

Nanotechnology

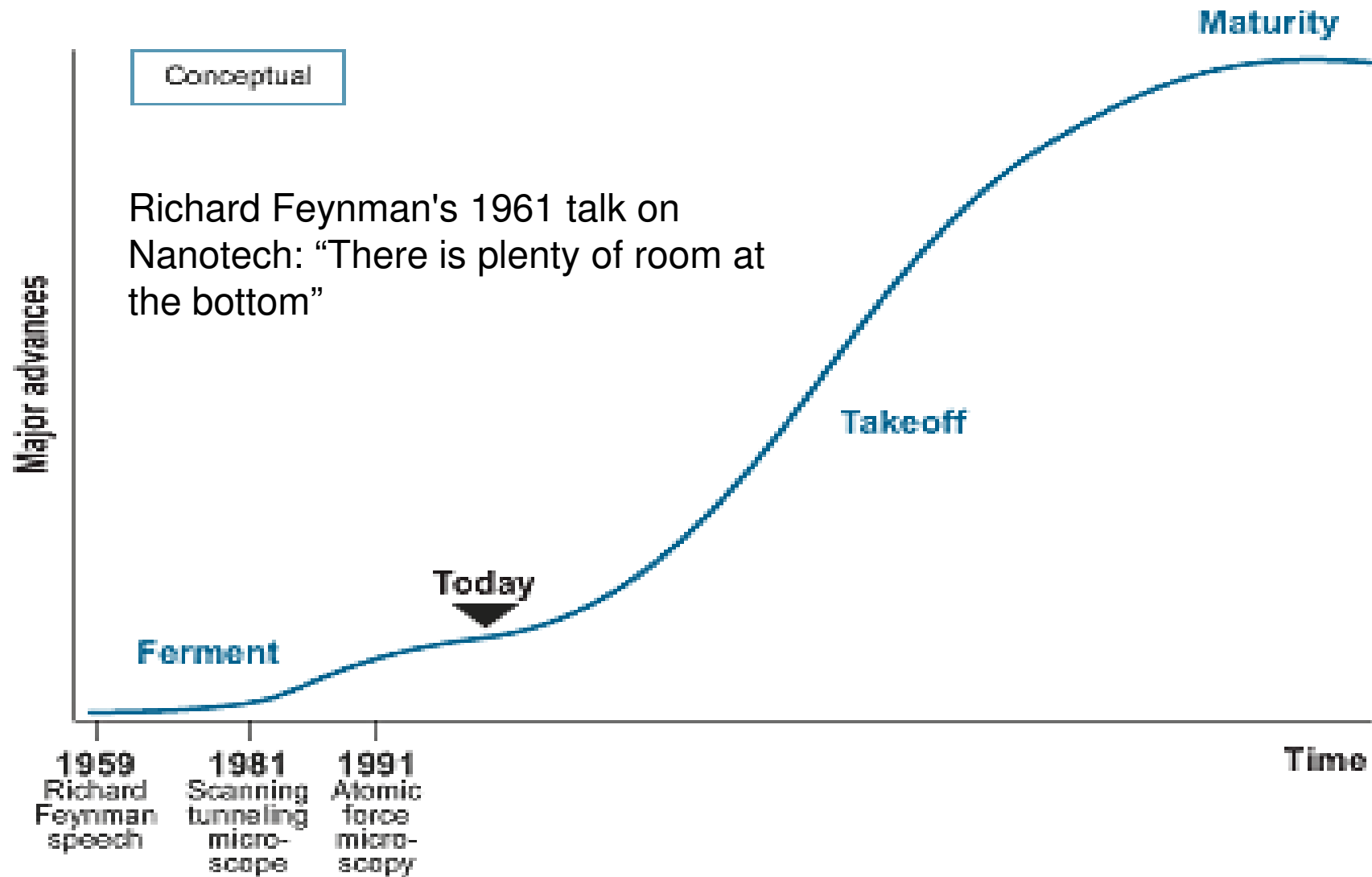
S. V. Chhatre

Elder Phrama

What is Nanotechnology?

- **NSF definition:** At least 1 dimension of the concerned object should be less than 100nm. Other 2 dimensions can be even macroscopic.

