Mitochondria provide cells with energy to carry out fundamental organism functions. In addition to the synthesis of ATP, as an energy carrier, mitochondria are involved in such important phenomena as apoptosis, necrosis or lipid oxidation. The proper functioning of mitochondria depends on the maintenance of transmembrane potential ($\Delta\Psi$) associated mainly with the difference in proton concentration across the inner mitochondrial membrane and ion transport and a number of substrates. One of the groups of proteins involved in ion transport are, discovered relatively recently, potassium channels of the inner mitochondrial membrane. Our initial research suggests that mitochondrial potassium channels change their activity when exposed to infrared light.

Especially the increase in potassium ion transport across the inner mitochondrial membrane has aroused the interest of many researchers. It has been shown that the activation of mitochondrial potassium channels in various cell types can lead to cell protection against damage, a phenomenon known as cytoprotection, especially in tissue hypoxia. The mechanism of this process is not fully understood, and the proposed research project aims to identify new infrared light-induced cytoprotective mechanisms.

According to WHO (World Health Organization) data, one of the main causes of morbidity and death in the modern world is hypoxia of the heart muscle or brain tissue, the search for new cytoprotective processes is extremely important. Numerous studies have shown that the opening of potassium channels using chemicals called potassium channel activators can initiate processes that protect cells from damage caused by various factors, including hypoxia associated with cardiac arrest, ischemia. The proposed research project aims to demonstrate that instead of chemicals to activate the potassium channels of the inner mitochondrial membrane, infrared light can be used, which in this wavelength range can penetrate deep into the tissue to a depth of 10 cm.

Mitochondrial potassium channels maintain ion homeostasis in mitochondria, are responsible for changes in mitochondrial volume, and also indirectly participate in the formation of a hydrogen ion gradient (ΔpH) between the mitochondrial matrix and cell cytoplasm. The resulting pH gradient is used by cells in the ATP synthesis process. For these reasons, mitochondrial potassium channels are an interesting object from the point of view of basic sciences, and the results obtained can be used in medicine.

A full description of the mechanisms behind the phenomenon of cytoprotection induced by mitochondrial potassium channels, however, requires an understanding of their regulation, structure and interaction with other proteins. To date, eight mitochondrial potassium channels have been identified. The first described was the ATP regulated potassium channel. In subsequent years, the presence of potassium channels regulated by calcium ions and voltage was demonstrated.

The beneficial effects of red or infrared light on the body in various situations associated with tissue damage has been observed for many years. It turns out that the main light absorber of this length is mitochondria, and in particular cytochrome oxidase, a protein that plays a key role in the generation of proton gradient in mitochondria. Our research indicates the possibility of regulating potassium channels by infrared light, as do the chemical compounds, potassium channel activators. Light induction of the phenomenon of cytoprotection in the heart muscle or the brain can have important implications in modern medicine.