Voltammetric Sensors for Hydrogen Peroxide Detection in Living Cells

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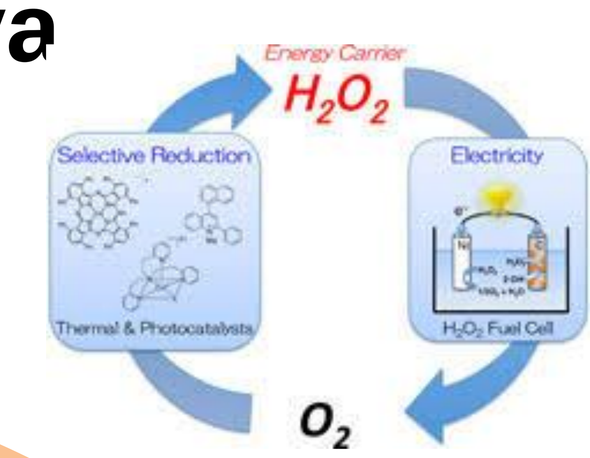
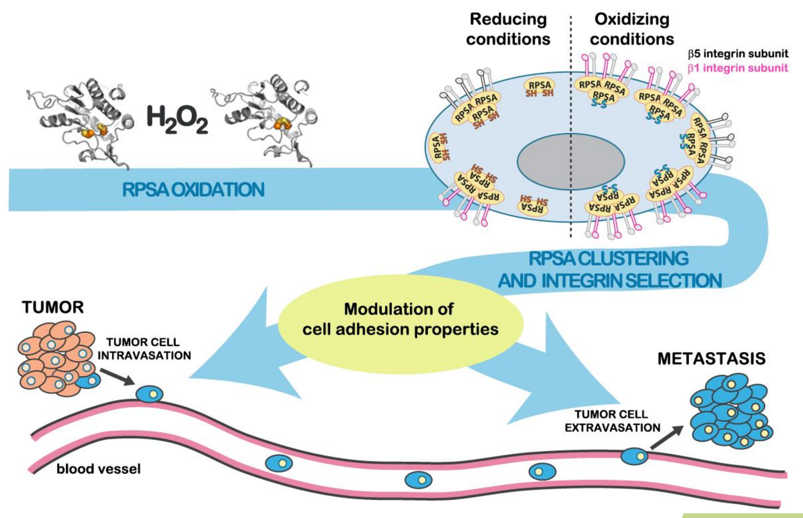




1 Background

Hydrogen Peroxide (H_2O_2) is one of the most important small molecules involved in various signalling processes at all living systems. Hydrogen peroxide is commonly created as a by-product in the respiration processes. There is significant amount of scientific information showing the involvement of H_2O_2 in signalling of stress responses, and in many other redox-signalling related processes. In most of the mechanisms featuring redox-signalling in the cells, it is confirmed that thiol-containing molecules play important role, usually undergoing a redox transformation in reactions with H_2O_2. The redox chemistry of H_2O_2 is quite complex, since it can be involved in variety of reactions. Depending on the pH, H_2O_2 can be seen as a substance with highly oxidative potential, but also as a compound with reductive properties. The two most simple 2-electron scenarios of oxidation and reduction of H_2O_2 can be described by following reactions:

$H_2O_2 + 2H^+ + 2e^- \longrightarrow 2H_2$ $E° = +1.534$ *V vs. SCE* (pH of 7.00)
$2H^+ + O_2 + 2e^- \longrightarrow H_2O_2$ $E° = +0.440$ *V vs. SCE* (pH of 7.00)

In this work, we show several ways of designing voltammetric sensors for hydrogen peroxide quantification. These methods can be designed for direct detection and quantification of hydrogen peroxide, but more efficient are the approaches in the so-called Electrocatalytic-Regenerative (EC') electrode mechanism. With the methods presented here, detection of hydrogen peroxide in micro-to-milimolar range is possible.

