

The main objective of the proposed research is to study the structure of living normal and cancerous cells at nanometer level. Cancer cells differ from healthy ones by many factors. The ability to divide uncontrollably, their organization in the tissue is impaired, they are irregular in shape. Very often, these cells have more than one nucleus, which is bigger than in normal cells. Above all, changes in the structure of cell membranes, like in proteins and surface receptors result in loss of function such as communication with other cells, responding to the mechanical and chemical signals. Lack of adequate intracellular connections promotes greater mobility of the cells, which is one of the factors enabling the formation of metastases. Standard methods used for imaging of live cells grown *in vitro* like high resolution confocal microscopy have its limits and require of using a fluorescent dye. Other more accurate microscopic methods like scanning electron microscope allows to study only fixed samples. This makes impossible to study changes in the nanostructure of living cells, while important for their life processes occur. In order to study the exact changes and differences in the structure of normal and cancer cells, the method of Positron Annihilation Lifetime Spectroscopy (PALS) will be used. This technique will bring a lot of new information not only on the cells structure itself but also on the process of carcinogenesis, with the accuracy of 0.2 nm.

In the proposed studies mammalian cells: normal, abnormal and cancer ones, *in vitro*, as well as organic compounds which are components of the cell, as proteins or lipids will be examined. PALS will enable to conduct such research with much better resolution than commonly used methods. It is based on the phenomenon of formation and trapping in the matter of a bound state of an electron and its anti-particle positron - positronium - which lifetime depends directly on the structure of the investigated material. Using mathematical models lifetime of positronium can be translated directly to the size of the free volumes - empty spaces between the molecules of chemical compounds building cells, like protein, water or lipids. Commonly, this method is used for testing materials: metals, polymers and organic chain compounds. In recent times, it is also used in studies of biological structures. Structures like biomembranes, collagen scaffolds or simple model organisms were studied with success. Complementary studies with SEM (Scanning Electron Microscopy), confocal microscopy and transcriptomic will be conducted. This will allow you to obtain new information on the molecular structure of the cells and associate them with PALS parameters.

The results of the proposed research will bring a lot of information regarding the structure of mammalian cells and its relation with life processes. The study of various cells types, both normal and neoplastic ones, will allow to better understand the process of carcinogenesis. Studied of the structure of living cells with such accuracy has not been so far carried out, due to the absence of the accurate methods. PALS method is non-invasive and may, in the future, be used to perform not only *in vitro* but also *in vivo* studies. This will allow to distinguish cancer cells when they are not yet detectable by other, commonly used methods.