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Biosensors - A Molecular Diagnostic Tool In Medicine

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Abstract: ***The term biosensor is often used to cover sensor devices in order to determine the concentration of substances and other parameters of biological interest even where they do not utilize a biological system directly. This articles states that a biosensor consist of three components-a biological detection system, a transducer and an output system. This method is widely used in the fields of research and development and in the physical chemistry and in electrochemistry.***

I. INTRODUCTION

BIOSENSOR

It is an analytical device which converts a biological response into an electrical signal. It detects, records and transmits information regarding a physiological change or process. It determines the presence and concentration of a specific substance in any test solution.

COMPONENTS OF BIOSENSOR

Biosensor includes three components.

- ✓ First component
- ✓ Second component
- ✓ Third component

FIRST COMPONENT-BIOLOGICAL ELEMENT

Biological element interact with the target compound and detect its presence in the test solution. Therefore it is highly specific, stable under storage conditions and immobilized.

SECOND COMPONENT-TRANSDUCER

Transducer measures the physical change that occurs in the reaction and transforms it into electrical output.

THIRD COMPONENT-DETECTOR

Detector detects the signals that are passed from the transducer to the microprocessor. This data is then converted to concentration units and are transferrd to a data storage device.

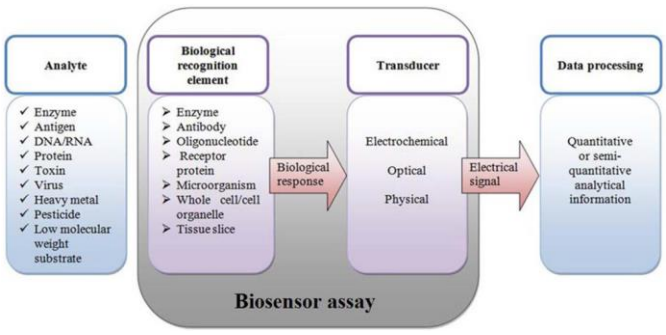

Figure 1

II. PRINCIPLE OF BIOSENSOR

Basic principle of biosensor invoived is as follows:-

- ✓ First biological recognization element which highly specific towards the biological material reacts with the analyte to form bound analyte.
- ✓ Second transducers detect and transduces signal from biological response to electrical response due to which reactions occur.
- ✓ Third detector amplifies the signals which are passed from the transducer and are displayed on the monitor for the measurement.
- ✓ The formation of bound analyte could be associated with the release of heat, gas (oxygen), electrons or hydrogen ions.

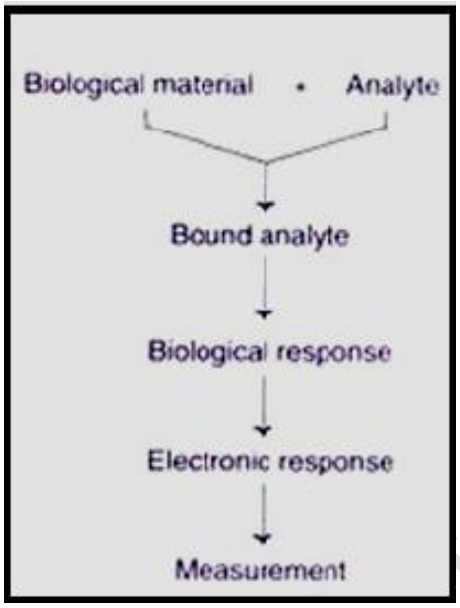

Figure 2

III. WORKING OF BIOSENSOR

Biosensors are operated based on the principle of signal transduction. These components include a bio-recognition element, a biotransducer and an electronic system composed of a display, processor and amplifier.

The bio-recognition element, essentially a bioreceptor, is allowed to interact with a specific analyte. The transducer measures this interaction and outputs a signal. The intensity of the signal output is proportional to the concentration of the analyte. The signal is then amplified and processed by the electronic system.

