Applications of Nano-Medicine in Drug Delivery

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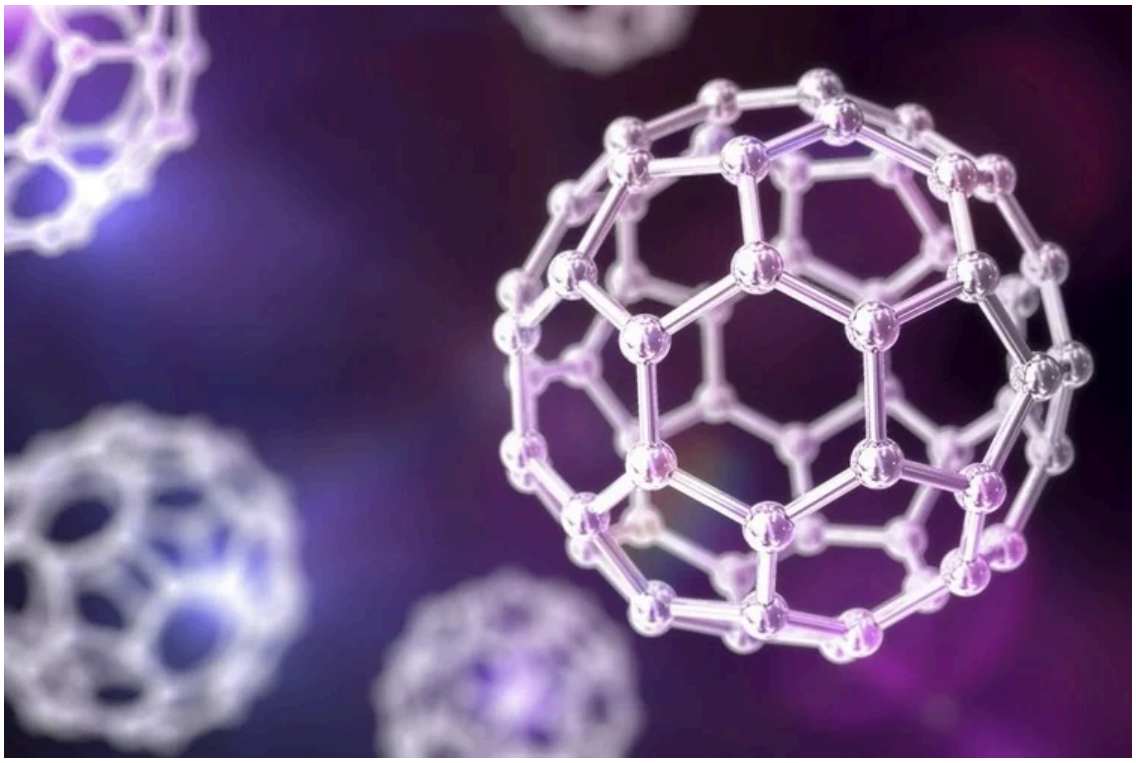
Introduction

The human body is a well-oiled machine, protecting you from enemies and even from yourself! Despite this, humans still experience occasional bouts of sickness, sometimes progressing into something more severe, or even fatal. To combat this issue, scientists have invested in nanomedicine. Nanomedicine is the application of nanotechnology to achieve innovation in healthcare, with the goal of mitigating the consequences of these severe illnesses in ways traditional medicine can't achieve.

In simple terms, nanomedicine leverages nanotechnology to improve diagnosis, treatment, and disease prevention. Medical scientists manipulate atoms and molecules to deliver targeted drugs inside of your body. These molecules can serve as tools on a very small scale, allowing for incredible precision.

Later in the article, we'll explore how leading research in the field has shown promising results in cancer therapy, coronary artery disease (CAD), and neurological illnesses.

