propagation of electrical signals must be investigated. These include: (a) The propagation/spread of fast excitatory synaptic potentials from the soma (Climbing fibre) to the dendrites and from the dendrites (Parallel fibre) to the soma and to other dendrites. (b) The localisation of fast AMPA-mediated and slow mGluR1-mediated synaptic potentials signals. (c) The role of specific membrane conductances and the interaction within different synaptic signals.
2) The role of glutamate receptors in cerebellar development and synaptic formation. Cerebellar development after cell differentiation is a relatively slow process with a crucial period in the first three postnatal weeks in rodents. During this period PN develop the dendrites that will form postsynaptic Parallel fibre contacts. Climbing fibre synapses also develop by progressive de-innervation until each PN is targeted by a single Climbing fibre input. The morphological development is associated with changes in the expression of AMPA, NMDA and mGluR1 subunits forming functional glutamate receptors. I would like to investigate the role of these receptors in this critical period of development, by combining electrophysiological and imaging techniques.

Teaching Statement

As undergraduate student in Italy, I was involved in university teaching at the department of Physics at University of Genoa. Since 2002, I teach *patch clamp* techniques at the Microelecrode techniques for Cell Physiology course at the Marine Biological Association in Plymouth and photolysis and in vitro imaging in the Optical technique workshop also in Plymouth. Details on these courses can be found at the web site:
http://www.mba.ac.uk/education/courses.htm

As a biophysicist, I am interested in quantitative approaches to physiology, neurobiology and pharmacology. In the future I would like to teach these subjects at undergraduate and graduate levels, although I consider research the most important part of my work and career. Given my technical experience in electrophysiology and optical techniques, I also would like to participate in teaching and organizing practical/laboratory courses at university and higher level.