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Bioenergetics of haloalkaliphiles

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Abstract
The research aims at finding out the distinctive lines of energetics in natronophilic microorganisms started to be described (Banciu & Muntyan, 2015). Among used methods were analyses of respiratory characteristics, electrical potential generation, pH changes in cells/vesicles suspension upon light/oxygen impulses, effects of ionophores and uncouplers, visualization of sodium transport using radioisotope ^{22}Na, phylogenetics. Summary of results: So far, a novel type of primary energy transformer, Na^+-motive cytochrome oxidase, which has been proven to operate in natronophilic strains of the genus *Thioalkalivibrio* (Muntyan *et al.*, 2015), has been discovered, and then found in several other extremophiles. It has been demonstrated that in these same strains, cell motility is provided by Na^+-motive flagella. In addition, it was shown that the rhodopsin-like pigment, proteorhodopsin, in the new natronophilic strain of a novel deep-lineage of the phylum Balneolaeota, *Cyclonatronum proteinivorum*, pumps Na^+ from cells (Sorokin *et al.,* 2018). The screening of Na^+-motive energy mechanisms revealed the sodium energy cycle, consisting of (i) primary mechanisms for generating Na^+-potential and (ii) Na^+-potential consumers, represented by flagella and FoF1-ATPase. Conclusion: Along the way, we first discovered that several species of bacteria simultaneously have in their genomes: (i) oxygen-consuming generators of Na^+-potential (Na^+-pumping cbb_3 oxidases) and (ii) consumers of Na^+-potential such as Na^+-ATPase of F0F1-type and flagella. Thus, for the first time, it became possible to establish the presence of a complete Na^+-cycle in energetics of oxygen-respiring bacteria.

Keywords: alkaliphiles, Na^+-motive enzymes, soda lakes.

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