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How Nanotechnology can Revolutionize Drug Delivery

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ABSTRACT

Nanotechnology has been immensely beneficial to the field of drug delivery as it has allowed pharmacologists to produce medicines that are much more effective than ever before. Read on to learn more.

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Introduction

The world of medicine has seen some of the most mind-blowing advancements over the years, which have transformed treatments and tremendously improved global quality of life. From specialized medical machines and advanced imaging to automated drug administration and robot-assisted surgeries, there have been countless highly impressive technological advancements in the healthcare sector. And among the many revolutionary developments in nanomedicine, one that stands out is **drug delivery through nanotechnology**.

Nanotechnology and Nanomedicine

Nanotechnology refers to the use of nanoparticles (ranging from 1 to 100 nm) – molecular or atomic building units of materials and devices- to come up with solutions to problems in different fields of science. For example, nanotechnology has been used to make water purification filters that deeply purge the water molecules off impurities, thanks to the nanoscopic size of the distillation particles that make the purifiers. The application of nanotechnology for medical purposes is referred to as nanomedicine.

Studies describe nanomedicine as the field of medicine that uses nanoparticles for the diagnosis, control, treatment, prevention, and monitoring of various diseases. Said application of nanotechnology in the field of medicine has been exceptionally instrumental in enhancing the efficacy of drugs for treating, or at the very least controlling, previously incurable ailments, such as inoperable tumors.

To understand how drug delivery through nanotechnology has altered the course of treatment for so many diseases, looking at the problem with drug delivery before said advancement is essential.

Figure 1.

Two people in lab coats working with test tubes in a research lab

Problems with Drug Delivery before Nanotechnology

As noted above, nanotechnology employs micro molecules to treat medical conditions, which are delivered to infected sites, automatically improving the chances of a positive remedial response.

One of the most long-lasting and perhaps also baffling issues, before nanomedicine, in the pharmacological sector has been the inescapable large-sized capsules used to treat illnesses. Back then, experts didn't have a way to condense therapeutic

molecules enough to produce micro-medicines that would primarily target infected sites.

Consequently, the large materials dispensed to combat infections and viruses weren't the most efficient in taking down only the foreign entities in the body. As a result, healthy cells were also damaged. Besides the lack of targeted delivery, large capsules also had solubility issues, i.e., they didn't dissolve in the bloodstream completely nor swiftly, which in turn affected the bioavailability. Bioavailability is the scientific term given to the absorption of a drug into the body's circulation system.

In a nutshell, drugs delivered without nanotechnology presented multiple problems; generalized delivery, low solubility, poor bioavailability, and widespread side effects. All said issues with the old drug delivery systems have been tackled by nanotechnology.

Nanotechnology Applications to Drug Delivery

- The most crucial benefit nanotechnology has had on drug delivery is for people with tumors. Since most malignant cells are super aggressive, potent compounds are needed to fight them. But such high-strength composites can be harmful to the healthy tissues surrounding a tumor; therefore, targeted delivery is a must when dealing with cancer sites. And that is now possible, thanks to nanomedicine.
- Moreover, generally, tumors require a lot of oxygen to survive, which is why they have pores in their blood vessels. These porous veins absorb nanoparticles much faster, making nano-drugs that much more effective.
- Drugs delivered through nanotechnology are more likely to transport through the epithelial and endothelial barriers- the tissues that separate organs from their surroundings.
- Drug delivery through nanotechnology allows transportation of poorly water-soluble medicines.
- Due to improved localized absorption, drugs delivered using nanoparticles improve medicinal retention in the affected area without exposing/damaging surrounding healthy tissues.
- One particularly astounding benefit of nanomedicine is the amalgamation of diagnostic and therapeutic agents. Nanoparticles allow experts to combine the two modalities to achieve dual goals.

Ending Note

Although nanomedicine has gained much significance over the past decade, it still has a long way to go. But if it is mass-marketed at a more rapid pace, drug delivery systems will boost exponentially.