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Current Synthetic and Systems Biology

Perspective

Cell Based Biosensors Revolutionizing Diagnostics and Environmental Monitoring

Olivia Hayes*

Department of Cell Based Biosensors, University Hospital Warsaw, Warsaw, Poland,

DESCRIPTION

Biosensors, devices that use biological materials to detect a range of chemical or biological analytes, have become an essential tool in various fields, from medical diagnostics to environmental monitoring. Among the many types of biosensors, cell based biosensors are particularly promising due to their ability to living cells to respond to specific stimuli in real time. These biosensors harness the natural biochemical processes of cells to detect changes in the environment, making them powerful tools for monitoring a wide array of conditions from detecting pathogens and toxins to measuring physiological changes in living organisms. By using living cells as a sensing platform, cell based biosensors can offer high sensitivity, versatility, and the ability to detect complex biological events that traditional, non living sensor systems cannot.

By utilizing living cells, these biosensors have the advantage of providing dynamic responses that mimic natural biological processes. They can detect both small molecular changes, like the presence of toxic chemicals, and more complex biological phenomena, such as cellular stress, immune activation, or enzyme activity. Cell based biosensors have great potential in medical diagnostics, particularly for detecting pathogens, toxins, and disease biomarkers. For instance, engineered cells can be designed to respond to bacterial or viral infections by producing a measurable output, such as a color change or fluorescence, when they encounter specific pathogens. This could be used for rapid point of care diagnostics, reducing the time and costs associated with traditional diagnostic methods.

In cancer detection, cell based biosensors can be engineered to respond to the presence of cancer biomarkers or the activity of tumor specific enzymes. This allows for the early detection of cancerous cells or tissues, facilitating earlier intervention and better patient outcomes. The ability to monitor real time cellular responses could also enable personalized medicine, where therapeutic treatments are adjusted based on how a patient's cells react to specific drugs. One of the most promising applications of cell based biosensors is in environmental monitoring. Traditional environmental sensors often detect pollutants or contaminants but may lack the specificity needed to identify biological or chemical hazards. Cell based biosensors, on the other hand, can be tailored to respond to specific pollutants, such as heavy metals, pesticides, or endocrine disrupting chemicals, making them highly effective for environmental safety and management.

Cell based biosensors are also proving valuable in food safety and quality control. By monitoring for the presence of harmful bacteria, such as *Salmonella* or *E. coli*, or for chemical contaminants like pesticides, these biosensors offer a fast, efficient way to ensure that food products are safe for consumption. Unlike traditional methods that may involve lengthy culturing or chemical analysis, cell based biosensors can detect contaminants in real time, providing rapid feedback to food producers and regulators. Additionally, cell based biosensors can be used to assess the fresh ness of food products. Cells can be engineered to respond to specific biochemical changes that occur as food deteriorates, providing an indication of spoilage. This could be used to improve food supply chain management, reducing waste and ensuring that consumers receive fresh products.

Cell based biosensors are increasingly being used in drug discovery and toxicity testing. By using cultured human cells or organoids, researchers can assess how potential drug candidates interact with specific cell types, providing valuable insights These biosensors can be programmed to detect changes in cell viability, metabolic activity, or gene expression, all of which can indicate whether a drug is having a desired effect or causing toxicity.

Correspondence to: Olivia Hayes, Department of Cell Based Biosensors, University Hospital Warsaw, Warsaw, Poland, E-mail: olivia.hayes@gmil.com

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