Coupling of Redox Enzymes with Electricity: Bioelectrocatalysis and Biofuel Cells

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Redox enzymes catalyze the exchange of electrons or redox equivalents between donor and acceptor molecules. This enables redox enzymes to be combined with electricity. Herein we present our recent work on bioelectrocatalysis and biofuel cells. 1) Electrically conductive sol-gel matrix was first applied in order to enhance the efficiency of electrochemical NADH regeneration for bioelectrocatalysis. Vanadia-silica gels could effectively improve direct electrochemical reduction of NAD+. When the redox enzyme entrapped in electrically conductive vanadia-silica gels was used, the reaction conversion was significantly enhanced from 30% to 100%. 2) We discovered that conductive nanoparticles could enhance the rate of heterogeneous electron transfer between NAD+ and electrodes in the presence of an organometallic mediator. 3) Ferritin is a globular protein capable of storing iron in the cavity. The naturally existing iron core of ferritin can be readily extracted and replaced with a variety of electroactive materials. Ferritin was immobilized on a gold electrode based on self-assembled monolayers and reconstituted with platinum. Applicability of Pt-cored ferritin to biofuel cells was examined.