2 Results-

First sensor is based on direct Quantification (reduction of H2O2) at metallic electrodes

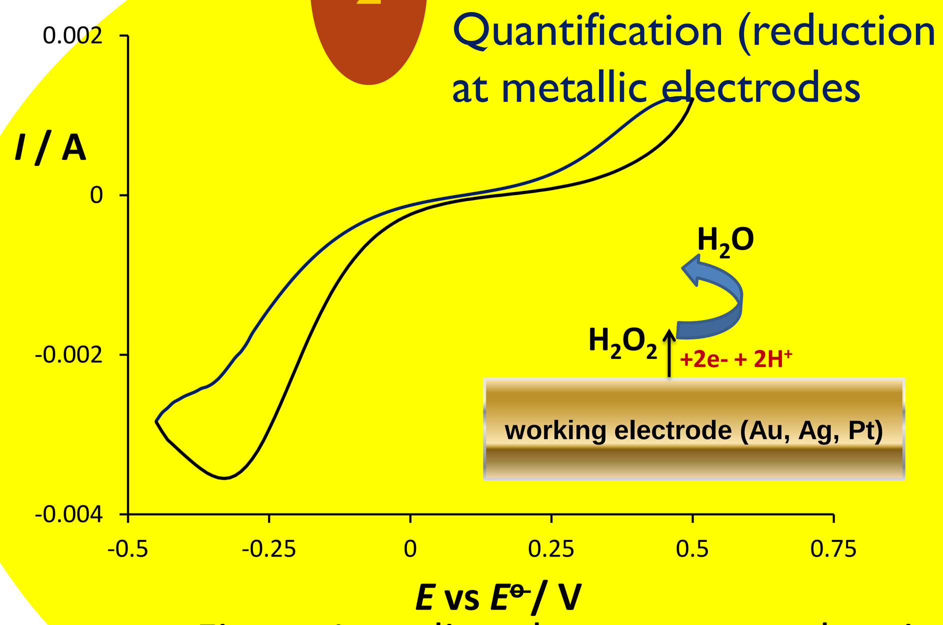
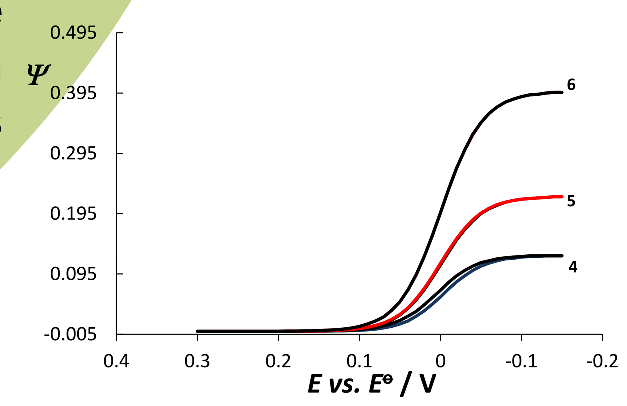
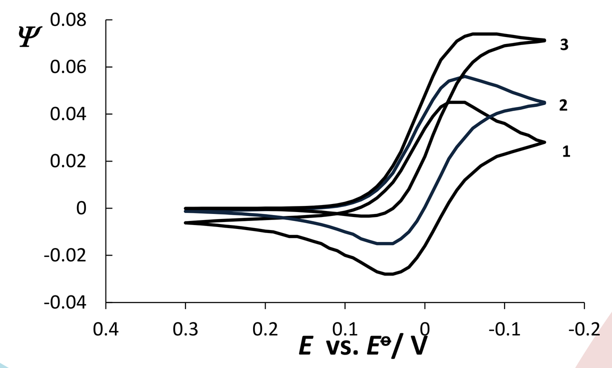


Figure 1. cyclic voltammogram showing reduction of H_2O_2 at bare metallic electrodes





3 Results-II

Second sensor is based on Redox properties of a given Enzyme that **is dissolved** in water And whose redox reaction is Coupled with some redox couple Sensitive to H2O2