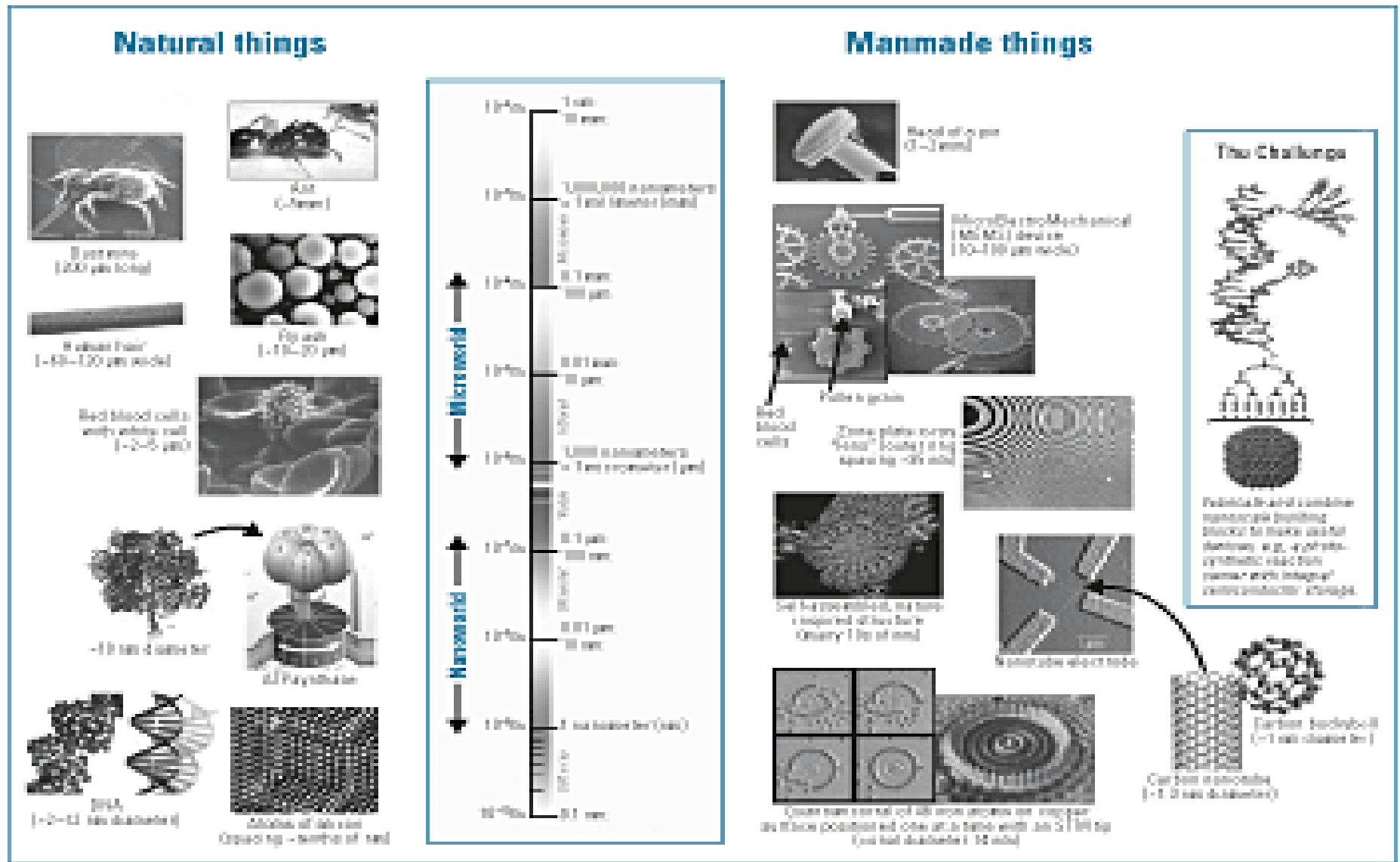
FIGURE 1
The nanotech curve



Source: "Nanotechnology Sector Report," Center for Economic Growth and the Lilly School of Management and Technology, 2004

