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Fundamentals of Nanotechnology-Based Drug Design Techniques

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Editorial

Nanomedicine is a field of medicine that employs nanoscale materials, such as biocompatible nanoparticles and nanorobots, for a variety of applications in living organisms, including detection, processing, visual, and actuation. Drugs with very low solubility have a variety of biopharmaceutical distribution problems, including reduced bioaccess after oral ingestion, lower diffusion potential into the outer membrane, higher intravenous dosage requirements, and undesirable side effects prior to the conventional formulated vaccine method. Many of these drawbacks, however, could be solved by incorporating nanotechnology into the drug delivery system.

Because of its possible benefits, such as the ability to alter properties like solubility, drug release profiles, diffusivity, bioavailability, and immunogenicity, drug design at the nanoscale has been extensively studied and is by far the most mature technique in the field of nanoparticle applications. As a result, more efficient administration routes can be created, as well as lower toxicity, less side effects, better biodistribution, and a longer drug life cycle. Engineered drug delivery systems are either tailored to a specific location or are designed to activate therapeutic agents in a managed manner at a specific location. Their development requires self-assembly, in which building blocks randomly shape well-defined configurations or patterns. They must also conquer obstacles such as opsonization/sequestration by the mononuclear phagocyte cell.

Nanostructures can distribute drugs in one of two ways: passive or self-delivery. Drugs are primarily inserted into the inner cavity of the structure through the hydrophobic effect of the former. Because of the low content of the drugs, which is encapsulated in a hydrophobic environment, the expected volume of the substance is released as the nanostructure materials are targeted to specific locations. The drugs intended for release, on the other hand, are specifically conjugated to the carrier nanostructure material for fast distribution. The timing of release is critical in this strategy because the drug will not enter the target site and will dissociate from the carrier very quickly; conversely, if it is released from its nanocarrier device at the right time, its bioactivity and effectiveness will be reduced. Another important feature is drug targeting, which uses nanomaterials or nanoformulations as drug delivery mechanisms and is divided into active and passive categories. Antibodies and peptides are combined with drug delivery systems in successful targeting to bind them to receptor complexes expressed at the target site. The prepared drug carrier complex circulates through the bloodstream and is guided to the target site by affinity or binding, which is influenced by properties such as pH, temperature, molecular site, and shape. The receptors on cell membranes, lipid elements of the cell membrane, and antigens or proteins on cell surfaces are the key targets in the body. The majority of nanotechnology-mediated drug delivery systems are currently aimed at cancer treatment and prevention. There have been significant advancements in the area of delivery mechanisms to distribute medicinal agents or natural-based active substances to their target locations for the treatment of different aliments recently. While a variety of drug delivery technologies have been successfully implemented in recent years, there are still several problems to be addressed and new infrastructure to be introduced in order to successfully distribute drugs to their target locations. As a result, nano-based drug delivery systems are currently being investigated in order to enable the development of a more sophisticated drug delivery system.

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