

# Chapter 4

## Artificial Intelligence and Nanotechnology in Biosensors

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### **ABSTRACT**

*Sensors and biosensors are devices for analytical purposes used for the quantification and qualification of an analyte of interest. The biosensor is able to interpret the chemical and physical changes produced in the presence of the compound to be analyzed, giving rise to an electronic signal capable of being interpreted. The newest application fields for biosensors vary depending on the type of transducer used and the biological agent, with the main applications being food, pharmaceutical and chemical industries, oil and gas prospecting, environmental control, quality control, medicine and engineering, biomedicine, pesticide control in agriculture, anti-doping control, etc. Biosensors have been linked with nanotechnology to improve their quality and reduce their size. With artificial intelligence, the quality of analysis is improved and provides concise results from a large amount of data. In this work, a study was carried out to understand the current scenario of this technology.*

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## **1. INTRODUCTION**

The demand for qualitative and quantitative analyzes around the world is growing. To respond to this demand, sensors and biosensors have evolved at a significant speed, along with artificial intelligence (AI). These technologies are culminating in the state of the art for this type of detection equipment, as they will carry out tests that are increasingly faster, more accurate, with the least impact on the environment and at the lowest possible cost.

Research in nanotechnology intends to study and develop materials and devices at the nanoscale, that is, in dimensions between 1 and 100 nm, where 1 nm is equal to  $1 \times 10^{-9}$  m, that is, one millionth of a millimeter or one billionth of a meter. . In association with nanotechnology, the microelectronic technologies developed by nanofabrication provide the miniaturization of circuits and electronic systems that lead to the development of new and advanced devices for molecular detection (Carrara, 2010), such as implantable biosensors for glucose control in the blood (Cash & Clark, 2010) and biochips for DNA detection in synthetic samples (Stagni et al., 2007). These are biosensors, nanoscale devices that convert a biological event (such as the molecular response to a viral or bacterial infection) into a detectable and measurable signal.

Biosensors are characterized as analytical tools of wide application in several scientific fields (Bahadır & Sezgintürk, 2015) as one of the most important categories among sensors, they have undergone a long development, from classical electrochemical biosensors to wearable and implantable biosensors, and have been widely applied in food safety, health, disease diagnosis, environmental monitoring and biosecurity.

A biosensor comprises three basic components, namely the bioreceptor, the transducer and the signal processing segments. Bioreceptors usually include enzymes, proteins, peptides, antibodies, nucleic acids and aptamers that capture their specific target. The interaction of the target with its bioreceptor induces biochemical signals that are converted into a detectable electrical signal through a transducer. The electrical signal is amplified and converted into a measurable signal using a signal processing system.

The development of such devices requires methods that allow large-scale fabrication and assembly of biofunctionalized surfaces that have appropriate detection sensitivity and selectivity. During the last few decades the selective biorecognition capabilities of enzymes and the optoelectronic, catalytic and mechanical properties of nanomaterials have enabled the rapid development of a wide range of diagnostic devices with significantly improved sensitivity and longer lifetime. Furthermore, for biocatalytic systems based on conventional enzymes, the development of portable and flexible devices, driven by a growing market demand, has made great progress in recent years. These devices have high potential for applications in personalized medicine, in computerized and connected bioelectronic devices and smart and responsive surfaces. Current efforts in manufacturing these devices focus on miniaturization, large-scale roll-to-roll processing, and rational design of material systems and interfaces to improve field sensing capabilities, maintain enzymatic activity, and increase sensitivity and stability for measurements in the field everyday. A key requirement in producing enzyme-based nanostructures for low-cost portable detection is to achieve uniform deposition of enzyme and nanostructure elements to ensure the necessary detection sensitivity and preserve the biological activity of the enzyme.

To carry out the analysis of this work, the biosensors were first presented with their definitions, structures, different types and functioning in order to have the basics of this technology. Likewise, each segment of research and its advances were exposed, such as neural networks in which data capture power, analysis and decision-making power are verified, wireless connections, which show production on an

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