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Nanotechnology's Contribution to Medical Advancement

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Introduction

The study, design, synthesis, construction, manipulation, and use of materials, devices, and systems at the nanoscale scale is known as nanotechnology. Agriculture, engineering, construction, microelectronics, and health care, among other professions, are becoming increasingly essential. In recent years, the use of nanotechnology in the field of health care has gotten a lot of attention. Nanotechnology allows for the development of treatments that are both faster and less expensive (2). Pharmaceutical nanotechnology includes nanomaterials and devices for drug delivery, diagnostics, imaging, and biosensors, as well as applications of nanoscience to pharmacy as nanomaterials (3). Nano medicine is described as modules with a size of less than one micron (1 um) that are utilised to treat, diagnose, monitor, and control biological systems [1].

Description

Medical and health-related applications

Nanomaterials' unrivalled sensitivity and performance, increased durability and flexibility, and unique physiochemical properties have been used in medical diagnosis for early disease detection, target-oriented clinical therapy, and regenerative medicine for tissue regeneration.

Diagnostics in medicine

The revolution in biosensors toward point-of-care testing via glucometer for blood glucose monitoring has engulfed the entire world. It has progressed from an early enzyme-based method to an amperometric-based basis and then to the reverse iontophoresis method. From in-vitro diagnosis to in-vivo blood glucose monitoring, the approach has progressed from invasive procedures to non-invasive monitoring [2,3].

Drug delivery systems and clinical therapy

The novel NPs not only serve as effective imaging agents for detecting sick tissues, but they also serve as perfect carriers for delivering anticancer medications and other therapeutic pharmaceuticals to the target site with maximum precision and minimal collateral damage to healthy tissues. The focus of therapeutic intervention is increasingly on intracellular molecular targets rather than the cell itself. Biocompatible packing materials can be used to deliver gene-encoding DNAs, gene-silencing short interfering RNAs, or recombinant proteins intracellularly. Liposomes, bacterial toxins, and viral NPs are commonly employed packaging scaffolds, although they are often destroyed and eliminated from circulation before reaching the potential target site [4,5].

Regenerative medicine and tissue growth

Tissue regenerative medicine research strives to create implants or scaffolds that can administer medicines, growth factors, and hormones for tissue repair. They supply bioactive chemicals throughout time to assist cell survival, invasion, and proliferation in tissue engineering. Complete tissue repair and functional recovery are envisaged as a result of this treatment approach. The use of carbon nanotubes, nanowires, and nanoparticles improves the development of extracellular matrix. To speed up bone regeneration, biomimetic hydrogels are employed as a controlled biomolecule delivery system for growth factors. When compared to typical composite micro particles, Nano filled composites have greater compressibility, tensile strength, and flexure strength. A new scaffold for osteochondral healing is a crosslink agent made of partly hydrolysed polyacrylamide (HPAM) and nanocrystal line hydroxyapatite (nHAp) [1,2].

Anesthesiological nano medicine

Nanotechnology advancements in the realm of anaesthesia provide promise through the employment of Nano robots. Millions of people, who undergo various sorts of surgery, as well as unwell cancer patients, benefit from this treatment. There are two spaces in the design of a Nano robot: An internal space that will be a closed vacuum environment into which liquids from the outside will not ordinarily be able to enter unless chemical analysis is required. Various chemical liquids in our bodies will be released into the environment. The receptor sensor, Central Processing Unit (CPU), effector, and power system are the three basic components. The receptor sensor's job is to recognise the many anaesthetic receptors on the cell. The effector is responsible for triggering the post receptor event. The CPU is in charge of everything. The power system gives the Nano robot with the energy it requires to function [4].

Microphysiometer

The Microphysiometer is made of multi walled carbon nanotubes, which are stacked and folded into very small tubes from multiple flat sheets of carbon atoms. The nanotubes are electrically conductive, so the amount of insulin in the chamber can be directly connected to the current at the electrode, and they work reliably at pH levels similar to those found in real cells. Current detection technologies gather tiny samples at regular intervals and evaluate their insulin levels to determine insulin production. The novel sensor measures the transfer of electrons created when insulin molecules oxidise in the presence of glucose to monitor insulin levels in real time. The current in the sensor increases as the cells create more insulin molecules, and vice versa, allowing real-time monitoring of insulin concentrations [3,4].

Nano nephrology

Nano nephrology is a branch of Nano medicine and nanotechnology that aims to diagnose, treat, and manage renal illnesses using nanomaterials and Nano devices. It entails (1) atomic-level analysis of kidney protein structures and (2) Nano imaging methods to analyse biological activities in kidney cells. (3) Nonmedical solutions that use nanoparticles, Nano robots, and other nanoparticle-based technologies to treat various renal disorders. Many clinicians aspire to create a Nano-scale prosthetic kidney. Nano-scale engineering breakthroughs will allow programmable and controllable Nano-scale robots to perform curative and reconstructive surgeries at the cellular and molecular levels in the human kidney.

Conclusion

On a molecular level, pharmaceutical nanotechnology has allowed for more

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precise detection and treatment of ailments. Pharmaceutical nanotechnology is a cutting-edge, highly specialised field that will alter healthcare in the not-too-distant future. Pharmaceutical nanotechnology has game-changing potential in the battle against a variety of diseases. It aids in the detection of antigens linked to diseases like as cancer, diabetes, and neurological diseases, as well as bacteria and viruses that cause infections. Nanotechnology allows for the mass production of extremely powerful items in enormous quantities. Nano medicines and Nano devices are still in the developmental stages. Because the development procedures are tightly entwined with biotechnology and information technology, the scope of the project is extremely broad. Traditional methods have limitations, which nanotechnology-based products can overcome. However, the major difficulties of toxicity, environmental risks, production cost, and accessibility to the unreachable in remote locations have yet to be overcome.

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Conflict of Interest

The author reported no potential conflict of interest.

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