

Grace Crim

Burke Award

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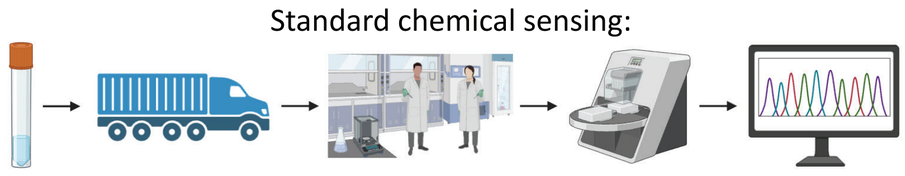
Indirect Electrochemical Biosensing of H_2O_2 Using Synthetic Cells

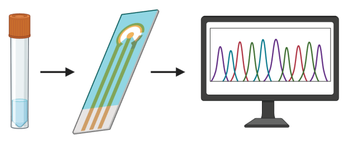
We are developing a novel biosensing chip that uses peroxide as a proxy sensor for neurotransmitters, but could also be designed for any biomolecule of choice.

Chemical Processing Takes Time, Money, and Effort

Standard chemical sensing:



Electrochemical biosensing:



Biosensors Are Commonly Used - But Have Different Definitions

Electrical definition:

Using electrical sensing to detect biological molecules

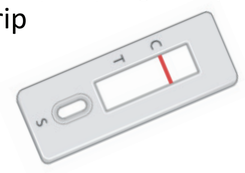
Example: continuous insulin monitor



Chemical definition:

Using biological and chemical molecules to sense other molecules

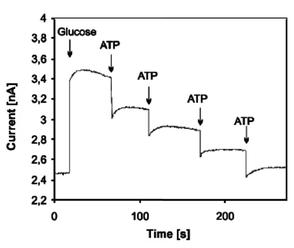
Example: pregnancy test strip



Amperometric Electrochemical Sensors

Bioreceptor → Transducer → Amplifier → Signal Processing → Display

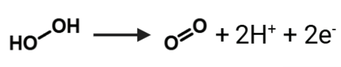
- **Amperometric**: continuous current measurements
  - Oxidation or reduction of electroactive species induces current

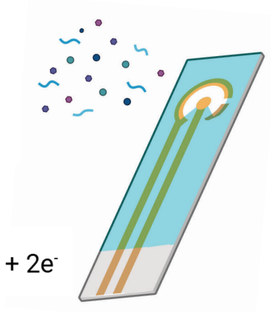


A. Kueng, C. Kranz, and B. Mizaikoff, "Amperometric ATP biosensor based on polymer entrapped enzymes," Biosensors and Bioelectronics, vol. 19, no. 10, pp. 1301–1307, Jan. 2004, doi: 10.1016/j.bios.2003.11.023.

$$i = \frac{nFAC_0\sqrt{D}}{\sqrt{\pi t}}$$

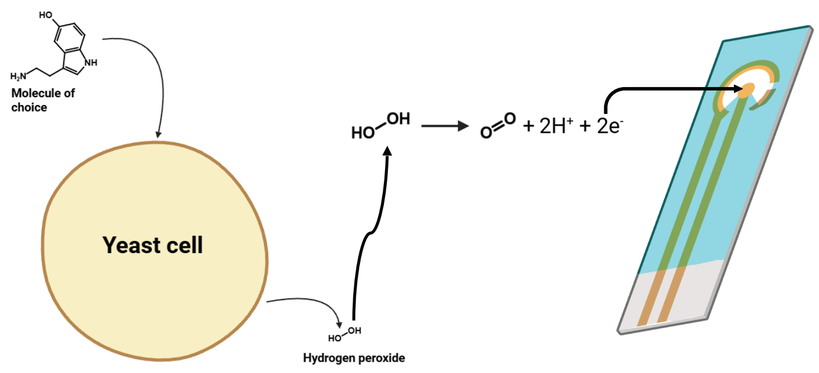
Cottrell Equation





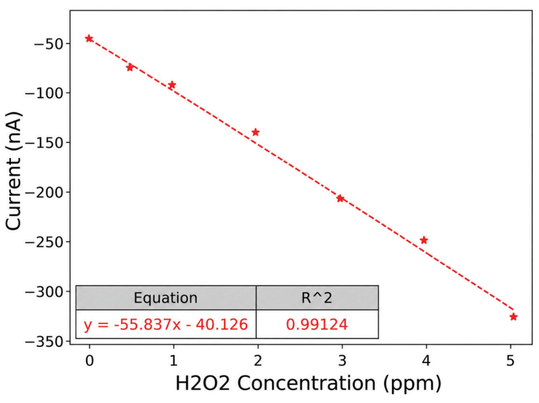
Indirect Sensing with Synthetic Biology

Our goal: **neurotransmitter detection** with engineered **yeast cells**



Chronoamperometry (CA) Shows Change in Current Over Time with a Steady Voltage

Linear relationship between maximum current and H_2O_2 concentration.



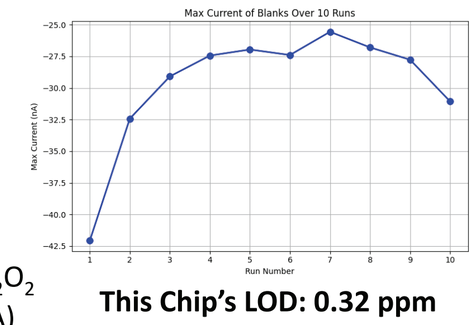
Limit of Detection (LOD) Must Be Low to Detect Changes in Input Chemical Concentration

- LOD: smallest detectable concentration
- Varies by chip

$$LOD = \frac{3\sigma}{m}$$

σ: standard deviation of 0ppm H_2O_2 final current measurements (nA)

m: sensitivity of the chip (nA/ppm)



This Chip's LOD: 0.32 ppm

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