Table 1 Summary of the Redox-coupled Conformational Change in Carboxyl Group of Asp51 in Subunit I of Bovine Heart Cytochrome *c* Oxidase

	H-bond	Accessibility	pK
fully oxidized state	4	matrix side	high
fully reduced state	1	intermembrane side	low

for the proton is reduced.

Thus, the crystal structure strongly suggests that the carboxyl group of aspartic acid-51 is the site of the proton pump that takes up the proton from the interior of the mitochondrion in the oxidized state and releases it in the exterior part of the mitochondrion in the reduced state. Needless to say, however, this crystal structure has been determined only in static, oxidized, and reduced states, not during enzyme turnover. Therefore, although these studies strongly indicate that the carboxyl group of aspartic acid-51 is the site of the proton pump, much more research is needed to prove that the proton really does pass through this site and that this site acts as the proton pump. To do so, we will need to use not only X-ray crystallography but also different spectroscopic methods, as well as currently exploiting techniques of altering the aspartic acid-51 amino acid by mutation. In this way, we should be able not only to determine the correctness of this theory but also make many new discoveries regarding the mechanism of the cytochrome oxidase reaction.

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