Mitochondrial Protein CYP11A1 Changes Mitochondrial Morphology

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Mitochondria are the "energy factories" of the cell. Their main function is ATP production, and they are normally thumb-shaped with lamellar cristae. Mitochondrial morphology regulates apoptosis and autophagy, which are important in neurodegenerative diseases and cancer. CYP11A1 is a steroid-hormone-producing enzyme located in the inner mitochondrial membrane. The expression levels of CYP11A1 are also correlated with changes in mitochondrial morphology during cell differentiation. Therefore, my project aims to examine the hypothesis that CYP11A1 can change mitochondrial morphology. I found that Y1 cells (mouse adrenocortical tumor cell) with endogenous CYP11A1 contained spherical mitochondria with arched cristae, while cells without endogenous CYP11A1 such as NIH-3T3 (mouse embryonic fibroblasts) and COS-1 (monkey kidney cell) had elongated mitochondria with lamellar cristae. Then, I overexpressed CYP11A1 by transfecting CYP11A1-expressing plasmids into COS-1 cells, followed by counting the numbers of mitochondria in different shapes or having different crista structures. The percent of spherical mitochondria was increased, and tubular-vesicular cristae were found inside mitochondria of cells transfected with full-length CYP11A1 plasmids. The percent of tubular-vesicular cristae was also increased in cells transfected with mutant CYP11A1 that lacks activity. I also found declines in the ATP production rates after cells were transfected with CYP11A1. I conclude that CYP11A1 can change mitochondrial morphology and reduce ATP production rates whether with or without its activity. These results imply the relation between the "normal" changes of mitochondrial morphology and steroid hormone production.

Awards Won:
Fourth Award of $500