Title Nanoscience and Nanotechnology in Biology and Medicine

P1 Nanoscience and nanotechnology refers to research and development of technologies at the atomic, molecular, or macromolecular levels - research where the characteristic dimensions are less than 1/1000 the diameter of a human hair. Nanotechnology research provides a fundamental understanding of phenomena and materials, that ~~which~~ are in the 1 - 100 nanometer range. For instance, DNA, our genetic material, is in the 2.5 nanometer range, while red blood cells are approximately 2.5 micrometers. This understanding enable the creation and use of structures, devices, and systems that have novel properties and functions because of their extremely small size. Recent advances in the understanding of and the ability to manipulate matter at this scale have resulted in incredible new opportunities for research and technological change in almost every field of science and enginring.

P2 Nanotechnology has the potential to radically change the study of basic biological mechanisms. It may also significantly improve the prevention, detection, diagnosis and treatment of diseases and adverse medical conditions. The key to this potential, is that nanotechnology operates at the same scale as biological processes. Most other technologies require the study of large numbers of molecules purified away from the cells and tissues in which they usually function, nanotechnology may offer ways to study how individual molecules work inside of cells.

H1 **Potentail Health Applications**

P1 Biomedical opportunities for nanotechnology include ~~include~~ the development of improved imaging contrast agents for the diagnosis of disease, systems for targeted drug delivery, tissue replacement tools for studying the basic functioning of living cells and their constituent proteins, and ~~to~~ sequence DNA in novel ways (using natural and fabricated nanopores.

(P1) Biomaterials and Tissue engineering. Nanotechnology based materials may provide solutions for repairing damaged tissues as well as ~~to~~ for monitor ing critical clinical indicators and interfacing for electrical measurement and stimulation. Such materials introduced into the body would not irritate or damage the surrounding tissues, nor would their function be impaired by longterm exposure to tissue fluids. Instead, they would actively communicate with host tissue and would dissolve into harmless components that could be absorbed or excreted when no longer needed. The synthesis and assembly of biologic materials and scaffolds with homol~~a~~ogous structure and function to the human body's own tissues and processes are within the realm of possibility and research pathways are becoming evident.

Responsive delivery of new generation therapeutics and diagnostics. While knowledge of cellular pathways related to disease has recently burgeoned, the subtleties of how these pathways function remain~~s~~ largely unknown. The ability to target pathway interventions to particular cell or tissue types, and to modulate the release or activation of agents in response to cellular signals, would allow specific interventions into disease pathways while minimizing side effects. Similar concepts can be used to deliver *in vivo* rom imaging agents for diagnosis, monitoring of disease and therapy, and early disease detection.

Point-of-care diagnostics. Effective detectors of specific molecules can be developed and integrated into compact devices. Such devices can be used to provide rapid information about diseased cells or tissues, and can be used to determine treatment options. Nano devices would be implanted in patients' bodies to provide real-time records for monitoring disease progression and therapeutic efficacy.

Imaging biological processes and the effects of disease. Current imaging methods can provide excellent informaton on the structure of molecules in vitro (e.g., X-ray diffraction) and high resolution of anatomical information in vivo (e.g.

Pl computed tomography). However, to understand dynamic living systems, and how they are a effected by disease, we need to be able to image biological processes non-destructively *in* Rom *vivo* in real time. Nanotechnology provides the opportunity for a new generation of imaging tools to probe living processes at the molecular and cellular level, allowing us to study how diseases disrupt normal molecular and cellular signals and pathways.

A1 **Implications and Ramifications of nanotechnology for ~~on~~ Society**

Pl With advancements in nanotechnology, one could envision a world where diseases are diagnosed and prevented or treated at early stages. Implanted nanotechnological materials would become part of the body and therapeutic agents would be delivered in the precise amount and at the site of action where they are needed. Achieving these goals, could result in enormous changes in society, as many people's quality and length of life would increase dramatically. As ~~Launching~~ new research projects are launched, the societal implications of nanotechnology research will be important to consider. Questions include: What is the long-term impact of incorporating nanoparticles that may be absorbed into the body? As large quantities of nanoparticulates are manufactured for incorporation into other products, what will be the direct heath effects? What will be their envirnomental impact on biological systems?

Style sheet

in vivo, in vitro	rom
long-term	adj
nanotechnology-based	adj
real-time	adj
real time	n. phrase
x-ray	

numbers
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