ROLE AND USE OF BIOSENSORS IN AGRICULTURE

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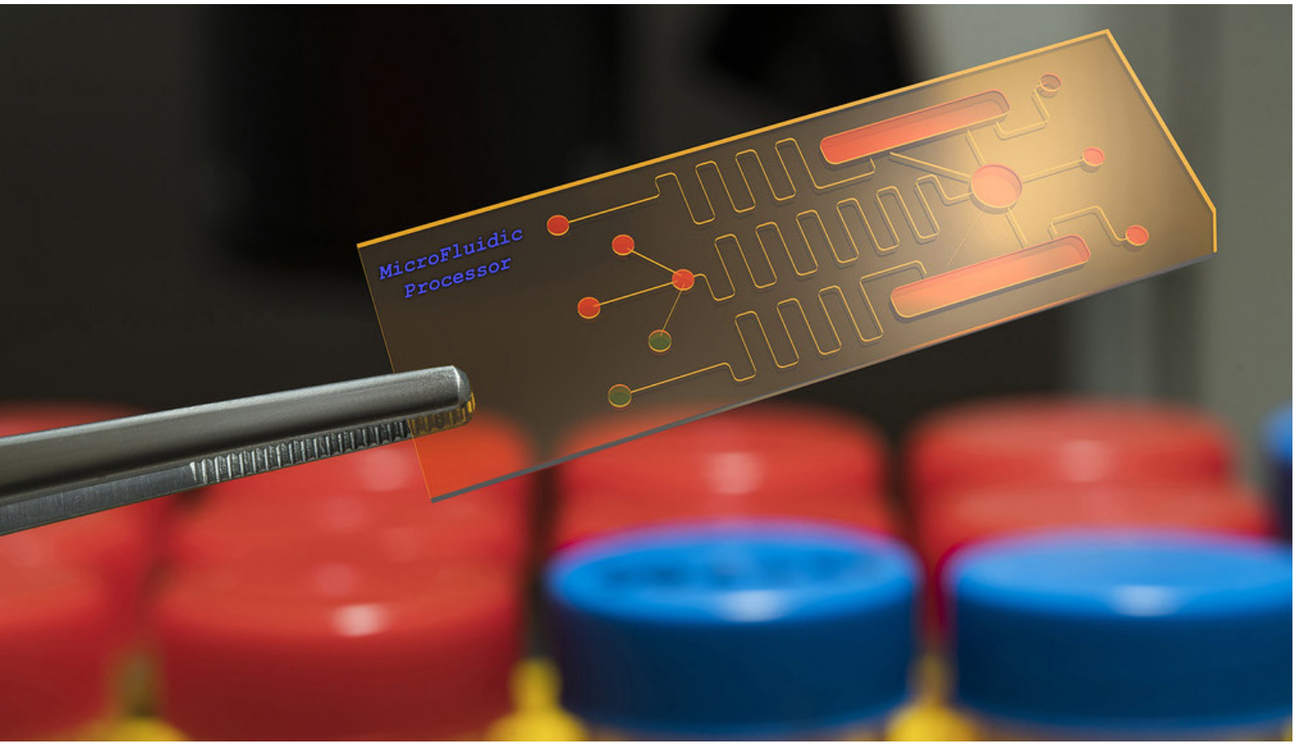
INTRODUCTION

Agriculture is an essential and steady part of human existence. Technological breakthroughs and revolutions have framed it into what it is today contributing strategically to the self-sustaining economic development of a nation. To achieve regional and global food security, technical interventions in the fundamental concepts of food processing, quality control, and disaster risk detection, diagnosis, and prevention are required. Rapid, real-time, portable, and cost-effective technologies are therefore sought in agriculture to enhance consumer livelihood and ensure optimal resource utilization. The study of agricultural process dynamics through molecularly recognizing materials, antigen-antibody contact, and subsequent transmission mechanism have benefited greatly from recent breakthroughs in biosensing technologies and material sciences.

WHAT ARE BIOSENSORS?

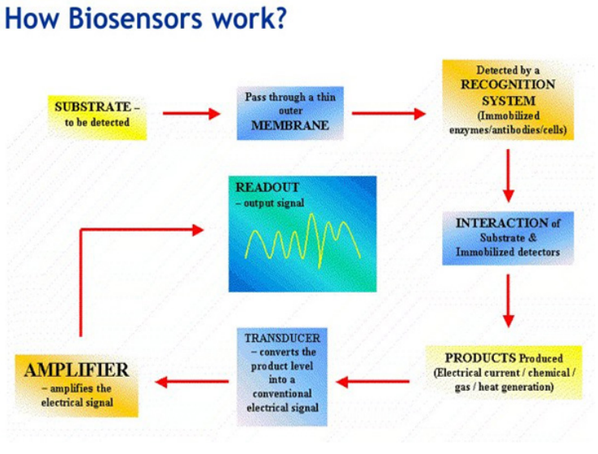
A sensor is a device that detects an input from the physical phenomenon which can be light, heat, moisture, motion or pressure and converts it into a measurable unit. A biosensor is a device that detects an analyte of biological interest and generates signals proportional to its concentration. Leland C. Clark Jr. 1956 created the first "real" biosensor for oxygen sensing and is regarded as the "father of biosensors". The field has made remarkable advancements ever since then and has evolved into a multidisciplinary area of study.

HOW IT WORKS:



A biosensor is driven by a union of three things that incorporates a bio-recognition element, a bio transducer and an electronic system composed of a display, processor and amplifier.

The bio-recognition element, essentially a bioreceptor be it an enzyme, an antibody or a nucleic acid is allowed to interact with a specific analyte. The transducer measures this interaction and outputs a signal having intensity proportional to the concentration of the analyte. The electrical system subsequently processes and amplifies the signal.



