ROLE AND USE OF BIOSENSORS IN AGRICULTURE

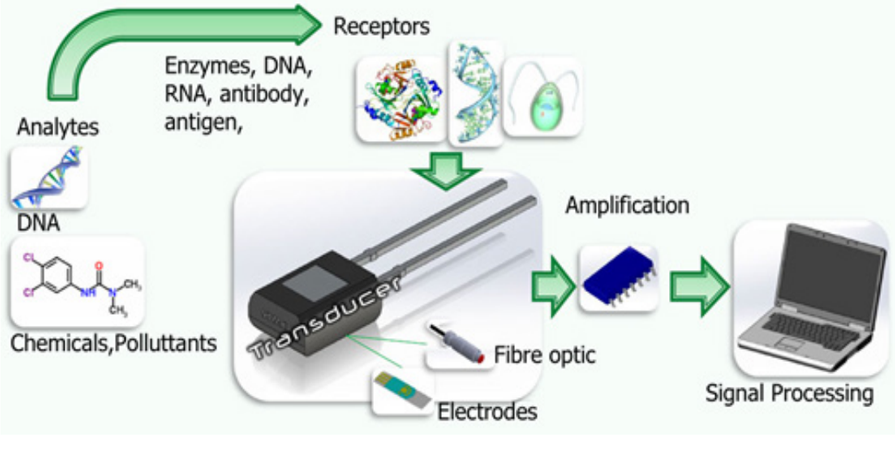
Abhinash Kumar

INTRODUCTION

A biosensor is an analytical device which converts a biological reaction into an electrical signal. Biosensors can be defined as analytical devices which contain a combination of biological detecting elements like sensor system and a transducer. The applications of these Biosensors mostly include checking ecological pollution control, in agriculture field as well as food industries. The major features of biosensors are stability, cost, sensitivity, and reproducibility. The aim of a biosensor is to create either discrete or continuous electronic signals which are proportional to a single analyte or a related group of analytes.

In the agricultural industries, the quality of a product is evaluated through periodic chemical and microbiological analyses which are expensive, slow, need well-trained operators and in some cases, need steps of extraction or pretreatment, increasing the time of analysis. Biosensors can give rapid, non-destructive and affordable methods for the quality monitoring of a product. Biosensors decrease assay time and cost or increase product safety.

Biosensors have been adapted to detect analytes in on-line systems. Biosensors have the potential to make an analytical revolution to resolve the problems in the agricultural and the food industries. Now, let us get into details of agriculture biosensors types and their principles in the farming sector.



WORKING OF BIOSENSORS

The preferred biological material like enzyme is chosen for conventional methods like physical or membrane entrapment and noncovalent or covalent binding. The chosen biological material is in contact with the transducer. To create a bound analyte through the analyte binds to the biological material this produces the electrical response to be measured.

In some cases, the analyte changed to a product and have some probability to connect with the release of heat, gases like oxygen, electrons or hydrogen ions.

PRINCIPLE OF BIOSENSOR

Immobilization of biological material

The biological components are suitably immobilized on the transducer surface. Enzymes are generally immobilized by glutaraldehyde onto a porous sheet-like lens tissue paper or nylon net fabric and the enzyme membrane thus produced are affixed to the transducer.

Surface treatment to the transducer

The transducer surface can be treated with 3-aminopropyl triethoxysilane. The biological components may now covalently link to this cross-linked silane via the reactive amino group remains free. This process yields non-reproducible results and often causes a large reduction in the activity of the biological components.

Interaction of analyte with biological material

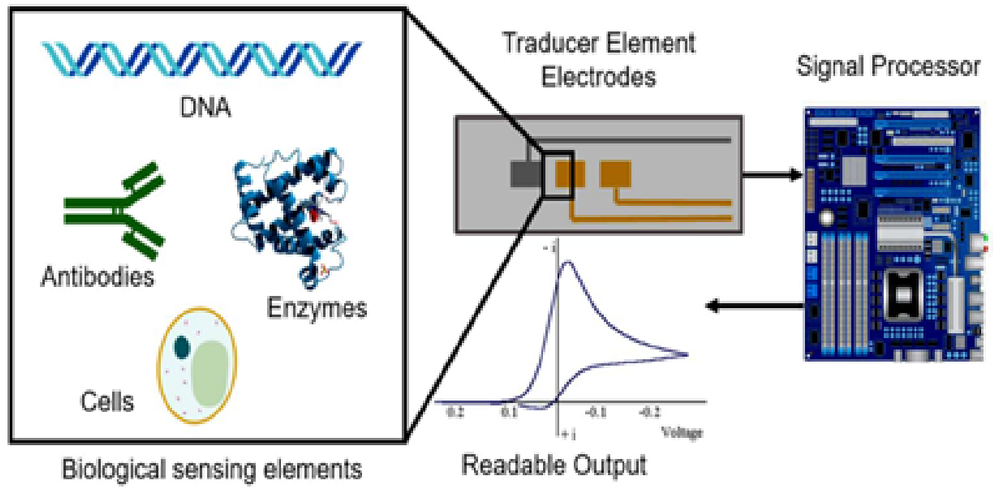
The biological component interacts particularly to the analyte, which produces a physical change close to the transducer surface. This physical change may be heat released or absorbed by the reaction, production of electrical potential due to change distribution of the electrons, movement of electrons due to redox reactions, the light produced or absorbed by the reaction, modify in the mass of biological components as a result of the reaction.

