TRANSFER OF ISOLATED ORGANELLES INTO CELLS: AN EXPERIMENTAL APPROACH TO THE EVOLUTIONARY ORIGIN OF CELL ORGANELLES

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Based on pioneering studies of Gunge and Sakaguchi (1979) and Yoshida (1979) an efficient method for the transfer of isolated mitochondria into yeast protoplasts has been worked out recently (Sulo et al., 1989). The essence of the method consists in preincubating mitochondria, isolated either from intact yeast cells or from protoplasts, and acceptor protoplasts with Ca^{2+} ions and subsequent incubation in the presence of polyethylene glycol. The isolated mitochondria are respiration-competent while the acceptor protoplasts contain defective, respiration-deficient mitochondria, so that the efficiency of transfer can be evaluated quantitatively by restoration of the respiratory competence of the acceptor protoplasts. In an alternative procedure, the isolated mitochondria and acceptor protoplasts are exposed to high-voltage electric pulses. Under optimal conditions the frequency of transfer has been found to be 10^{-4}.

The treatments enabling transfer of the isolated organelles into protoplasts are, at the same time, inducing protoplast-to-protoplast fusions. Accordingly, the following mechanism may be operating: The isolated organelles are first adsorbed on the surface of the protoplasts, assisted by Ca^{2+} ions, and entrapped between two protoplasts which then fuse together and engulf the entrapped mitochondria. A similar mechanism has been proposed to account for the entrance of transforming DNA into yeast protoplasts (Brzobohatý and Kováč, 1985).

Attempts have been undertaken to introduce DNA into isolated mitochondria, recombine it with the endogenous DNA

and implant such mitochondria into acceptor protoplasts.

The experimental procedures represent a step in attempts at recapitulating the evolutionary process by which originated the cell organelles. The first evolutionary event may have been the adsorption of bacteria or blue-green algae on the surface of a proto-eucaryotic cell and their interioration upon fusion of two adjacent cells. Ca^{2+} ions may have been instrumental in the process.

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