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Analysis of in situ localization of elements in the cellular structure of cancers of the head and neck region

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The formation of free oxygen radicals is part of metabolic pathways under physiological and pathological conditions (e.g. oncogenesis) in the human body. Maintaining the balance between their formation and elimination gives the cells homeostasis. The focus of our research points at Fe, Mn, Zn and Cu, which are essential cofactors in a number of enzymes critical in cell metabolism. Reactive forms of oxygen, such as superoxide can cause mutations in DNA or attack enzymes that make amino acids and other essential molecules. To combat this potential danger, most cells produce an enzyme that detoxifies superoxide - superoxide dismutase (SOD). Recent studies of SOD are aimed at understanding its role in various diseases, in case of our studies cancer of the head and neck region. The main role in the redox processes is played by Fe ions, although Cu ions, which are components of the cytochrome molecule, are also indicated as the important player [1]. Other components of SOD, such as Zn and Mn, which are part of this enzyme and may play a significant role in processes related to aerobic combustion in healthy cells, cannot be excluded either. In the case of anaerobic combustion, which is predominant in tumor tissue, the elements included in SOD should not be present.

Differentiation between iron oxidation states in biological systems can is achievable using XAS spectroscopy [2]. Studies of absorption edges of 3d transition metals was realized for biomolecules [3], heme [4], human brain tumor [5], ovarian cancer [6] and major organs of tumor-bearing mice [7]. Preliminary studies of cancer tissues were recently performed on XAS beam line in Solaris in the FLY (fluorescence yield) mode.

The main goal of our study is to recognize differences between the standardized ancer cells, cells from tissue in original form and homogenate. We expect to find variation of the oxidation state of iron on states of oxidation cycle (including cytochrome oxidase) and presence of other ions included in SOD for normal tissue.

The investigations were executed on iron $L_{2,3}$ absorption edge for two various methods of tissue preparation. Obtained results allowed detection of iron in cancer and healthy tissue with distinguishes of Fe^{3+} and Fe^{2+} states, as shown below (results from FLY mode). Imaging of normal and cancerous tissue was carried out on the Demeter beam line at the Solaris synchrotron in Krakow at the STXM terminal station.

References

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