LABORATORY 12

Laboratory of Bioinformatics of Cell Processes and Motocontrol

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The leading researchers of the laboratory include:

Corresponding member of Russian Academy of Science	L. Chailakhian		
Dr.Sc. (Biology)	M. Berkinblit	Dr.Sc. (Biology)	S. Minina
Dr.Sc. (Biology)	V. Bozhkova	Dr.Sc. (Biology)	N. Samosudova
Dr.Sc. (Math.)	V. Dunin-Barkowsky, President of the RNNS	Dr.Sc. (Biology)	Yu. Panchin
Dr.Sc. (Biology)	Z. Khashaev	Dr.	J. Burmistrov
Dr.Sc. (Biology)	E. Liberman	Dr.	L. Kudina
Dr.Sc. (Math.)	I. Lukashevich	Dr.	D. Voronov

DIRECTIONS OF ACTIVITY

The general theme of the scientific work in the laboratory is: analysis of the information processes in cellular systems and in motor control. The main directions of theoretical researches in this realm: developmental biology (analysis of principles for the realization of genetic information in the developmental systems), neurobiology (neural communication and biochemical modulation in neural centers), motor control (study of geometry of manipulative space and of control goal-directed moving). Also some new bioinformatical principles are worked out including the building of computerized system for the analysis of expert knowledge.

MAIN RESULTS

Developmental biology. Dr. V. Bozhkova with co-workers elaborated methods for differentiation between heritable symptoms and influences from environment, which determinate the development of multi-factorial injuries in the human CNS. In infants with dyslexia (a special injury of reading) injuries of subtle movements on the oculus-motor and articulation levels are discovered, which inherit interlinkable (coherently). (V. Bozhkova, V. Petryaevskaya).

Dr. Plonsky studied mediator systems from structures accepting the taste stimulus. To date the synaptic nature of signal transmission between receptor cells in taste buds and afferent fibers has not been unambiguously identified. It has long been known that serotonin stimulates gustatory sensory afferent fibers when the biogenic amine is injected into the tongue near taste buds2, suggesting that 5HT is a taste bud neurotransmitter. Chinese Hamster Ovary cells stably expressing 5HT2c receptors were used as biodetectors to monitor 5HT release from taste buds. When taste buds were depolarized with KCl or stimulated with bitter, sweet, or sour (acid) tastants, serotonin was released. KCl and acid-induced 5HT release, but not release due to sweet or bitter stimulation, required Ca2+ influx. These experiments establish serotonin as a taste bud neurotransmitter and reveal new transmitter release mechanisms.

Dr. Panchin with co-workers has developed a model system for studying a selective formation the electric connections between identified neurons in vitro. This model was used to test a hypothesis that the specificity of electric connections may be determined by

different combinations of gap junction proteins presented on cell membranes. For the first time it was shown that the isolated neurons preserve the capacity to form selective electric connections, and the conditions for this selectivity were studied in details. It was shown that isolated neurons implanted in vitro to the CNS of other animal form the electric connections with the same neurons with which they are connected normally. When such partners are inaccessible improper connections are formed. Main results of this year deals with the new group of transmembrane mammalian proteins (pannexins) proposed earlier in our laboratory. The genome organization and the tissue distribution of all three pannexins in humans and mice was described. Together with the cell biology laboratory of Lille University we demonstrated that human pannexins are capable to form the gap junctions. It was shown that pannexins play special role in the calcium homeostasis and conducting calcium waves between adjacent cells. The study of pannexins function in the model animal (marine mollusk Clione) was also continued. We cloned several new molluskan pannexins and demonstrated their differential expression in the nervous system.

Dr. Voronov investigated the early heart development in vertebrate animals, using the chick embryo as experimental model. He gave a detailed description of the process using *in vivo* labeling, and performed various microsurgical experiments to study mechanical forces moving the process. D. Voronov developed a new method of embryo culture, which gave an opportunity to get rid of artefacts, which were inevitable using the traditional methods of embryo culture. The results obtained by him allowed to revise significantly the concepts concerning biomechancs of developing heart, and to built an adequate model of the process.

Neurobiology. The work of Dr. Dunin-Barkovsky pursued two main directions: (1) the study of the neuron mechanisms of breathing, and (2) functioning of cerebellum neuron networks. The experimental work in the first direction included study of neuron activity in the breath center of the medulla under influence of hypoxia during the wake-sleep cycle (in co-authorship with A.T. Lovering, E.H. Vidruk, J.M. Orem). It is shown that the hypoxia increases activity of all the breath neurons except for preinspiratory ones. Also submitted was the paper on identification of algorithmically defined activity patterns in work of neurons of different brain structures in non-anaesthetized animals. Experimental and model study of the cell activity in cerebellum and visual cortex of guinea-pig permitted to characterize features of the exact rhythm episodes in these structures (co-authors: R. Tikidgi-Khamburjan, L. Podladchikova, G. Bondar', S. Ivlev from the A.B. Kogan Research Institute for Neurocybernetics, Rostov-on-Don, Russia).

