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CONTRIBUTION OF NA^+/K^+ ATPASE TO BIOCHEMICAL ADAPTATIONS OF FRESHWATER FISH TO POLLUTED WATER OF THE ORE-DRESSING INDUSTRIAL COMPLEX NEAR KOSTOMUKSHA, KARELIA

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The impact of human activities on water bodies has substantially increased in the past yeas. Therefore, more attention is now given to the existence and survival of the aquatic organisms in contaminated water. Aquatic ecosystems, communities and organisms, including fish, are extremely sensitive to disturbances in the chemical composition of the environment that may inhibit metabolic pathways and reduce the resistance of cells in the organism. Biochemical changes in the cells and tissues of an organism are commonly observed before external signs come to sight (Stroganov et al., 1983; Nemova and Vysotskaya, 2004). The effect of toxicants on the organism is accompanied by the involvement of the cellular and molecular mechanisms that control metabolic homeostasis. It is common knowledge that the ion composition of an organism's internal fluids in the normal condition would always differ to a certain degree from the ion composition of the ambient medium. The state of the mechanisms that maintain the water-salt homeostasis is an essential criterion in assessment of the physiological fitness of an organism. Stress resistance depends not only on the maturity of morphological structures responsible for adaptation to the respective factors, but also on the activity of the constituent enzymes that supply the structures with energy and maintain the ion homeostasis in the cell. The key role in the processes of osmotic and ion regulation is known to belong to active transport enzymes which carry ions against their concentration gradient. Of particular importance among these is the enzyme Na^+/K^+ ATPase. It is the enzyme in the outer membrane of cells in all animal tissues that helps maintain a key property which differentiates living cells from dead cells – asymmetric distribution of sodium and potassium ions on the cell membrane inside and outside. Asymmetric distribution of univalent cations is essential for the formation of the cell's membrane potential, as well as for metabolite transport across the cell membrane, and for regulation of intracellular metabolic reactions (Boldyrev, 1998). Active transport of Na ions from the cell and K ions into the cell, performed by Na^+/K^+-ATPase, is an inseparable property of a living cell.

Investigating the index of active ion transport we can estimate the contribution of Na^+/K^+-ATPase to biochemical mechanisms of freshwater fish (pike, whitefish) adaptation to highly mineralized, particularly rich in potassium ions, technogenic water of Lake Kostomukshskoye, which was impounded to supply the mill with recirculated water. Wastewater from the Kostomuksha mining and ore-dressing complex contains a mixture of metals with high potassium concentration and a high percentage of suspended ore particles. In the contaminated zone, high water mineralization is primarily due to the presence of K^+ (157 mg/l) and sulphate ions (266 mg/l), and the water can be classified into the sulphate-potassium class. Among other elements one may note (Lozovik, 2007) elevated content of Li^+ (83 μg/l) and Ni^+ (11 μg/l). High alkali and alkali-earth metal and hydrocarbonate concentrations in the polluted zone were responsible for the shift of pH toward the alkaline region (8.0). Potassium ion content in Lake Kamennoye water in the clean-environment zone (Kostomukshsky nature reserve territory) is 0.29 mg/l, which is much lower than in the polluted zone. The

increase in Na ion content is insignificant – from 1.0 mg/l in Lake Kamennoye water to 17 mg/l in the polluted zone. The concentrations of elements (Co, Ni, Cr) are a few microgrammes per litre of water in the polluted zone, which slightly exceeds the corresponding values observed in the clean zone (Morozov, 2006).

Research into the activity of Na^+/K^+-ATPase in different tissues (gills, muscles, kidneys, liver, gonads) of fish from the lakes in question revealed tissue-specificity and reduction in the activity of the enzyme in the fish caught in the polluted zone. Since the activity of Na^+/K^+-ATPase is regulated, first of all, by univalent cations, a change in the Na^+/K^+ ratio changes the enzyme activity in a specific way. Suppression of the activity of the active transport enzyme Na^+/K^+-ATPase, which concentrates potassium ions within the cell, is presumably a consequence of the substantial rise (~ 500-fold) in the potassium ion concentration in the ambient environment – the highly mineralized impoundment reservoir, as compared with the normal freshwater habitat. Changes in the composition of the medium, first of all in the content of sodium and potassium ions, as the most variable component, alter the electrolytic composition of an organism (Hlebovich, 1974) and thus trigger adaptive modification of the activity of the membrane enzyme which maintains the intracellular ion homeostasis.

Thus, changes in the activity of Na^+/K^+-ATPase is an example of biochemical adaptation which success depends on the ability of the fish to modify their water-salt metabolism in accord with the environment. The optimal microenvironment of the organism's macromolecules is thus maintained, which is the main principle behind the strategy of biochemical adaptation (Hochachka and Somero, 1977; Nemova and Vysotskaya, 2004).

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ROLE OF THE INSERTION SEQUENCE ELEMENTS IN THE GENOME ORGANIZATION OF THE *ALIIVIBRIO SALMONICIDA*

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Growing evidence show that bacterial genomes actively evolve under pressure of environmental changes. Rearrangements caused by mobile genetic elements and insertion sequence (IS) elements in particular, greatly contribute to the generation of the occasional fitter mutants and thus increase the genetic variability in bacterial populations. IS elements normally encode no functions other than transposases