

CONVERSION OF BIOMEMBRANE-PRODUCED ENERGY INTO ELECTRIC FORM

II. INTACT MITOCHONDRIA

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SUMMARY

The transport of synthetic ions penetrating across intact mitochondrial membranes has been investigated. It is shown that anions of phenyl dicarbaundecaborane (PCB⁻) are extruded from mitochondria on transition to the energized state. Discharge of the energized state is accompanied by movement of the extruded anions back into the mitochondria.

The penetrating cations dibenzyl dimethyl ammonium (DDA⁺), tetrabutyl ammonium and triphenyl methyl phosphonium, when added to liver or heart mitochondria in the presence of oxidizable substrates or ATP, bring about the same responses that accompany the active transport of natural penetrating cations Ca²⁺ or K⁺ in the presence of valinomycin, *i.e.* acidification of the incubation mixture, a transient increase in ATPase and oxidation rate in State 4, cyclic oxidation of NAD(P)H reduced by succinate and swelling of the mitochondrial matrix. The latter process requires the addition of inorganic phosphate.

DDA⁺-induced swelling is found to be supported by both ATP hydrolysis and respiratory chain electron transfer from substrates to oxygen or to ferricyanide.

All effects of penetrating cations in mitochondria are potentiated by the addition of small amounts of the penetrating anions, PCB⁻ or tetraphenyl boron, which increase the permeability of the membrane for the cations under study.

The data obtained confirm the conclusion that it is the electric field (negative inside the mitochondria) which is the motive force for the transport of penetrating ions across the mitochondrial membrane.

INTRODUCTION

In the previous paper, the phenomenon of accumulation of anions penetrating submitochondrial particles was described¹. It was found that the energy-dependent

Abbreviations: PCB⁻, phenyl dicarbaundecaborane; DDA⁺, *N,N*-dibenzyl *N,N*-dimethyl ammonium cation; FCCP, *p*-trifluoromethoxycarbonyl cyanide phenylhydrazone; TMPD, *N,N,N',N'*-tetramethyl-*p*-phenylenediamine; TTFB, tetrachlorotrifluoromethyl benzimidazole.