AGRICULTURE BIOSENSORS TYPES

There are many types of Biosensors based on the sensor devices and the biological materials and some of them are discussed below.

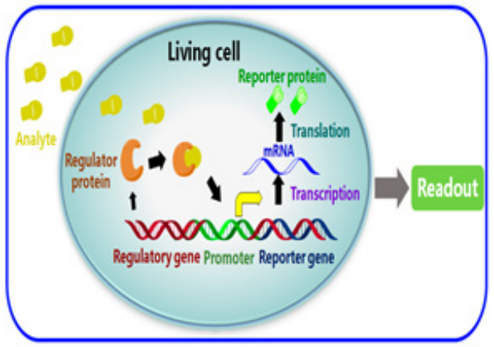
1. Electrochemical Biosensor

It is a very simple device. It measures the measurement of electronic current, ionic or by conductance changes conceded by bio-electrodes. The sensor substrate generally contains three electrodes; a reference electrode, an active electrode, and a sink electrode. An auxiliary electrode (also known as a counter electrode) may be present as an ion source. The target analyte is involved in the reaction that takes place on the active electrode surface, and the ions produced to make a potential which is subtracted from that of the reference electrode to give a signal.



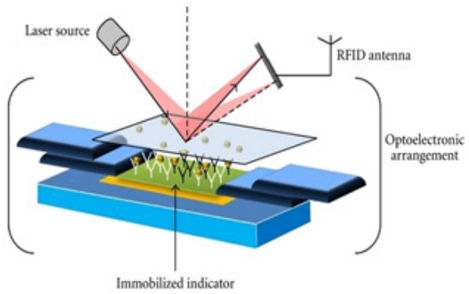
2. Whole cell biosensor

In this type of biosensor whole cell or organelles use as a biological component. The cells are very cheaper, have a longer active lifetime, and are less sensitive to inhibition, pH, and temperature variations than enzymes.



3. Optical biosensor

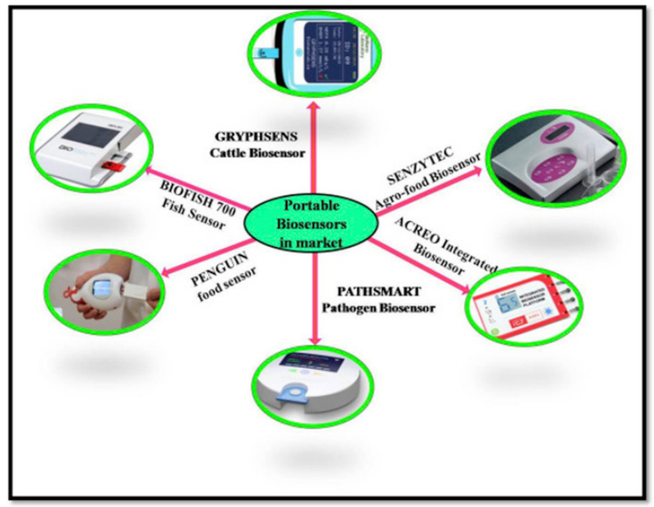
It detects how much light is produced or absorbed through the biochemical reaction. A most capable biosensor is luminescence biosensor for the detection of bacteria in food and clinical samples. Bacteria are also used as a biosensor it gets fluoresces in the presence of specific pollutants which they like to eat and detect the oil spills area.



BIOSENSORS IN AGRICULTURE

Agriculture includes the production of crops and the rearing of livestock producing different products which are used in daily life. These elements have always been disposed to damage in the form of pests and diseases causing a loss in the profits. Hence, a way of increasing profits would be to decrease the loss of crops and livestock by such natural threats. With the advancement in bioterrorism, the need for biosecurity becomes necessary. Also, the need for biosecurity is necessary when agricultural produce or any living object is to be transported across international borders. Biosensors can play a major role in this field as they provide rapid and specific detection compared to the older techniques.

A concentration of herbicides, pesticides and heavy metals in agricultural lands is increasing and this is a matter of concern. Biosensors can be used to compute the levels of pesticides, herbicide, and heavy metals in the soil and groundwater. Biosensors can be used to forecast the possible occurrence of soil disease, which has not been feasible with the existing technology. The biological diagnosis of soil using biosensor means opening the approach to reliable prevention and decontamination of soil disease at an earlier stage



The basic principle of soil diagnosis with the biosensor is to approximate the relative activity of "good microbes" and "bad microbes" in the soil on the source of quantitative measurement of differential oxygen consumption in the respiration of two types of soil microorganisms. The measurement proceeds during two sensors impregnated with "good microbes" and "bad microbes", respectively, are immersed in a suspension of the soil sample in buffer solution. By comparing two data it can be possible to quantitatively decide which microbe favors the soil. It is feasible, therefore, to predict whether or not soil disease is prepared to break out in the tested soil beforehand. It is to be emphasized that the biosensor offers an innovative system of diagnosing soil condition based not on experience but on numerical data. Nitrate biosensor has been developed for the detection of the quantity of nitrate present in the soil.

Enzyme biosensors based on the inhibition of cholinesterases have been used to identify traces of organophosphates and carbamates from pesticides. Selective and sensitive microbial sensors for the quantity of ammonia and methane have been studied. However, the commercially obtainable biosensors for wastewater quality manage are biological oxygen demand (BOD) analyzers based on micro-organisms like the bacteria *Rhodococcus erythropolis* immobilized in collagen or polyacrylamide.