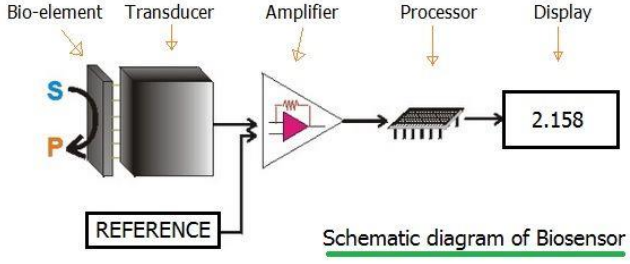

Figure 3

IDEAL BIOSENSOR

An ideal biosensor should have the following characteristics:

- ✓ The output signal must be relevant to measurement environment.
- ✓ The functional surface must be compatible with the transducer.
- ✓ High specificity and selectivity.
- ✓ Sufficient sensitivity.
- ✓ Sufficient sensitivity and resolution.
- ✓ Sufficient speed of response.
- ✓ Sufficient dynamic range.
- ✓ Sufficient accuracy and repeatability.

TYPES OF BIOSENSOR

- ✓ Based on bioreceptors.
  - Enzyme biosensor.
  - Microbial biosensor.
  - Affinity biosensor.
- ✓ Based on transducer
  - Potentiometric
  - Amperometric
  - Conductometric
  - Optical
  - Piezoelectric.

PRINCIPLE OF DETECTION

PIEZOELECTRIC	Measures change in mass
ELECTRO-MECHANICAL	Measures change in electric distribution
OPTICAL	Measures change in light intensity
CALORIMETRIC	Measures change in heat

Figure 4

IV. EXAMPLES OF BIOSENSORS

A. ELECTROCHEMICAL DNA BIOSENSORS

They are used in the clinical diagnosis of genome mutation detection. Steps involved in the electrochemical DNA biosensor hybridization includes:

- ✓ Formation of the DNA recognition layer.
- ✓ Actual hybridization event.
- ✓ Transformation of the hybridization event into an electrical signal.

Types of Electrochemical DNA biosensors:

- ✓ Electrodes
- ✓ Chips

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✓ Crystals

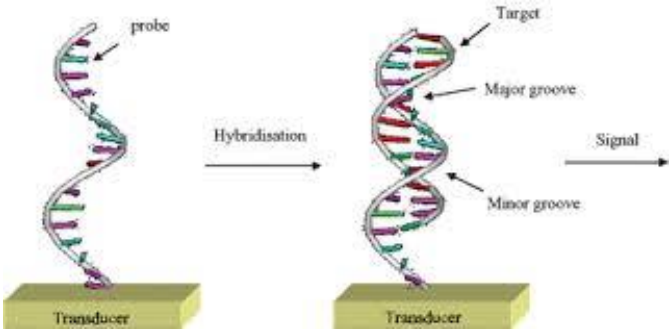

Figure 5

B. GLUCOSE BIOSENSOR

They are used in diabetes patients for monitoring the glucose level in the blood.

The mechanism of detection is as follows:

✓ Glucose reacts with glucose oxidase (GOD) to form gluconic acid. Two electrons and two protons are also produced.
✓ Glucose mediator reacts with surrounding oxygen to form hydrogen peroxide and GOD.
✓ Now this GOD reacts with more glucose.
✓ Higher the glucose content, higher the oxygen consumption.
✓ Glucose content can be detected by Platinum electrodes.

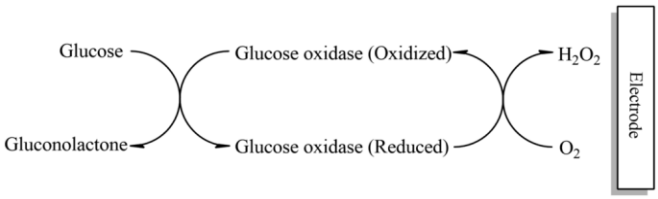

Figure 6

V. ADVANTAGES OF BIOSENSOR

The key benefits of biosensors include the following:

✓ Rapid and continuous measurement
✓ High specificity
✓ Very less usage of reagents required for calibration
✓ Fast response time
✓ Ability to measure non-polar molecules that cannot be estimated by other conventional devices.

VI. DISADVANTAGES OF BIOSENSOR

✓ They are expensive. Its cost of source, extraction, isolation and purification is high.
✓ Tend to lose activity due to deactivation relatively at short period of time.
✓ Response time is slower.
✓ Less selective.
✓ No catalytic activity.

APPLICATIONS OF BIOSENSOR

✓ Quality control.
✓ Food analysis.
✓ Drug development.
✓ Environmental field monitoring.
✓ Industrial Process control.
✓ Crime detection.
✓ Drug development.
Study of biomolecules and their interactions.

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