ELECTRON MICROSCOPY IN BIOMEDICAL RESEARCH
AT THE UNIVERSITY OF NOVI SAD

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1. HISTORY

The beginning of the development of electron microscopy at the University of Novi Sad is connected to the second half of the 1960s, when the Faculty of Medicine started to develop more intensively. The first transmissive electron microscope – LEM 4C (Fig. 1), produced in Slovenian »Iskra« and designed by professor A. Strojnik, PhD in engineering, was acquired for the needs of the Institute of Histology and Embryology in this faculty. That was the beginning of the formation of the first laboratory for electron microscopy on the University of Novi Sad and it was founded by Professor Radivoje Milin, chief of Institute, but the most merit was recognized in the work of Dr. Radivoj Krstić, who was then an assistant professor, but organized the laboratory with great youthful enthusiasm. Almost every day, he tested the abilities of the new microscope, as well as its experimental prototype, which was delivered to him especially for the purpose of testing specific technical performances. Beside that, he was improving the technique of preparing samples for microscopes, as well as the technique of making quality electromicrographies, during which he was greatly helped by the Institute photographer Rade Samardžija, a great expert in photography and a great enthusiast in this work. In 1970, when Dr. Radivoj Krstić left the Institute, further development of the work was enabled by engaging a lab scientist Mira Belić in the technical preparation of samples, and in the second half of the 1970s Dr. Josif Milin, who was then an assistant professor, joined intensively her work and later became a professor who started a successful cooperation with researchers-clinical workers of different specialties, but also with researchers in other scientific fields, especially biology.

In time, the need for using the electron microscopy in different fields of biomedical science, but also in other scientific disciplines at the University of Novi Sad
overcame the abilities of the existing electron microscope which could no longer satisfy the interest of numerous researchers in testing different changes at the ultrastructural level in other sciences beside biomedical ones. The need appeared for acquiring a new electron microscope, which would serve all the researchers at the university. In 1979 a transmissive electron microscope-JEOL JEM100C was acquired and situated in the Institute for Biology, now the Department of Biology and Ecology at the Faculty of Sciences. The fact should be mentioned that a scanning electron microscope JEOL JSM35 (Fig.2) was acquired at the same time and situated in the same building. This was the beginning of forming the Laboratory for electronic microscopy, opened and available not only to researchers from university but also to all the ones who needed to follow the ultrastructural changes during their researches. In the beginning, assistant professor Miroslav Gantar was in charge of the work on both microscopes, and he also passed the training for working with them, which was organized by JEOL in Japan. Later, a skilled assistant Miloš Bokorov, BSc in biology was in charge of the work with the scanning electron microscope (SEM). Unfortunately, we have to state the fact that the transmissive electron microscope was relatively rarely used for several reasons, one of them being the incomplete equipment for preparation of samples, another one the lack of staff, people who would be bound to this work by their working positions. However, in contrast to transmissive electron microscopy, which did not succeed completely in this laboratory, the scanning electron microscope has been in use from the beginning until today, for almost 25 years. During that time Miloš Bokorov BSc in biology, provided technical help with taking and making the photographs to many researchers, not only from the University of Novi Sad, but also from almost all university centres in former Yugoslavia. Scanning electron microscopy at the University of Novi Sad was used more by the researchers in the fields of material sciences, and less in biomedical researches. The reason for that was the fact that when SEM was acquired, the proper equipment for the preparation of samples to be analysed was not acquired simultaneously, so that their preparation was performed in laboratories for electron microscopy at other university centres, especially at the Faculty of Medicine in Niš.

Since the need increased for including electron microscopy more in clinic practice in the Institute of Histology and Embryology at the Faculty of Medicine, in 1988 a new transmissive electron microscope, OPTON EM109 was acquired. Since then, the
Laboratory for electron microscopy in this Institute has continued its work more intensively, under the leadership of Professor Josif Milin. Technical preparation for microscopic analysis of experimental and clinical material was taken over by a lab expert Elvira Dragić, and later Živana Bogdanovski. This laboratory worked, with shorter or longer breaks, until Professor Josif Milin's death 2000, and unfortunately at the moment it is not working since the microscope is seriously damaged.

In 2002 the University of Novi Sad acquired a new scanning electron microscope JEOL JSM 6460LV together with the necessary equipment for the preparation of biological and non-biological material for microscopic analysis, due to the smart action of the University of Novi Sad, as a capital equipment from the Ministry of Science and Technological Development of Serbia, based on the participation of scientific project from the territory of AP Vojvodina in total budget for scientific projects financially supported by the Ministry of the Republic of Serbia. It has been situated at the Department of Biology and Ecology in the Faculty of Sciences, as the old SEM was. Today it is fully used, under the technical supervision of the skilled assistant Miloš Bokorov, BSc in biology. This laboratory for electron microscopy, equipped with a transmissive and two scanning electron microscopes with proper equipment was established at Department of biology and ecology, Faculty of Sciences (Trg D. Obradovića 2) as a University centre for electron microscopy in 2003.

2. RESEARCH

The laboratory for electron microscopy at the Faculty of Medicine

Experimental biomedical research

The first researches done in the Laboratory for electron microscopy at the Institute of Histology and Embryology at the Faculty of Medicine were related to the research of ultrastructural changes of pineal gland under the influence of various noxious effects, concerning the fact that the research of histophysiology of this gland was a research orientation in this institution under the supervision of professor Radivoje Milin, for many years. The items tested were the ultrastructural changes of pineal gland under the influence of noise, coldness, physical and emotional stress [1], immobilization, pharmaceutics (morphine, cocaine), electromagnetic fields [2], lactation, but also the unknown structural characteristics of pinealocytes (rod synapses, lipiddation of pinocytal secretory granules, localization of specific enzymes as alkaline and acid phosphatase and ATP-ase).

