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Magnetic Nanoparticles Synthesis for Biosensing

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Editorial

Nano platforms have been shown to be effective agents in biomedical research. Magnetic nanoparticles (MNPs) have gotten a lot of attention lately because of their unique structural, behavioural, and diverse application characteristics, such as their unique magnetic properties and tunable size, high chemical stability with increased surface area, functionalizable surface with different molecules, and biocompatibility with various cell types. They've also been used in specialised research domains due to features including superparamagnetism, high magnetic susceptibility, and an inductive magnetic moment that may be modulated with an external magnetic field, all of which are important for immobilisation near a physiological system.

Drug delivery systems, magnetic hyperthermia treatment, contrast compounds for Magnetic Resonance Imaging (MRI), tissue engineering, gene delivery, cell separation and selection, magnetorelaximetry, antimicrobial agents, and lab-on-a-chip are all examples of their importance. Despite the quantity of review studies and research works on MNPs demonstrating their impact over the previous few decades, there are still some undiscovered areas that need to be addressed for future progress.

The negative effects of MNPs on live cells and their toxicity on physiological systems, for example, are of great concern. Furthermore, because MNPS' size influences their extended circulation in the human body and their ability to flow through capillary organs and tissues to prevent embolism, all of these concerns bring up a slew of new avenues for further research into their synthesis and development processes. As a result, a full evaluation concentrating on the MNPs' missing but potentially important components will be a valuable contribution. This review study concentrates on elements of MNP synthesis and applications, as well as difficulties and potential advancements.

Established MNP synthesis techniques, as well as their applicability and conveniences in biological applications, are discussed in this study. Because discussing syntheses need clarity from a biocompatibility standpoint, related materials, solvents, and functionalities are presented. Furthermore, the MNPs are illustrated, including their surface modification and features pertinent to biomedical applications. Dedicated sections are also being created to highlight specific biomedical uses of MNPs, as well as potential obstacles, from various imaging techniques and lab-on-a-chip application perspectives. We have largely highlighted the connected metrics with possible study subjects such as toxicity to be complete and objective from a review point of view. In a word, this study summarises certain syntheses discussions and biomedical applications that have been left unexplored by the existing research.

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Applications in magnetic bio sensing

MNPs rely on a range of magnetic detecting techniques, which can be divided into two categories: volumetric-based approaches and surface-based techniques. Volumetric based sensors, such as the Planar Hall Effect (PHE) and Nuclear Magnetic Resonance (NMR) devices, allow easy and rapid sample preparation and detection. Surface-based sensors, such as Giant Magnetoresistance (GMR) and Tunnel Magnetoresistance (TMR) sensors, on the other hand, have extremely low detection limits but require time-consuming sample preparation. Furthermore, both SQUIDs and atomic magnetometers (AMs) are highly sensitive instruments that can be operated using either technique, depending on the application.

The magnetic characteristics of the material, which may be modified by modifying elements such as particle size, shape, and composition, are used in these biosensing approaches. In the next sections, we focus our discussion on the implications of size, shape, and composition on the magnetic characteristics of MNPs and eventually on the sensing ability of these nanomaterials.

Chen et al. have explored the relationship between particle size and MNP performance in biosensors. Chen et al. created magnetic iron oxide particles with diameters of 120, 440, and 700 nm, then functionalized their surfaces with streptavidin for use in protein detection that was both specific and sensitive [1-5].

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