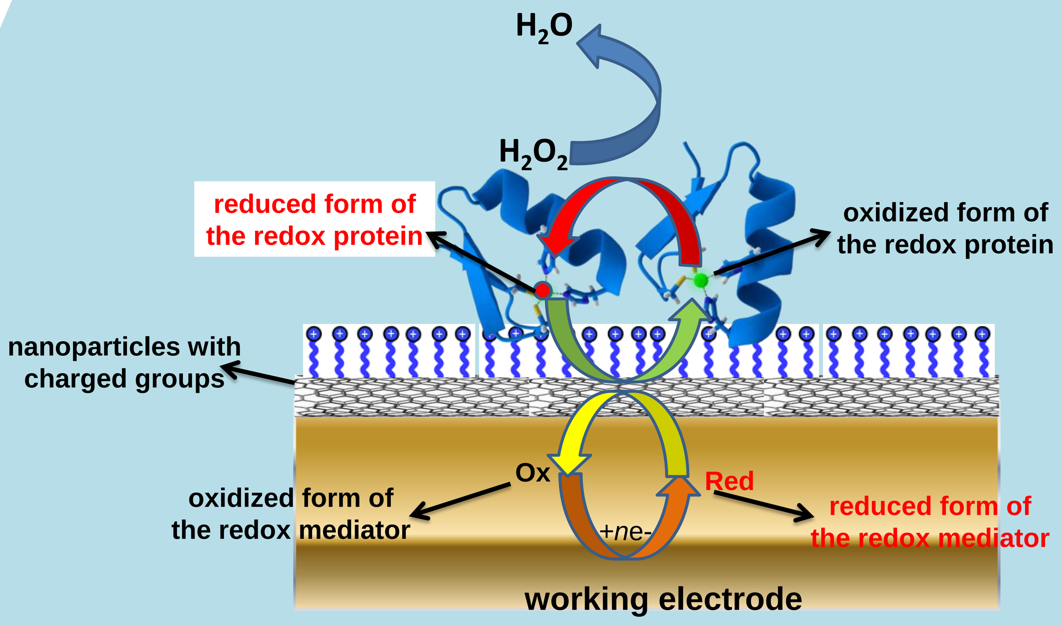
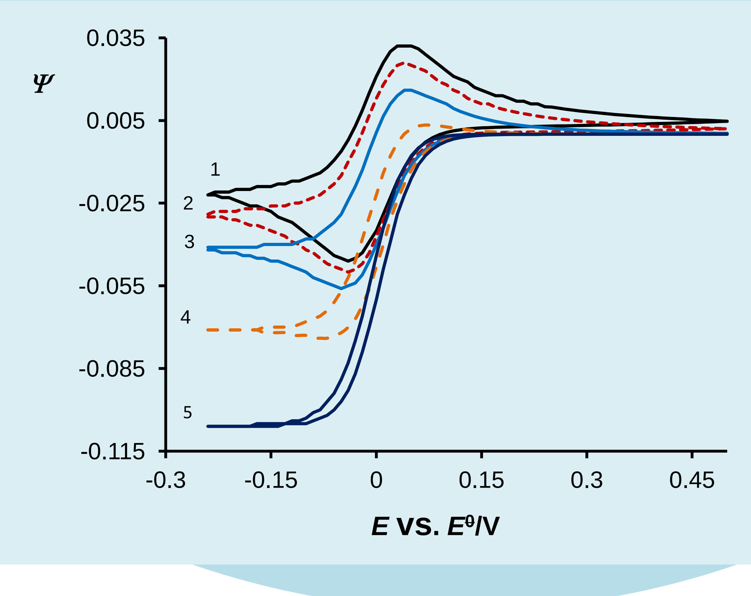
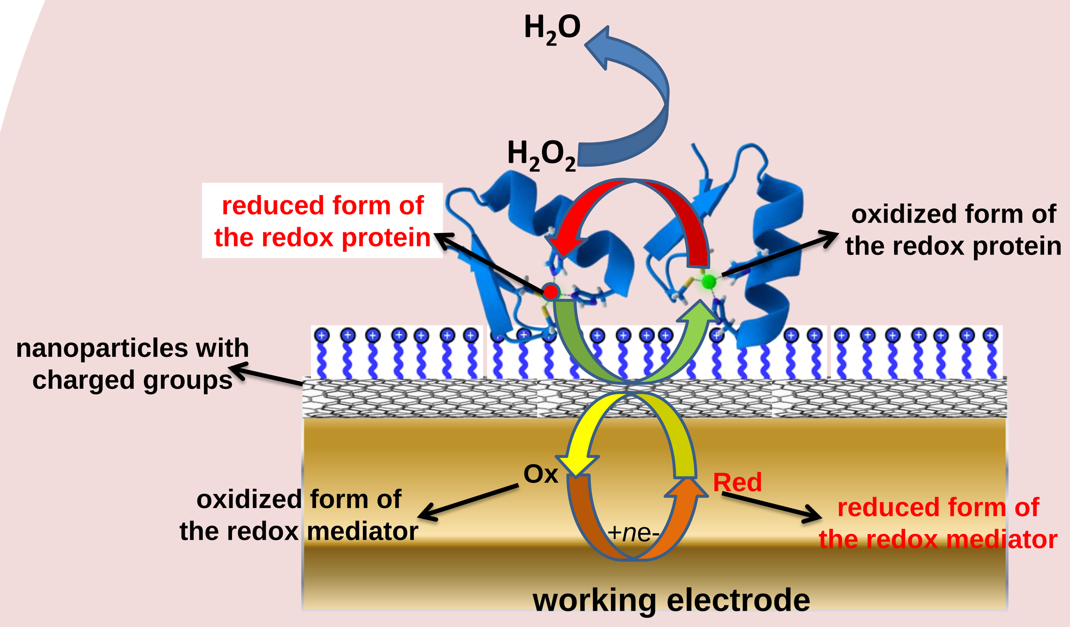


