

Utilization of Synchrotron Radiation in Neurochemical Research

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The investigation of the biochemical mechanisms that may participate in the pathogenesis of brain gliomas, Parkinson's disease, amyotrophic lateral sclerosis is of great importance. The elemental and molecular chemical micro-imaging was performed with the use of the methods based on synchrotron radiation i.e. synchrotron radiation x-ray fluorescence (SRXRF), X-ray absorption near edge structure (XANES) spectroscopy, extended x-ray absorption fine structure spectroscopy (EXAFS) and Fourier transform infrared microspectroscopy (FTIR). The SRXRF method was used for topographic and quantitative elemental analysis of thin tissue samples. 2D mapping of the different oxidation state of sulfur, iron and copper in the samples was made with the use of XANES spectroscopy. The investigation of changes in main biological molecules in case of brain gliomas and ALS was performed with the use of FTIR micro spectroscopy.

The higher levels of S, K and Cl were found in glioma cells. The analysis of iron oxidation states showed that Fe occurs in the glioma and Parkinson's brain mainly in the oxidized form (Fe³⁺). Moreover, low intensity of pre-edge peak indicates that Fe occurs mainly in the complexes of octahedral geometry, in which the number of ligands bound to the transition metal ion is 6. It was noticed that cancer cells accumulate sulfur mainly as sulfide (S²⁻) form. The level of Ca was higher for region of hippocampus and cortex in case of animals with pilocarpine induced epilepsy. The opposite relation was observed for Cu and Zn level. The elemental analysis was coupled with determination of main biomolecules of the samples. The tissue areas were mapped to generate 2D images of the molecules of interest. The major spectral differences between control and cancerous tissues were identified for the vibrational frequencies characteristic for proteins and lipids. The absorption spectra measured near Fe-K edge indicating differences in iron local environment for Parkinson's and glioma samples compared to control tissue.