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Nanotechnology and Medicine in the Future

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Perspective

Nanotechnology is the science and engineering that goes into the design, synthesis, characterisation, and use of materials and devices whose smallest functional organisation, in at least one dimension, is on the Nano scale, or one billionth of a metre. Individual molecules and interacting groups of molecules in relation to the bulk macroscopic properties of the material or device become important at these scales because they have control over the fundamental molecular structure, allowing control over the macroscopic chemical and physical properties. Nanotechnology has various uses in medicine, and this article discusses a few of them.

These materials and devices can be designed to interact with cells and tissues at a molecular (i.e., subcellular) level, with a high degree of functional specificity, for applications in medicine and physiology, allowing a level of integration between technology and biological systems not previously possible. It's important to remember that nanotechnology isn't a single emerging scientific discipline in and of itself, but rather a fusion of traditional sciences like chemistry, physics, materials science, and biology that brings together the required collective expertise to develop these novel technologies [1]. Nanotechnology holds a lot of promise, not only in terms of improving present approaches, but also in terms of introducing whole new tools and capabilities.

The fundamental characteristics and bioactivity of pharmaceuticals and other materials can be changed by changing them at the Nano scale. These tools can be used to manage a variety of drug or agent characteristics, such as:

- Changes in solubility and time spent in the blood pool.
- Controlled release for short or long periods of time.
- Controlled release triggered by the environment or extremely specific site-targeted delivery.

Fluorescent biological labels, drug and gene delivery, pathogen bio-detection, protein detection, DNA structure probing, tissue engineering, tumour detection, separation and purification of biological molecules and cells, MRI contrast enhancement, and phagokinetic studies are some of these applications [2]. Nano medicine research's long-term goal is to characterise the quantifiable molecular-scale components known as Nano machinery. Precise control and manipulation of Nano machinery in living cells can lead to a deeper knowledge of cellular mechanisms and the development of sophisticated technologies for the early diagnosis and treatment of various diseases. The importance of this study lies in the creation of a platform technology that will influence Nano scale imaging methodologies used to investigate molecular pathways in living cells [3]. Molecular imaging has evolved as a strong method for visualising the molecular events of an underlying disease, sometimes before it manifests in other ways. The combination of nanotechnology and molecular imaging creates a flexible framework for the development of innovative Nano probes with enormous potential for improving the sensitivity, specificity, and signalling capacities of numerous biomarkers in human diseases.

Nanoparticle probes can improve signal sensitivity, spatial resolution, and the capacity to communicate information on biological systems at the molecular and cellular levels in imaging techniques. Magnetic nanoparticles can be used as contrast enhancement probes in Magnetic Resonance Imaging (MRI). For multimodal imaging, gene transfer, and cellular trafficking, these magnetic nanoparticles can be used as a core platform for the addition of various functional moieties such as fluorescent tags, radionuclides, and other biomolecules. Target cells can be detected and gene delivery and expression of green fluorescent proteins can be monitored optically using a (MRI) with hybrid probes of magnetic nanoparticles and adenovirus. Nuclear techniques like Positron-Emission Tomography (PET) have the potential to provide improved detection sensitivity, allowing nanoparticles to be used at lower concentrations than MRI allows. Furthermore, hybrid imaging can map signals to atherosclerotic vascular regions by combining the high sensitivity of PET with the anatomical detail given by Computed Tomography (CT) [4]. The build-up of the contrast agent in the target location is always required for molecular imaging, and this can be accomplished more efficiently by directing nanoparticles bearing the contrast agent into the target. This necessitates the usage of targeting groups to gain access to target molecules hiding behind tissue barriers. Nanoparticles with numerous contrast groups enable signal amplification for imaging modalities with low sensitivity [5].

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