FIGURE 2

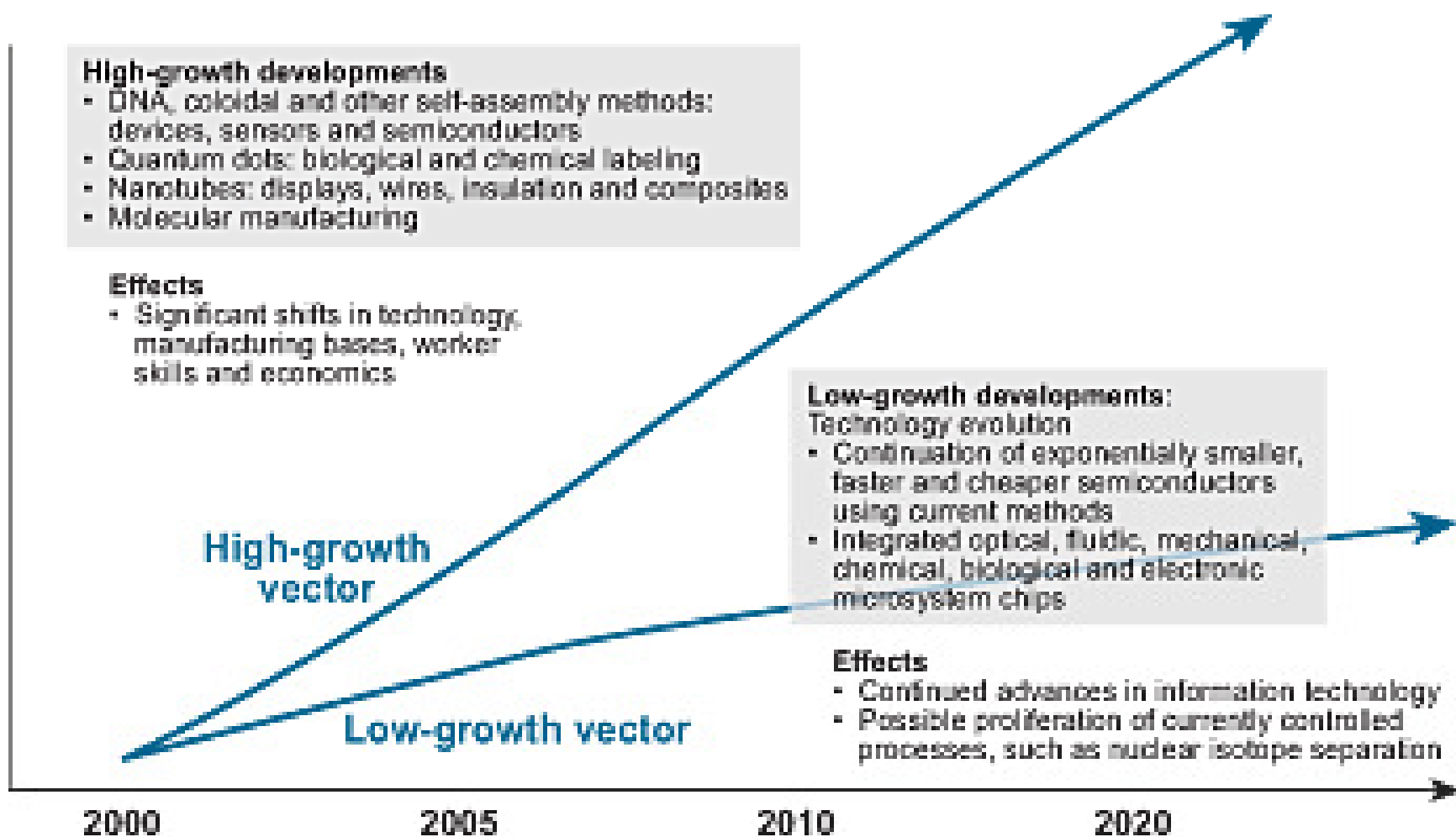
The scale of things — nanometers and more



