Nanomedicine

What if doctors could search out and destroy the very first cancer cells that would otherwise have caused a tumor to develop in the body? What if a broken part of a cell could be removed and replaced with a miniature biological machine? What if pumps the size of molecules could be implanted to deliver life-saving medicines precisely when and where they are needed? These scenarios may sound unbelievable, but they are the long-term goals of the NIH Roadmap's Nanomedicine initiative that we anticipate will yield medical benefits as early as 10 years from now.

Nanomedicine, an offshoot of nanotechnology, refers to highly specific medical intervention at the molecular scale for curing disease or repairing damaged tissues, such as bone, muscle, or nerve. A nanometer is one-billionth of a meter, too small to be seen with a conventional lab microscope. It is at this size scale – about 100 nanometers or less – that biological molecules and structures inside living cells operate.

Nanotechnology involves the creation and use of materials and devices at the level of molecules and atoms. Research in nanotechnology began with applications outside of medicine and is based on discoveries in physics and chemistry. This is because it is essential to understand the physical and chemical properties of molecules or complexes of molecules in order to control them. The same holds true for the molecules and structures inside living tissues. Researchers have developed powerful tools to extensively categorize the parts of cells in vivid detail, and we know a great deal about how these intracellular structures operate. Yet, scientists have still not been able to answer questions such as, "How many?" "How big?" and "How fast?" These questions must be addressed in order to build "nano" structures or "nano" machines that are compatible with living tissues and can safely operate inside the body. Once these questions are answered, we will design better diagnostic tools and engineer structures for more specific treatments of disease and repair of tissues.

NIH will begin its effort by establishing Nanomedicine Development Centers, which will serve as the intellectual and technological centerpiece of the NIH Nanomedicine Roadmap Initiative. These centers will be staffed by highly multidisciplinary scientific teams including biologists, physicians, mathematicians, engineers and computer scientists. Research conducted over the first few years will be directed toward gathering extensive information about the physical properties of intracellular structures that will inform us about how biology's molecular machines are built.

As this catalogue of the interactions between molecules and larger structures develops, patterns will emerge, and we will have a greater understanding of the intricate operations of molecular structures, processes, and networks inside living cells. Mapping these networks and

understanding how they change over time is crucial to help us understand nature's rules of biological design that, in turn, will enable researchers to use this information to correct biological defects in unhealthy cells. This knowledge will lead to the development of new tools that will work at the "nano" scale and allow scientists to build synthetic biological devices, such as tiny sensors to scan for the presence of infectious agents or metabolic imbalances that could spell trouble for the body, and miniature devices to destroy the infectious agents or fix the "broken" parts in the cells. This initiative is an important component of the NIH Roadmap endeavor because these tools will be developed and applied, not just for a single disease or particular type of cell, but for a wide range of tissues and diseases.

The URL for the NIH Roadmap web site is nihroadmap.nih.gov. Support for the NIH Roadmap and its initiatives is provided by all Institutes and Centers, whose representatives direct and oversee each initiative. For more information on the Nanomedicine initiatives, contact Tom Hoglund at the National Eye Institute (NEI), (301) 496-4308, hoglundT@nei.nih.gov. Biomedical scientists who wish to discuss Grants and Funding Opportunities should contact Dr. Richard S. Fisher, Program Director at the NEI, fisherR@mail.nih.gov. Further information about the NIH can be found at its Web site: www.nih.gov.