Beside the pineal gland the subject of research were also the effects of different noxious effects on the ultrastructure of other neuroendocrine and endocrine organs as the influence of: coldness on the change of structure of neurosecretory cells of supraoptical nucleus in epiphysectomised rats, irradiation stress on the subcommissural organ, epiphysectomy on parafollicular cells of thyroid gland, alcohol on adenhypophysis in rats [3] etc. Beside researchers from the Institute, the laboratory was used by researchers from other faculties, especially from the Institute of Biology, in testing the ultrastructural properties of neuroendocrine cells in brain Ostrinia
Clinical research

With acquiring a new electron microscope (OPTON EM 109) the Laboratory for electron microscopy at the Faculty of Medicine under the supervision of professor Josif Milin, starts a more intensive cooperation with clinic workers of different specialties. In cooperation with the researchers from the Department of Haematology, Internal clinic, regional hospital in Novi Sad, the ultrastructural characteristics of eosinophilic granulocytes in eosinophilic leucosis [4], as well as mast cells in cases of generalized mastocytosis have been tested. In cooperation with cardiologists from the Institute of Cardiovascular Diseases in Sremka Kamenica the ultrastructural properties of capillaries in syn. Angina pectoris have been tested, and in cooperation with the Institute for forensic medicine, the ultrastructural properties of myocardium have been analysed after the lethal dose of cocaine. With researchers from Gynaecological clinic, the surface changes of intrauterine device have been tested, as well as degeneration of syncytiotrophoblast of placental terminal villi in GPH-Gestose. The ultrastructural changes in inflammation of paradontium during the reparation affected by calcium-hydroxide have been tested for the needs of researchers in the Department of Stomatology at the Faculty of Medicine.

University centre for electron microscopy at the Faculty of Sciences

Since 1979, when TEM and SEM were acquired and situated in the Institute for biology at the Faculty of Sciences, at the University of Novi Sad, the electron microscopy has been used more intensively in researches in different scientific disciplines, biological ones, but also more and more in material sciences.

In the domain of biological sciences TEM is used mostly in microbiological tests, for the needs of researchers from the Cathedra of Microbiology at the Institute of Biology. The microbe structure of waste water was tested, and there has been some research on the microorganisms whose size is beyond the power of the resolution of light microscopes, e.g. Metallogenium symbioticum. Likewise, microbiologists researchers from the Faculty of Technology tested ATP-ase activities of brewers’ yeast. This microscope is also used for the analysis of ultrastructural changes of specific endocrine structures like neurosecretory cells in brain with Sesamia cretica Led. in diapause, pinealocytes after the immobilization stress and follicular and parafollicular cells of thyroid gland under the influence of alcohol [5], for the needs of researchers from the Cathedra of Zoology and Physiology at the Institute of Biology.

Scanning electron microscopy, as a microscopy, which provided new possibilities to researchers, is used in many biological branches. It is intensively used in researches within the domain of microbe ecology at the Cathedra of microbiology at the Institute of Biology, where the morphological diversity of microflora of the activated sludge and activated carbon in the machine for refining waste water has been tested [6], furthermore in the tests of spores of fungi and decomposition of biodegradable plastic by the bacteria and microfungi as well as in the taxonomic determination of...
halrophylic algae _Bacillaria paradoxa, Entomoneis paludosa_ etc. originating from the Danube-Tisza-Danube canal network [7].

It is also used in the domain of botanical researches where the seedlings’ cell-wall ornaments of species _Glycyrrhiza_ L. 1753, _Vicia_ L. 1753 i _Oenothera_ L. 1753. have been researched as a differential morphological character. Furthermore, gland hairy appendages of _Argimonia eupatoria_ L. 1753 (_Rosales, Rosaceae_) have also been tested, seeds of some species order of _Oenothera_ L. 1753 have been analysed, and it has also been used for taxonomic seed evaluation of species _Vicia_ L. (Fabaceae) [8], for the needs of researchers from the Kathedra of Botanics. SEM also enabled the researchers from the Department of Zoology to test specific morphological characteristics of taxonomic importance for insects e.g. _Siro duricorius_ (Joseph, 1868) (Cyphophthalmi, Opiliones) and _Trojanella serbica_ (Opiliones, Laniatores, Travunioidea) [9] and the taxons related to species _Cheliosia canicularis_ (Diptera: Syrphidae) [10].

The research mentioned and done in the Laboratory for electron microscopy at the Faculty of Medicine, as well as the University centre for electron microscopy, are related to professors and assistants of the University of Novi Sad and they depict their research interest. However, it should be pointed out that the list of researches connected to these laboratories would be much broader if the works of numerous researchers from other universities, which have cooperated with these laboratories over the last years, were mentioned.

All previously said clearly points to the fact that the electronmicroscopy has been incorporated into all fields of biomedical researches and that it is being used more and more in the clinical-diagnostic purposes, which orders its further development. The fact that the University centre of electron microscopy has been established since 2003 at the Department of Biology and Ecology at the Faculty of Sciences, gives hope that, with the improvement of this institution, it will be possible to answer the increasing interest in ultrastructural research in different scientific fields developing at the University of Novi Sad, but also to enable providing services to researchers from other university centres in our country and the surrounding countries, as well.

3. REFERENCES