

Nanotechnology and controlled drug delivery

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Introduction

Nanotechnology advances in drug delivery deal with the development of synthetic nanometer sized targeting delivery systems for therapeutic agents. It uses the improved properties of materials at the nanometer scale. At this scale, manmade structures match typical sizes of natural functional units in living organisms thus allowing them to interact with biomolecules. Major goals are the increase of drug availability and efficacy by e.g., the overcoming of obstacles (e.g., air-blood barrier). Therapeutic systems in this class are up to a million times larger than classical drugs like aspirin. Their increased complexity however, gives these systems the unique power to tackle more challenging diseases.

Why it is Important in Clinical Medicine

Nanomedicine has the potential to enable early detection and prevention, and to essentially improve diagnosis, treatment and follow-up of diseases. Nanomedicine is a very special area of nanotechnology, because: (1) it is an extremely large field ranging from in vivo and in vitro diagnostics to therapy including targeted delivery and regenerative medicine, (2) it interfaces nanomaterials with "living" human material and (3) it creates new tools and methods that impact significantly existing conservative practices. THIS PARAGRAPH IS SOMEWHAT OUT OF POINT

Before and After Nanotechnology Revolution

As shown in Table, the drug delivery technologies in relation to the current nanotechnology revolution can be classified into three categories. NOT SURE ABOUT THIS CLASSIFICATION E.G., WHY DID YOU INCLUDE NANOPARTICLES AND DENDRIMERS AS 'BEFORE NANOTECHNOLOGY?', SHOULD INCLUDE THE REFERENCE

Period	Before nanotechnology (past)	Transition period (present)	Mature nanotechnology (future)
Technology	Emulsion-based preparation of nano/micro particles	Nano/micro fabrication	Nano/micro manufacturing
Examples	Liposomes	Microchip systems	Nano/micro machines for scale-up production
	Polymer micelles	Micro needle transdermal delivery systems	
	Dendrimers	Layer-by-layer assembled systems	
	Nanoparticles	Micro dispensed particles	

The current technology of manufacturing of engineering materials (e.g., semiconductor devices) at the nano/micro scale is advanced enough to develop nano/micro scale processes for producing products other than semiconductors. Imagine that the current soft gelatin capsules, which are in the centimeter scale, are manufactured at the nano/micro scale.

Current State of Development & Applications

Although we heard a lot about making medicines more efficient by nanotechnology, still the applications in drug delivery are at the beginning. Here are a few examples:

Nanoparticles: Nanoparticles are currently the most studied branch of nanotechnology. Scientists at Rice University, Texas have developed small, uniform nanospheres of cerium oxide – a highly popular industrial antioxidant – which have the capability of treating cardiac arrest, traumatic brain injuries, and even Alzheimer's.

Magnetic Nanoparticles: A team of researchers have developed magnetic nanoparticles that can be loaded with drugs or genes and directed towards deep targets in the body by using an external electromagnet.

Self-healing and Injectable Nanomedicines: A team of researchers have developed a variety of injectable nanomaterial that could accentuate the process of blood clotting and prevent blood loss in a near-fatal accident.

Safety

Although many individual researches have warned that nanomaterials can cause damage to the human body, the exact mechanisms of toxicity are unknown and conclusive data are yet to be established. Moreover, reports on nano-toxicity mostly focus on inorganic nanomaterials consisting of heavy metals. Investigation about the toxic effect of polymeric nanomaterials on living subjects is also urgently required.

Nanotechnology for Future Drug Delivery Systems

Predicting the future of nanotechnology in drug delivery systems is not simple because the technology is moving forward fast and dynamically changing and we are in the middle of such changes. We can find possible clues from the efforts to overcome the problems facing the research community today. First things that can be predicted is the small design of drug delivery systems. Also multifunctional drug delivery systems have been reported, but only few of them were used successfully in small animal models. While nanotechnology is expected to produce new nano/micro devices, it is also expected to develop the way the current drug delivery systems are produced. Nanotechnology-based approaches, which is often called "nano/micro manufacturing" can provide powerful new ways for mass production of nano/micro particles with high drug loading efficiencies.

Links

Useful Links

Animated Nanomedicine movie (<https://www.youtube.com/watch?v=2VcNpl8-PRI>)

Advanced drug delivery systems: Nanotechnology of health design A review (<http://www.sciencedirect.com/science/article/pii/S1319610312001986>)

Nanotechnology-based drug delivery in mucosal immune diseases: hype or hope? (<http://www.nature.com/mi/journal/v5/n1/full/mi201149a.html>)

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