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Applications and Types of Biosensors in Agriculture

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Introduction

A biosensor is an analytical tool that transforms an electrical signal from a biological reaction. Biosensors are analytical tools that combine a sensor system and a transducer with other biological detecting components. These biosensors are used mostly in the food and agriculture industries for monitoring ecological pollution control. The four main characteristics of biosensors are reproducibility, sensitivity, cost, and stability. The primary purpose of a biosensor is to produce periodic or irregular electrical signals that are proportional to a single analyte or a collection of related analytes. The first true biosensor for oxygen detection was invented by Leland C. Clark Jr. in 1956, and he also called as "Father of Biosensors".

The quality of a product is assessed in the agricultural sectors by routine chemical and microbiological studies, which are costly, time-consuming, demand highly skilled personnel, and in certain cases require extraction or pretreatment stages, extending the analysis timeframe. Biosensors can provide quick, non-destructive, and cost-effective ways to monitor a product's quality. Biosensors can shorten test times, lower assay costs, or improve product safety.In order to detect analyses in online systems, biosensors have been modified. Biosensors have the ability to bring about an analytical revolution that will tackle the issues facing the food and agriculture industries.The details of agriculture biosensors types are given below.

Agriculture biosensors types for environmental monitoring

More accurate monitoring of an ever-growing variety of analytes in air, soil, and water is necessary due to stricter restrictions and a higher public awareness of environmental hazards. Monitoring infections in fields and streams is also necessary due to growing environmental safety concerns among the general population. Manufacturers in a wide range of sectors are looking for technology to quickly identify contamination problems at the

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source as demand mounts to recycle water, reduce the use of antibacterial treatments, and maintain quality discharges. Operators are searching for ways to avoid paying the price of complicated monitoring systems. The rapid detection of organisms using biosensors will be crucial for the environmental monitoring of infections.

The growing availability of enzymes, antibodies, and genetically modified microorganisms that are related to environmental pollutants as well as the robustness, sensitivity, and affordability of signal transducers have all contributed to the recent interest in using biosensors for environmental monitoring.

Agriculture biosensors types

Based on the sensor devices and the biological materials the types of biosensors are discussed below.

- **Electrochemical Biosensor:-** It is a really basic gadget. It records electronic current, ionic current, and conductance variations allowed by biological electrodes. A reference electrode, an active electrode, and a sink electrode are typically included on the sensor substrate. As an ion source, there could be an auxiliary electrode (sometimes called a counter electrode). The active electrode surface undergoes a reaction involving the target analyte, and the ions created create a potential that is subtracted from the reference electrode's potential to produce a signal.
- **Whole cell biosensor:-** Whole cell or organelles used as a natural element in this type of biosensor. The cells are veritably cheaper, have a longer active continuance, and are less sensitive to inhibition, pH, and temperature variations than enzymes.
- **Amperometric biosensors:-** The most often reported electrochemical method for signal transduction has proven to be the use of amperometric biosensors. There are commercially available "one-shot" (disposable) sensors and online (multi-measurement) systems that can monitor a variety of target analytes. A constant usable potential between a working and a reference electrode characterises the basic operation of amperometric biosensors, in contrast to potentiometric devices. Redox reactions brought on by the functional potential result in a net current flow. The size of this current is related to the amount of electro active species present in the test solution, and amperometric monitoring may be used to track both cathodic (reducing) and anodic (oxidising) processes. Enzymes are typically used as the bio recognition a

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element in the amperometric biosensors that are described. Typically, the most often employed catalysts for these biosensor forms have been oxidase and dehydrogenase enzymes.

- **Potentiometric biosensors:-** These biosensors are constantly complete by examiner creating the electrode prototypes lying on a synthetic substrate, covered by a performing polymer with some enzyme is connected. The biosensors comprise two electrodes which are tremendously responsive and strong. All types of biosensors typically enthrall least sample medication since the natural detecting element is extremely choosy used for the analyte troubled. By the physical and electrochemical changes the signal will be generated by in the layer of conducting polymer suitable to modifying passing at the outside of the biosensor.
- **Opticalbiosensor:-** It measures the amount of light that the biological reaction produces or absorbs. For the detection of bacteria in food and clinical samples, luminescence biosensors are one of the most effective biosensors. By fluorescing in the presence of particular contaminants that they really like eating, bacteria are employed as biosensors to locate oil spills.

Biosensors in Agriculture

The practise of agriculture involves growing crops and raising animals to produce a variety of goods utilised in daily living. These elements have a history of causing harm in the form of pests and diseases, which reduces profitability. Consequently, reducing the loss of livestock and crops due to such natural risks would be a strategy to boost earnings. Bio security is now required due to the development of bioterrorism. Agricultural products or any other live object that is being transferred across international boundaries need bio security. In comparison to more traditional methods, biosensors offer speedy and precise detection, which makes them extremely useful in this field.

It is alarming that agricultural fields now include higher concentrations of pesticides, herbicides, and heavy metals. Pesticide, herbicide, and heavy metal concentrations in the soil and groundwater can be determined using biosensors. With the help of biosensors, it is now possible to predict when soil diseases can appear, something that was previously impractical. By employing a biosensor to do a biological diagnosis of the soil, we can more effectively prevent soil illness and clean up its contamination.

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The fundamental idea behind using a biosensor to diagnose soil is to roughly estimate the relative activity of "good microbes" and "bad microbes" in the soil based on a quantitative assessment of the difference in consumption of oxygen between two different types of soil microorganisms. Two sensors, one with "good microbes" and the other with "bad microbes," will be immersed in a suspension of soil sample in buffer solution as the measurement is carried out.

It may be feasible to determine which microbes the soil favours quantitatively by comparing two sets of data. Therefore, it is possible to foresee whether or not soil disease would manifest itself in the tested soil in the future. It must be emphasised that the biosensor provides a novel method of analysing numerical data rather than experience to determine the state of the soil. For the purpose of determining how much nitrate is present in the soil, a nitrate biosensor has been created.

To find traces of organophosphates and carbamates from pesticides, enzyme biosensors based on the inhibition of cholinesterases have been utilised. Microbial sensors have been studied that are sensitive and selective for methane and ammonia concentrations. But the currently available biosensors for controlling the quality of wastewater are biological oxygen demand (BOD) analyzers based on microorganisms such the bacteria Rhodococcus erythropolis immobilised in collagen or polyacrylamide.

Applications of biosensors

- Biosensors offer a wide range of applications that goal to improve the quality of life.
- This category includes their application for a variety of purposes, including environmental monitoring, disease detection, food safety, defence, and drug development.
- Biosensors can be utilised as platforms for tracking the nutritional value, quality, safety, and traceability of food.
- These applications are classified as 'single shot' analysis tools, which require low-cost and disposable sensor platforms.
- A biosensor is required for an application such as pollution monitoring to function for a few hours to several days.

Conclusion

Biosensors are used mostly in the food and agriculture industries for monitoring ecological pollution control. The major features of biosensors are stability, cost, sensitivity and reproducibility. The rapid detection of organisms using biosensors will be crucial for the environmental monitoring of infections. Biosensors offer a wide range of applications that goal to improve the quality of life.