Photosynthetic microbial fuel cells (pMFC) are a technological solution with direct generation of energy as a result of treatment of organic waste. In microbiological fuel cells, organic compounds are biodegraded into carbon dioxide, protons and electrons are produced as the result of this process, which use the anode as the terminal electron acceptor. The released electrons migrate through the external electric circuit to the cathode and generate an electric current. At the cathode a reduction of oxygen to water take place, which is catalyzed by electrons and protons formed on the anode. In pMFC, microalgae are cultivated in anode chamber. An additional benefit of pMFC is the production of microalgae biomass, which can be used to obtain biofuels or other valuable substances (omega-3 acids, biodegradable plastics, proteins, pigments, pharmaceuticals). However, in order to increase the application capabilities of pMFC, it is necessary to extend basic research related to the formation of biofilms and the growth rate of microalgae biomass. The next step related to the optimization of pMFC activity are studies on the expression of key genes in the cells of microorganisms carrying out anaerobic respiration and photosynthesis.

The issue that will be solved as part of the proposed project is the impact of electric current on the adhesion and detachment of cells to the surface of the electrode. Few studies indicate that the use of electrical stimulation, to regulate the potential of the anode, accelerates the growth of bacteria and enhances the electrochemical activity of the anode. The basis for undertaking work on this issue is the lack of clear data available in the literature. There are also studies showing that at the same voltage the cells are detached from the surface of the electrode and are deactivated. Photosynthesis in pMFC is carried out by microalgae, which by producing oxygen provide an electron acceptor in the cathodic space. The carbon dioxide created as a result of anaerobic respiration on the anode will be used to intensify the cultivation of the biomass of *Chlorella vulgaris*, *Arthrospira platensis* and *Platymonas subcordiformis* Then, after optimization of the carbon dioxide concentration, the culture medium will be gradually replaced by the outflow from the anode space. The microalgae and cyanobacteria biomass will be used to obtained value-added products i.e. lipids, phycocyanin and hydrogen.

The aim of the project is to explain the process of biofilm formation on the anode under the influence of electric current, increase the photosynthetic efficiency of microalgae and cyanobacteria by biosequesteration of carbon dioxide in the cathode. The last task involve operation of several units of the pMFC built into modules and optimization the functioning of a photosynthetic microbial fuel cell. The substrate used in the research will be municipal wastewater and cheese whey. Two types of inoculum will be tested. The presented research include molecular analyses related to the expression of genes responsible for the process of photosynthesis and the transfer of electrons to the anode. In addition, next generation sequencing will be performed to identify the microorganisms involved in the processes. Such detailed research concerning both the anode and cathode space has not been presented in the literature so far, which underlines the innovative nature of the research. The obtained results will be used to optimize the operation of pMFC in the biological field, which will complement the engineering studies very widely described in the literature (concerning ion exchange membrane, electrode construction, cell type, etc.).