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Detection of Melanoma Biomarkers using Biosensor Technology

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Introduction

Cancer is the second most common cancer in the world, and its mortality rate has been rising in recent years. The rate of a patient's survival is unpredictable due to the limitations of cancer diagnosis and treatment. A timely diagnosis of cancer is essential for effective treatment. A cancer diagnosis based on biomarkers could significantly improve early detection and treatment. Because they are portable, easy to use, and capable of real-time analysis, biosensors are crucial for identifying biomarkers. Numerous biosensors for the detection of nucleic acid and protein-based cancer biomarkers are discussed in this review. It focuses on various methods for cancer biomarker detection with electrochemical, optical, and mass-based transduction systems. Additionally, it emphasizes the analytical abilities of various [1].

Description

Cancer is the leading cause of death worldwide, accounting for more than 1500 deaths per day and more than 200 new types of the disease. Due to late detection, cancer patients' survival rates remain low despite recent technological advancements. Cancer stage and poor prognosis Conventional methods like ultrasonography, MRI, and biopsy are ineffective for detecting cancer in its early stages because. The phenotypic characteristics of the tumor are the basis for these strategies. Cancer has many stages and a complicated beginning and end. Cellular signaling is disrupted by a variety of genetic or epigenetic changes, which leads to tumorigenic change and cancer.

Substances that undergo significant changes following cancer treatment are known as biomarkers. Diagnostic, prognostic, or predictive biomarkers can be nucleic acids, proteins, metabolites, isoenzymes, or hormones. Prognostic biomarkers provide information about the course of disease recurrence, whereas diagnostic biomarkers are associated with illness identification. On the other hand, predictive biomarkers assess how well a patient will respond to treatment. A cell's presence, absence, or change in concentration of specific biomarkers is frequently. Early diagnosis and monitoring of disease progression may benefit from the discovery and detection of these biomarkers that are specific to cancer. For biomarker identification, traditional enzyme-linked immunosorbent assay or polymerase chain reaction-based methods have technological limitations like slow detection and high energy consumption [2].

These methods are ineffective for continuous patient monitoring throughout therapy due to their manual nature. In addition, every cancer is complex, involving multiple cellular actions involving multiple molecules. As a result, accurate diagnosis and prognosis require the simultaneous detection of numerous biomarkers. Clinical cancer diagnosis aims to provide analytical techniques that are specifically capable of detecting biomarkers in a sensitive and parallel manner, making it possible to conduct testing at the point of care. Due to their superior analytical performance and real-time measurement, cancer biosensors have recently gained popularity. They may be able to detect extremely low quantities of biomarkers in physiological samples due to their reduced minimum detection limits, which can aid in the early detection of cancer.

They may be able to detect extremely low quantities of biomarkers in physiological samples due to their reduced minimum detection limits, which can aid in the early detection of cancer. They also eliminate the delay between sample preparation and analysis and enable the reuse of biorecognition molecules. Additionally, biosensors have a great potential for simultaneously detecting multiple biomarkers. In this review, we talked about the well-known changes on the molecular level and the biomarkers that are related to them in cancer [3]. For the purpose of detecting these indicators of cancer, the most recent biosensor design and manufacturing technologies are discussed. In contrast to previous studies, this one focuses on the analytical performance of these biosensors in terms of linear detection range, detection limit, sensitivity, stability, and fabrication processes.

Depending on the target, cancer biosensors employ antibodies, complementary nucleic acid probes, or other specific biorecognition molecules fixed on a transducer surface. The biological reaction that occurs when biorecognition molecules interact with the biomarker is transformed by the transducer into a signal that can be measured. Electrochemical, optical, and mass-based transducers are the main types of transducers used in cancer biosensors; the type of transducer used is determined by the type of biological response. Electrochemical transducers are used to turn the interaction between the biomarker and biorecognition molecules into a quantifiable electrochemical signal. Occasionally, an electrochemical probe is used to boost the signal. Light absorption, luminescence, total internal reflection, surface plasmon resonance, and other optical phenomena are utilized by optical transducers to identify the target [4]. Due to their ability to simultaneously detect multiple targets, optical biosensors are particularly appealing.

These optical biosensors use optical fibers and waveguide devices to improve the interaction between the guided light and the sensor surface, thereby increasing detection sensitivity. In contrast, mass-based transducers look for changes in mass to identify the biomarker. They are composed of a piezoelectric crystal that responds to an electric field by oscillating at a particular frequency. The crystal's mass and the frequency of the electrical supply both have an impact on the crystal's oscillation frequency. The concentration of the biomarker is determined by measuring the oscillation frequency of the crystal as a function of the change in mass that occurs when the biorecognition molecule immobilized on a piezoelectric crystal attaches the target. Piezoelectric crystals are frequently made from quartz crystals, which are known for their high sensitivity.

Cancer biosensors have a number of benefits, but they also have a few disadvantages. Stability suffers as a result of the immobilization matrices

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used to construct the majority of cancer biosensors' lack of biocompatibility. Additionally, biorecognition molecules-biomarker interactions that produce weak biological signals may decrease detection sensitivity. In recent years, cancer biosensors have made extensive use of nanomaterials to improve their analytical performance. In biosensors, nanomaterials play a variety of roles due to their exceptional optical, thermal, electrical, and catalytic capabilities. The biosensors have exceptional stability and sensitivity due to their high biocompatibility and capacity to collect a large number of biomolecules. Additionally, they share dimensions with biomolecules, making it simple for them to be conjugated to them [5].

Conclusion

Due to their increased surface area and tunable optical and electrical characteristics due to size and form, nanoparticles, among other nanomaterials, are utilized extensively in cancer biosensors. The utilization of semiconductor quantum dots in cancer diagnostics is also expanding. They can be used in high-throughput applications due to their distinctive optical properties, such as their broad excitation and narrow emission spectra. Detection by multiplexing Carbon nanotubes, also known as, can be broken down into two categories: carbon nanotubes with and without walls, respectively. Biosensors for cancer also frequently make use of nanotubes. Due to their distinctive structure, CNTs possess outstanding characteristics. Their superiority Because of their large surface area, high conductivity, and chemical durability, they are useful for biosensing. Other nanomaterials have been used for the same purpose, including composite nanomaterials, nanowires, and nanocantilevers. Cancer biomarker detection has utilized a variety of strategies

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