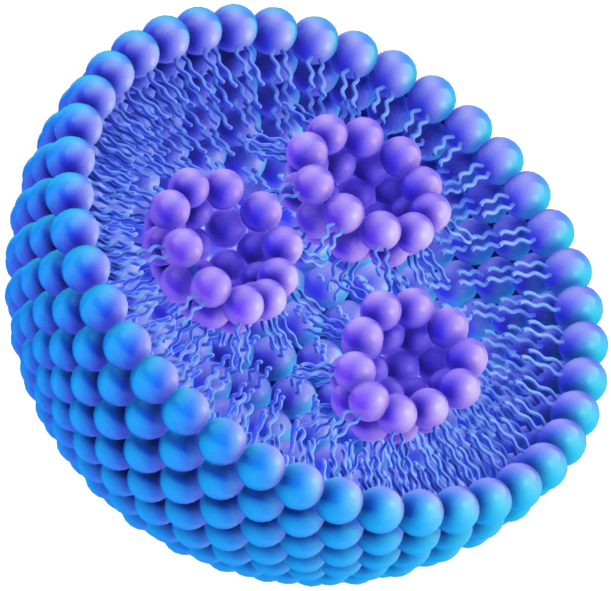


Visualization of a nanoparticle | Image Credit: Kateryna Kon/Shutterstock.com

1. Overview of Nano-Medicine in Drug Delivery

This is known as the Nano-Drug Delivery Systems (NDDS). It works by engineering nanostructures (1-100 nm) that carry an extremely tiny capsule of drugs, which target, administer, and deliver the medicine to a specified location. (Han, et. al).

You might be wondering, why would scientists go through all the trouble of NDDS when current treatments exist? Well, this is seeing that nanomedicine can enhance drug efficacy, prolong drug stability, and improve targeted delivery. (Gelperina, et. al).



Visualization of a Lipid Nanoparticle | Source: NanoTech Pharma

2. Types of Nanoparticles Used in Drug Delivery

Now that we know what NDDS can do for us, let's cover the types of nanoparticles. These molecules come in a wide variety of forms, ranging from metal-based particles to carbon nanotubes, and organic to inorganic. For example, take Lipid Nanoparticles (LPNs), a type of organic nanoparticle. These spherical molecules consist of a lipid matrix (a bilayer with hydrophilic heads and hydrophobic tails) and have the ability to carry therapeutic cargo, such as mRNA and small molecule drugs, allowing diverse uses. This type of nanoparticle is just one of many, but it shows the amazing potential of nanotech in medical care.

3. Applications in Treatment

Nano-medicine has several applications for illnesses such as cancer, heart disease, and neurological disorders. Modern cancer therapies sometimes cannot completely distinguish cancer cells from healthy cells, leading to adverse side effects. Recent advances in nanotechnology, such as the development of nanocarriers (nanomaterials transporting drugs to specific areas in the body) have allowed for specific targeted treatment for particular organs (Fan, et al.). This is crucial! Targeted therapies can increase treatment effectiveness, leading to better patient outcomes. Similarly, nanomedicine's role within coronary artery disease (CAD) has grown as we begin to learn more about our biology and the promise of the implementation of nanotechnology within healthcare. As an example, nanoparticles have been used to help detect CAD biomarkers for high-resolution imaging and for improving heart-based biomaterial functionality (Smith, et al., Hu, et al.). Early detection is vital to ensure timely interventions for heart attacks or other complications. Moreover, nanocarriers' applications in prevention of disease development through inhibition has great potential to influence neurological disorders such as Alzheimer's and Parkinson's disease. (Saeedi, et. al) By leveraging this technology, we are seeing a transformative shift in the approach towards disease treatment with the potential to better patient outcomes.

4. Challenges and Future Directions

Nanomedicine is an innovation in healthcare and companies like Abbott Laboratories and Precision NanoSystems Inc. are industry leaders in this space. Abbott Laboratories is a reading global healthcare company focusing on applying nanotechnology to improve drug delivery and diagnostics. Meanwhile, Precision NanoSystems Inc. is creating a platform called NanoAssemblr to develop a scalable and reproducible manufacturing process. This would lead the industry development of high-quality nanomedicine products and accelerate its commercialization.

However, innovation and success come with its challenges. As nanomedicine continues to develop, continuous and rigorous safety assessments are crucial to keeping this technology safe for patients. In addition, there are many challenges when it comes to reproducibility and scalability. For example, growing from a specialized lab to an industrial scale will require huge amounts of time, money, and effort, requiring driven people and companies to propel this innovation forward.

5. Conclusion

At its core, nanomaterials and nanocarriers' ability to deliver proteins, peptides, and nucleic acids has opened new opportunities for treatment and clinical applications. Nanomedicine brings with it the promise of a bright future, from disease treatment to regenerative medicine, there is incredible potential in this technology's impact as research continues to progress and as we learn more about ourselves and how our bodies function.

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