The 2nd Annual Conference of the Korean Society for Bioinformatics (KSBI2003)

Structure function relationships amongst the purple acid phosphatase family of binuclear metal-containing enzymes

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Abstract

The purple acid phosphatases comprise a family of binuclear metal-containing enzymes. The metal centre contains one ferric ion and one divalent metal ion. Spectroscopic studies of the monomeric, ~36 kDa mammalian purple acid phosphatases reveal the presence of an Fe(III)Fe(II) centre in which the metals are weakly antiferromagnetically coupled, whereas the dimeric, ~110 000 kDa plant enzymes contain either Fe(III)Zn(II) or Fe(III)Mn(II). The three dimensional structures of the red kidney bean and pig enzymes show very similar arrangements of the metal ligands but some significant differences beyond the immediate vicinity of the metals. In addition to the catalytic domain, the plant enzyme contains a second domain of unknown function.

A search of sequence databases was undertaken using a sequence pattern which includes the conserved metal-binding residues in the plant and animal enzymes. The search revealed the presence in plants of a "mammalian-type" low molecular weight purple acid phosphatase, a high molecular weight form in some fungi, and a homologue in some bacteria.

The catalytic mechanism of the enzyme has been investigated with a view to understanding the marked difference in specificity between the Fe-Mn sweet potato enzyme, which exhibits highly efficient catalysis towards both activated and unactivated phosphate esters, and other PAPs, which hydrolyse only activated esters. Comparison of the active site structures of the enzymes reveal some interesting differences between them which may account for the difference. The implications for understanding the physiological functions of the enzymes will be discussed.