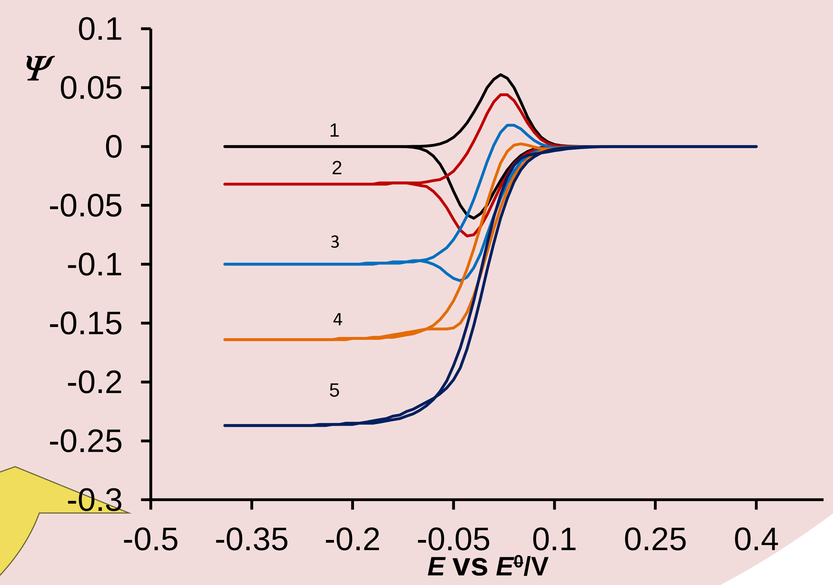
Figure 2. Scheme of voltammetric sensor for H2O2 detection based on „dissolved redox enzyme" with redox mediator Curve 1 is without H2O2, and curves 2-5 are with consecutive increase of H2O2 concentration . Faradaic currents on voltammograms originate from the reaction Ox + ne- ↔ Red Redox mediator Ox is initially present in the electrochemical cell



4 Results-III

Thirs sensor is based on Redox properties of a givenEnzyme that is **adsorbed** on working electrode Surface and whose redox reaction is Coupled with some redox couple Sensitive to H2O2





5 Conclusions

**We present several scenarios under conditions of cyclic voltammetry for quantification of hydrogen peroxide in living cells.
The methods can be direct, but commonly a so-called „redox enzyme" mediatorsare used for getting sensitive quantification of H2O2.**

References

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