A CASE STUDY

Asian Journal of Bio Science, Vol. 4 Issue 2 : 312-313 (October, 2009 to March, 2010)

Biosensors

JYOTI J. GAVALI, ASHWINI G. DASHPUTRE, M.O.LOKHANDE AND **B.A.AGLAVE**
Department of Biotechnology, H.P.T. Arts and R.Y.K. Science College, NASHIK (M.S.) INDIA

(Accepted : July, 2009)

Key words : Biosensor

A biosensor is an analytical device containing on immobilized biological material enzyme, antibody, nucleic acid, hormone, organelle or whole cell which can specifically interact with an analyte and produce physical, chemical or electrical signals that can be measured. An analyte is a compound (e.g. – glucose, urea, drug, pesticide) whose concentrations has to be measured. Biosensors basically involve the quantitative analysis of various substances by converting their biological actions into measurable signals. A great majority of biosensors have immobilized enzymes. The performance of the biosensors is mostly dependent on the specificity and sensitivity of the biological reaction, besides the stability of the enzyme. The nature of interaction between the analyte and the biological material used in the biosensor may be of 2 types -

– The analyte may be converted into a new chemical molecule by enzymes (such biosensors are called catalytic biosensors)

– The analyte may simply bind to the biological material present on the biosensor (eg- to antibodies, nucleic acids) (these biosensors are known as affinity biosensors)

A successful biosensor must have at least following features:-

– It should be highly specific for the analyte.

– The reaction used should be as independent of factors like stirring, pH, and temperature etc. as is manageable.

– The response should be linear over a useful range of analyte concentration.

– The device should be tiny and biocompatible, in case of it is to be used for analyses within the body.

– The device should be cheap, small and easy to use.

– It should be durable, that is should be capable of repeated use.

– The assay cost should be lower than that of conventional tests.

– Should require small sample volume.

– Assay should be rapid, accurate and repeatable.

– It should be robust, stable and sterilizable. But in any particular biosensors, only some of the above features may be achievable.

General features of biosensors:

A biosensor has 2 distinct components.

– Biological component – enzyme, cell etc.

– Physical component – transducer, amplifier etc.

The biological component recognizes and interacts with and the analyte to produce a physical change (a single) that can be detected by the transducer. In practice, the biological material is appropriately immobilized on to the transducer and the so prepared biosensors can be repeatedly used several times (may be around 10000 times) for a long period (many months)

Principle of a biosensor:

The desired biological material (usually a specific enzyme) is immobilized by conventional methods physical or membrane entrapment, non-covalent or covalent binding). This immobilized biological material is in intimate contact and the transducer. The analyte binds to the biological material to form a bound analyte which in turn produces the electronic response that can be measured.

In some instances, the analyte is converted to a product which may be associated and the release of heat, (gas oxygen), electrons or hydrogen ions. The transducer can convert the product linked changes into electrical signals which can be amplified and measured.

Types of biosensors:

– Electrochemical biosensors
  – Amperometric biosensors
  – Potentiometric biosensors
  – Conductimetric biosensors
– Thermometric biosensors
– Optical biosensors

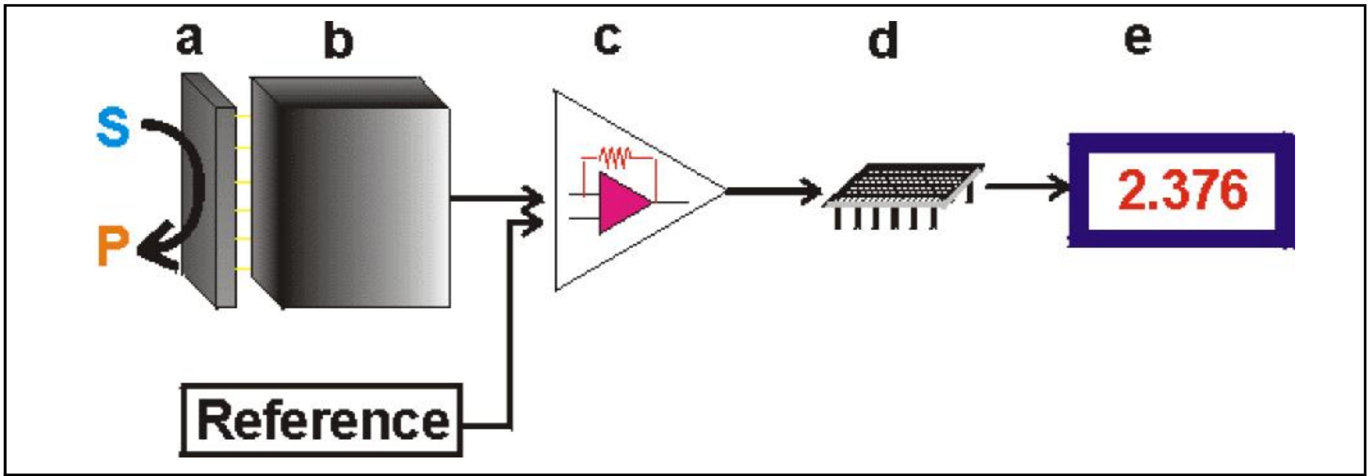

Fig. 1 : Schematic diagram showing the main components of a biosensor. The biocatalyst (a) converts the substrate to product. This reaction is determined by the transducer (b) which converts it to an electrical signal. The output from the transducer is amplified (c), processed (d) and displayed (e).

– Fibre optic lactate biosensor

– Optical biosensor for blood glucose

– Luminescent biosensors to detect urinary infections

– Piezoelectric biosensors

– Whole cell biosensors

– Immunobiosensor

Applications of biosensors:

There are many potential application of biosensors. The main requirements for a biosensor approach to be valuable in terms of research and commercial applications are the identification of a target molecule, availability of a suitable biological recognition element, and the potential for disposable portable detection systems to be preferred to sensitive laboratory-based techniques in some situations. Some examples are given below:

– Glucose monitoring in diabetes patients

– Other medical health related targets

– Environmental applications e.g. the detection of pesticides and river water contaminants

– Remote sensing of airborne bacteria e.g. in counter-bioterrorist activities

– Detection of pathogens

– Determining levels of toxic substances before and after bioremediation

– Detection and determining of organophosphate

– Routine analytical measurement of folic acid, biotin, vitamin B12 and pantothenic acid as an alternative to microbiological assay

– Determination of drug residues in food, such as antibiotics and growth promoters, particularly meat and honey.

– Drug discovery and evaluation of biological activity of new compounds.

– Protein engineering in biosensors

– Detection of toxic metabolites such as mycotoxins

– Biosensors can be used for monitoring of fermentation products and estimation of various ions. Thus, biosensors help for improving the fermentation conditions for a better yield. Biosensors are employed to measure the odour and freshness of foods to detect the toxic gasess and other chemical agents used during war.