Dr. Samosudova with co-workers (Dr. N.P. Larionova, Dr. V.P. Reutov (Inst. High. Nerv. Act. and Neurophysiol. RAS) with participation of eng. A.V. Lukanov continued study of the interaction between glial cells and synapses on Purkin'e cells of the granular cells (GC) axons and dendrites under action of glutamate and NO excess. This may serve as a model of insult. It is established that in this conditions injuring the cerebellum neuron net, one sees the appearing of spiral-like structures, "wrappers", provided by modified GC processes. Under glutamate one can see the wrappers around spines, the endings of dendrites, while in the presence of NO they appeared in preference around buttons, terminals of granular cells axons. This result permits to suggest existence of two different GC types. It seems that the fact of two different types of reactions to the cerebellum stimulation in presence of NO is a morphologic manifestation of the existence of these functionally different GC, because it is observed either degeneration of GC processes around the dendrite spines or intensive metabolism giving "wrappers" around boutons in conditions of hard injury of the cerebellum neuron net.

Dr. Burmistrov investigated problems of the motocontrol in high crustaceous. In particular the locomotor activity of fresh-water cancers was studying after functional excluding of vision. Results show that the exploratory activity of animals and their habituation to experimental conditions are modulated by the visual system functioning in higher parts of brain.

Correspondent member of RAN L.M. Chailahjan with coworkers recorded space-time picture of the systole-diastole expanding process in the frog's auricle under isothermal and isotonic regimes. One found the non-uniform character of the trabeculae contractions along their axes under systoles and synchronous decreasing of the distance between trabeculae. One concluded that trabeculae have a topping role in the signal transmission from trabeculae to the contractions in intra-trabecular tissue. (Together with Z. Khashaev, V. Petryaevskaya, M. Vladimirova and co-workers from ITEB RAS).

Dr. Khashev investigated mechanism of some phenol compounds action with method of intracellular spontaneous biopotential measurement. After introduction of toxins in the Ringer solution surrounding neuromuscular preparation the frequency of biopotentials elevated very sharply. One saw that that concentrations of toxicants having the same elevation of frequency differed onto some orders for different substances. The proposed electrophysiological methods must permit to investigate of the ion transport under supertoxicant action in artificial biological membranes. (Together with L. Chailahjan and A. Tumanova).

Motor control. Drs. Berkinblit and Adamovich continued work on using the virtual reality method for investigation of motocontrol patterns in healthy humans and of its possibilities in rehabilitation of patients with motor injuries after insults.

Dr. Kudina studied the excitability of firing motoneurones activated by voluntary contraction of the flexor carpiulnaris or tibialis anterior. It was tested by single monosynaptic excitatory Ia afferent volleys. In order to estimate stimulation effects, the peri-stimulus time histograms of single motoneurones were plotted and the firing indices were calculated. It was shown that within the range of 4-15 imp/s the firing-frequency effect was absent during testing by low-intensity excitatory volley. At higher intensity of afferent volley the excitability increased within low-rate range. It is suggested that the characteristics of the interspike-interval excitability trajectories underlies these relations. Findings explicate, in great extent, the conflicting literature data which were usually reported without considering afferent volley intensity effect. (Together with Dr. Andreeva.)

Bioinformatical principles. Dr. Lukashevich used her structure method for complex analysis of the clinical information about states of patients with the stutter syndrome and of infants having speech development retardation. She created a learning-diagnostic computer system for the electroencephalography and an atlas of EEG incorporated into the system "EED-EXPERT", which automatically forms descriptions of EEG and conclusions. At the same base the learning-diagnostic computer systems are built in the domain of neuropsychology and clinical-laboratorial diagnostics.

Dr Chernavsky with Drs. A. Karpovich and V. Karpoushkin has begun the preparation to the experiments on the space perception.

Dr. Liberman with co-workers prepared experimental investigation of the influence of transmission to the rotating coordinate system onto cytoskeleton of the fish Mauther cells. (With S. Minina, V. Eidus, and S. Zyuzina).

WORK WITH YOUNG SCIENTISTS

1. Bozhkova V.P teaches at the defectology faculty of the Moscow Pedagogical State University. She lectured the cours "Basics in Genetics".

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2. Chernavsky A.V. teaches at the chairs "Higher Geometry and Topology" in the mechanichs-mathematical faculty of MSU.

GRANTS FROM:

- **Russian Foundation of Basic Research (No. 02-04-48775):** "Новое семейство трансмембранных белков паннексинов и их роль в избирательном формировании электрических связей". (Yu. Panchin)
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- **Russian Foundation of Basic Research (№ 03-04-48369)** "Исследование механизмов вариабельности активности простых и сложных импульсов клеток Пуркинье мозжечка". (В.Л. Дунин-Барковский, со-исполнитель).

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