Laccases (EC 1.10.3.2) are copper-containing oxidoreductases that have a relatively high redox potential which enables them to catalyze oxidation of phenolic compounds, including lignin-derived phenolics. The laccase-catalyzed oxidation of phenolics is accompanied by concomitant reduction of dioxygen to water via copper catalysis and involves a series of electron transfer reactions balanced by a stepwise re-oxidation of copper ions in the active site of the enzyme. The reaction details of the catalytic four-copper mechanism of laccase-mediated catalysis are carefully re-examined and clarified. The substrate range for laccase catalysis can be expanded by means of supplementary mediators that essentially function as vehicles for electron transfer. Comparisons of amino acid sequences and structural traits of selected laccases reveal conservation of the active site trinuclear center geometry but differences in loop conformations. We also evaluate the features and regions of laccases in relation to modification and evolution of laccases for various industrial applications including lignocellulosic biomass processing.
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