CHARGE-SPECIFIC MECHANISM OF PENETRATING IONS ACCUMULATION LOCALIZED IN MITOCHONDRIAL MEMBRANE

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Experiments with mitochondria and "sonic" submitochondrial particles (SMP) revealed the existence of a mechanism for ion accumulation specific only to the sign of the charge of transported ion. The mechanism can operate with any ion tested (natural or synthetic) which is able to penetrate through artificial membrane made of mitochondrial phospholipids. It was found that penetrating cations switch on the operation of a proton pump inducing the acidification of the medium with mitochondria but not with SMP which have an opposite polarity of membrane. Anions induce alkalinization of the medium with SMP but not with mitochondria. The effects of two synthetic ions, N,N-dimethyl N,N-dibenzyl ammonium (DDA^+) and tetraphenyl boron (TPB^-) were studied in detail. Both ions decreased the electric resistance of phospholipid membranes due to their transmembrane diffusion. In mitochondria DDA^+ induced an energy-dependent H^+ efflux, transient increase of State 4 respiration, cyclic oxidation of succinate-reduced NAD and swelling of mitochondria. All effects of DDA^+ in both phospholipid membranes and mitochondria were greatly potentiated by small amounts of TPB^- anion. DDA^+ was found to be quite ineffective in SMP. TPB^-, but not DDA^+, was accumulated in SMP at the expense of respiration or ATP hydrolysis. The process was sensitive to antimycin in the former and to oligomycin in the latter case. TPB^- accumulation was accompanied by alkalinization of the medium. The uncoupler TTFB reversed pH changes induced by ion transport and provoked the loss of ions accumulated. Similar results were obtained if tetrabutyl ammonium or triphenylmethyl phosphonium cations instead of DDA^+ and phenyl dicarbaundecaboran or picrate anions instead of TPB^- were used. It may be concluded that charge-specific ion accumulation in mitochondria and SMP is due to ion movement in electric field created by the energy-dependent H^+/OH^- separation.