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Advances in Nanomaterial-Based Sensors for Early Disease Detection

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Abstract: *Nanomaterial-based sensors are emerging as highly promising tools for the early detection of diseases, offering superior sensitivity, specificity, and miniaturization compared to traditional diagnostic methods. By leveraging the unique properties of nanomaterials such as gold nanoparticles, carbon nanotubes, graphene, and quantum dots, these sensors can detect disease biomarkers at much lower concentrations, enabling earlier diagnosis and intervention. This paper reviews the latest advancements in nanomaterial-based sensors, focusing on their applications in cancer, infectious diseases, and neurological disorders. Key developments include gold nanoparticle-based colorimetric sensors for cancer biomarker detection, graphene-based electrochemical sensors for prostate cancer and other malignancies, and quantum dot-based fluorescence sensors for both cancer and pathogen detection. Despite their promise, challenges remain, including issues with sensitivity, selectivity, reproducibility, biocompatibility, and scalability. Future directions for nanomaterial-based sensors involve improving their performance, developing multiplexed platforms for simultaneous detection of multiple biomarkers, and integrating these sensors into wearable or point-of-care devices. Overcoming these challenges and achieving regulatory approval will be crucial for the widespread clinical adoption of these advanced sensors, ultimately transforming healthcare by enabling more effective, rapid, and accessible early disease detection.*

Keywords: Nanomaterial

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