ROLE AND USE OF BIOSENSORS IN AGRICULTURE:

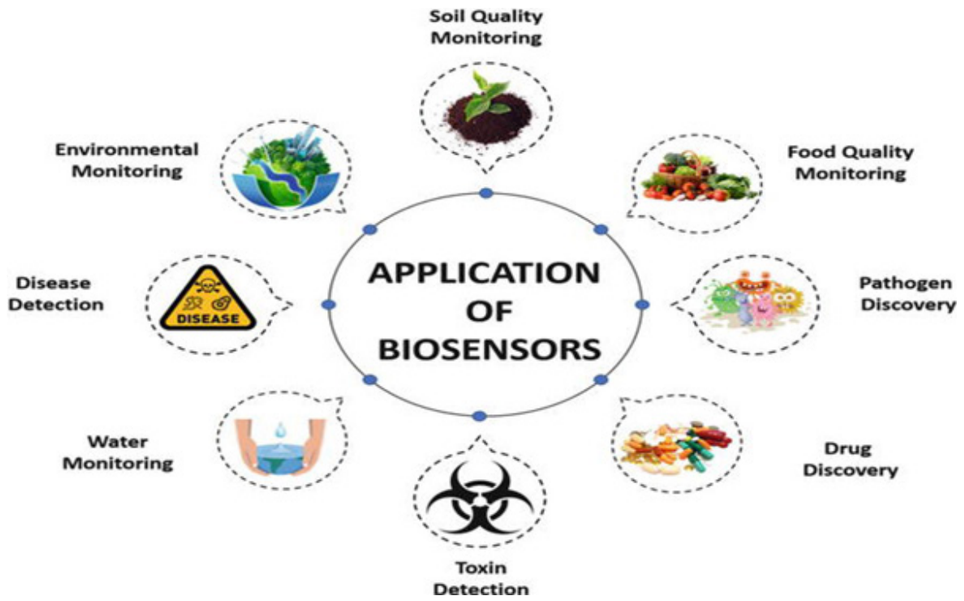
Biosensors have advanced the field of climate-smart agriculture. The technology has the potential to advance food, chemical, and other industrial innovative tools and techniques for the monitoring and management of swift infection disease diagnostic, the capacity enhancement of plants for nutrient uptake, the capacity enhancement of animal production, etc. Here are some of the applications.

1. Residue detection

Over and indiscriminate use of pesticides, herbicides and heavy metals has led to severe environmental issues of great concern as it has contaminated soil and waterbodies and resulted in severe health issues of high risk such as cancer, organ deformability and reproductive failures. Biosensors are used to detect the levels of pesticides, herbicides and heavy metals in the soil ensuring that biochemical and other categories of contaminants are kept at bay from conceding the quality and safety of food via the mitigation of pests and pathogens that could affect agricultural produce thus help in securing food safety and quality of the produce.

2. Identifying pathogen:

Biosensors have been developed for detection of the pathogens such as soybean rust fungus, Phakopsora pachyrhizi using the SPR technique where antibodies against Phakopsora pachyrhizi are used as the biological recognition element having a response range of 3.5–28 mg/ml of antigen solution (leaf extract) and a detection limit of 800 ng/ml. Thus, such methods are inevitable for the world's most acute crop diseases thus preventing damage and spread.



3. Biosecurity purposes:

Increasing global trade across the world has threatened agriculture with the introduction of invasive alien species and bioterrorism, necessitating the need for biosecurity. There have been cases where bacteria such as anthrax have been deliberately introduced in other areas to infect nations' populations and cause damage. Biosensors play a crucial role in this field as they provide rapid and specific detection of organisms compared to traditional approaches.

4. Monitoring Agricultural by-products:

A biosensor has been created to detect aflatoxin in olive oil. Humans are susceptible to cancer from the aflatoxins generated from moulds Aspergillus flavus and Aspergillus parasiticus. Acetylcholinesterase (AchE) is inhibited by aflatoxin, and this inhibition causes a drop-in AchE activity, which can be detected using a choline oxidase amperometric biosensor.

5. Foreseeing soil:

The fundamental principle lying behind soil diagnosis with a biosensor is to quantify the differences in oxygen consumption between two different types of soil microorganisms to evaluate the relative activity of "good microbes" and "bad microbes" in the soil wherein two sensors are submerged in a suspension of soil sample in buffer solution, one with "good bacteria" and the other with "bad microbes," respectively and oxygen consumption data of two microorganisms is obtained on a computer screen 30 minutes later making it feasible to determine which bacterium prefers the soil quantitatively by comparing data. Therefore, it is possible to anticipate whether or not soil disease would manifest itself in the examined soil.

ADVANTAGES OF BIOSENSORS:

- ✓ Quick and continuous measurements can be obtained with high specificity,
- ✓ Very little reagent usage is necessary for calibration,
- ✓ Have the capacity to measure non-polar molecules that other traditional instruments cannot estimate.

CONCLUSION

Through the use of smart sensing techniques, a smart system is capable of carrying out an integral approach, from sensing to acting, to carry out the best online control for performance or product quality. In addition, the use of biosensors has advanced the field of climate-smart agriculture. The employment of biosensors in the bio-monitoring of biological risks, which are frequently found in the agriculture and food industries has resulted in a huge surge in demand for biosensors in the market. To increase a biosensor's acceptance among end users such as food handlers and agro-allied sectors, research-oriented towards extending its shelf life must be focused and also it should be inexpensive with a simple configuration for access to the illiterate farmers in developing countries.