THE SCIENCE WORLD
A Monthly e Magazine
ISSN:2583-2212
Popular Article
December, 2025 Vol.5(12), 11052-11055

Biosensors: Tiny Tools Changing Big Worlds

Chaudhari Mahesh P[1]., Patel Vinay M[2]., Muniraju Aishwarya[3]., Savaliya Ravi[4]
[1]Jr. Officer, Banas Dairy, Palanpur, Gujarat, India
[2]Senior Research Assistant, Dairy Engineering Department, G N Patel College of Dairy Science, Kamdhenu University, Sardarkrushinagar, Gujarat, India
[3]M. Tech Scholar, Dairy Microbiology Department, ICAR- National Dairy Research Institute, Karnal, India
[4]Jr. Officer, Banas Dairy, Palanpur, Gujarat, India
DOI:10.5281/ScienceWorld.18018354

Introduction

- Biosensors are analytical devices or tools that combine biological components with transducers to detect and measure specific biological or chemical substances.
- A device which uses a living organism or biological molecules, especially enzymes or antibodies, to detect the presence of chemicals
- They are used in a wide range of applications, including healthcare, environmental monitoring, food safety, and biotechnology. Biosensors offer a rapid and selective means of quantifying various analytes, making them invaluable for both research and practical purposes

History

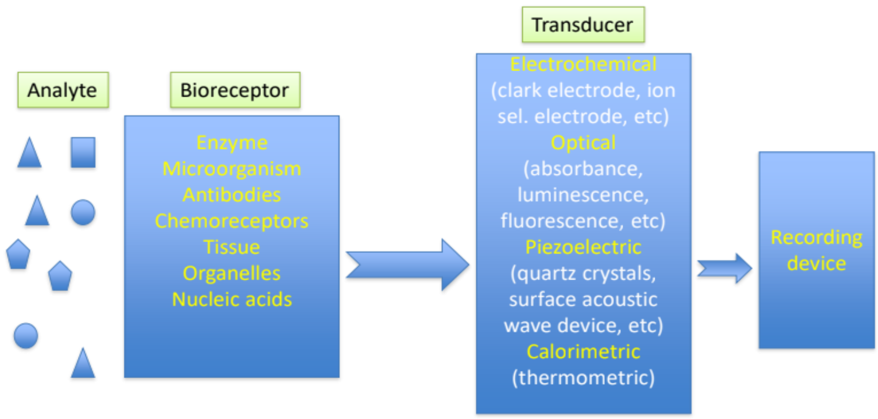
- In 1962, Leland C. Clark and Champ C. Lyons developed the first enzyme-based biosensor, known as the Clark electrode, which measured oxygen levels using an enzyme and an electrode. In 1963, Garry A. Rechnitz and S. Katz Enzyme electrode based Potentiometric determination of urea after urease hydrolysis
- The 1970s saw the introduction of the glucose biosensor, which used glucose oxidase to measure blood glucose levels. This was a major breakthrough in medical diagnostics. This biosensor was made from a thin layer of glucose oxidase (GOx) on an oxygen electrode.

biosensor was made from a thin layer of glucose oxidase (GOx) on an oxygen electrode. The amount of glucose was estimated by the reduction in the dissolved oxygen concentration

- In 1977, **Karl Cammmann** introduced the term "biosensor"

Key Components in Biosensors

- Biological Component: The heart of a biosensor is its biological element, which can be enzymes, antibodies, DNA, or whole cells. This component interacts with the target analyte and generates a measurable signal, such as a change in electrical current, optical response, or thermal output.
- Transducer: The transducer is responsible for converting the biological interaction into a quantifiable signal. Common transducers include electrodes, optical sensors, and piezoelectric devices. The choice of transducer depends on the specific application and the nature of the target analyte.
- Signal Processing System: Biosensors often include signal processing components, such as amplifiers and data processing algorithms, to enhance the accuracy and sensitivity of the measurements. This allows for the conversion of the biological response into a digital or analog output that can be easily interpreted.



Classification Of Biosensors

1. Biological Element Used

1. Antibody/antigen Interactions:

An immunosensor utilizes the very specific binding affinity of antibodies for a specific compound or antigen.

2. Enzymatic Interactions

The specific binding capabilities and catalytic activity of enzymes make them popular bioreceptors.

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 15/12/2025

3. Nucleic acid Interactions

Biosensors that employ nucleic acid interactions can be referred to as genosensors. The recognition process is based on the principle of complementary base pairing, adenine:thymine and cytosine:guanine in DNA.

4. Cells

Cells are often used in bioreceptors because they are sensitive to surrounding environment and they can respond to all kinds of stimulants. Cells tend to attach to the surface so they can be easily immobilized.

TRANSDUCTION MECHANISM

1. Optical Biosensors: Rely on changes in optical properties, such as absorbance, fluorescence, or refractive index, to detect analytes
   e.g., Surface Plasmon Resonance
1. Electrochemical Biosensors: Measure changes in electrical properties, such as current, potential, or impedance, to detect analytes
   e.g., amperometric and potentiometric biosensors.
2. Electronic biosensors: Amperometric biosensors are self-contained integrated devices based on the measurement of the current resulting from the oxidation or reduction of an electroactive biological element providing specific quantitative analytical information.

Piezoelectric biosensors

They are a group of analytical devices working on a principle of affinity interaction recording. A piezoelectric platform or piezoelectric crystal is a sensor part working on the principle of oscillations change due to a mass bound on the piezoelectric crystal surface.

Applications

1. A spore inhibition-based enzyme substrate assay (SIB-ESA)

- Detection of aflatoxins M1 in milk
- Spores of *Bacillus spp*. have been lyophilized/ immobilized in micro centrifuge tube /sensor disk to which milk and substrate is added

2. A real time microbial assay for detection of β-lactam antibiotics in milk

- Resistance mechanism of some **β-lactamase** generating *Bacillus spp*
- ***B. cereus*** and ***B. licheniformis*** produce β-lactamase enzyme due to induction by β-lactam antibiotics and the enzyme production is proportional to the concentration of inducer present in milk

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 15/12/2025

- Noncompetitive enzyme action on inducer (β-lactam) resulting in indirect reduction of starch iodine mixture through penicilloic acid

3. Affinity Based Biosensors

- Proteins, DNA or microbial receptor
- Charm assay, which employs an immune reaction to bind the antibiotic to a microbial receptor and detects this complex using a low-level ^{3}H or ^{14}C radio-label.
- The Charm assay can detect a family of antibiotics, notably ß-lactams, sulphonamides, tetracyclines, novobiocin, aminoglycosides and macrolides, as well as various other substances such as chloramphenicol.

4. Microbial Biosensors

- Microorganisms as such/ or their spores as biological recognition element
- Microbial spore germination based optical biosensor for the detection of bacterial contaminants or analyte of interest
- Selective enrichment of target bacteria
- The enriched bacterial cells will produce specific marker enzymes which act on germinogenic substrate and produce specific germinant (sugars and amino acids).
- The germinants induce spore germination and germination mediated concomitant de novo acetyl esterase enzymatic activity
- Quantification of fluorescent signal

5. Optical Biosensor

- Linear optical phenomenon
- Fluorescence
- Surface plasmon resonance (SPR)
- Total internal reflection fluorescence (TIRF)

Hurdles to Application of Biosensors

1. Diversity and complexity of samples.
2. Relatively high development costs for single analyte systems
3. Limited shelf and operational life

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com

Published 15/12/2025