

Measurements of the Oxidation State of Manganese Inside Brain, Heart, and Liver Mitochondria Using XANES Spectroscopy

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ABSTRACT

Most intracellular Mn is found in mitochondria. We have used the shift in the manganese absorption edge in x-ray absorption near edge structure (XANES) spectroscopy to determine the oxidation state of Mn in brain, heart, and liver mitochondria, as well as in PC12 cells. We compared the XANES spectra of Mn in brain, heart, and liver mitochondria over a range of Mn concentrations with those of Mn standards and over a range of conditions selected to increase ROS and Mn(III) production.

The standards used include Mn(II)ATP, Mn(II)HPi, Mn(II)Cl₂, Mn(III)porphyrin, Mn(IV)O₂ and other complexes. Spectra from brain, heart, and liver mitochondria showed no significant differences. Over the full range of Mn concentrations studied intramitochondrial spectra closely matched those of the Mn(II) standards, particularly a sum of Mn(II)ATP and Mn(II)HPi. There was no indication of the presence of Mn(III) in mitochondria. Similarly, hours of incubation, even incubation under conditions known to increase ROS production, caused no indication of the presence of Mn(III). We conclude that the amount of Mn(III) present inside mitochondria is quite small. The intramitochondrial Mn(III) formed must be reduced to Mn(II) because of the instability of Mn(III) complexes.

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