Biocatalytic H_2 production under aerobic conditions: Challenges and opportunities

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Hydrogenases are nature's catalysts designed for rapid and reversible oxidation of H_2 into protons and electrons. Both the formation and consumption of H_2 are catalysed with conversion rates of up to 10,000 molecules per second. All hydrogenases known so far utilise abundant transition metals such as nickel and iron for catalysis, which is in sharp contrast to man-made H^+/H_2-cycling catalysts that predominantly rely on the rare precious metal platinum. This situation currently boosts research on biological and bioinspired catalysts. Since transition metals are intrinsically susceptible to dioxygen, the catalytic centers of most hydrogenases become inactivated or even destroyed upon interaction with O_2. This property hampers the application of these biocatalysts in, e.g., light-driven H_2 production by coupling hydrogenase with oxygenic photosynthesis.

However, some microorganisms are able to gain energy from the controlled combustion of H_2 with dioxygen. This process is mediated by so-called "oxygen-tolerant" [NiFe]-hydrogenases. In this context, O_2 tolerance is defined as sustained $H+/H_2$ cycling in presence of O_2. This talk will briefly introduce the fundamental aspects of how certain [NiFe]-hydrogenases cope with the detrimental effects of O_2. The second part is dedicated to the biotechnological application of O_2-tolerant hydrogenases, including achievements and challenges of solar-driven H_2 production with cellular systems.

Literature:

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