Copied from NSF website: http://nano.gov/html/facts/The_scale_of_things.html

FIGURE 3

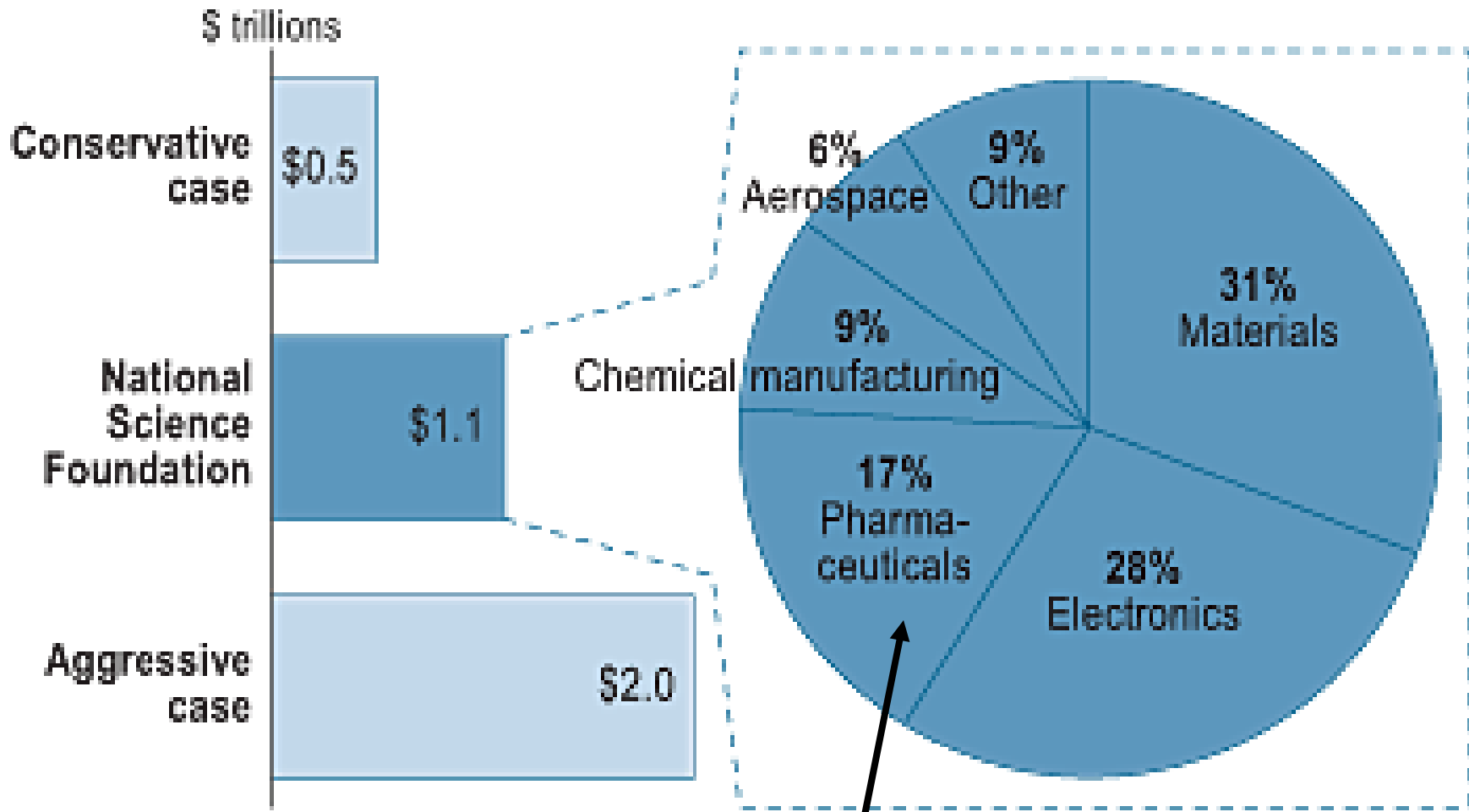
The growth of nanotechnology



Source: "Nanotechnology Sector Report," Center for Economic Growth and the Lally School of Management and Technology, 2004.

FIGURE 4

Nanotechnology-related goods and services, 2010–2015



Source: National Science Foundation and In Realis

Our bread & butter

Main Fields of Application:

1. Electronics

- Molecular transistors
- Saturation in VLSI technology

2. Biotechnology

- Drug delivery

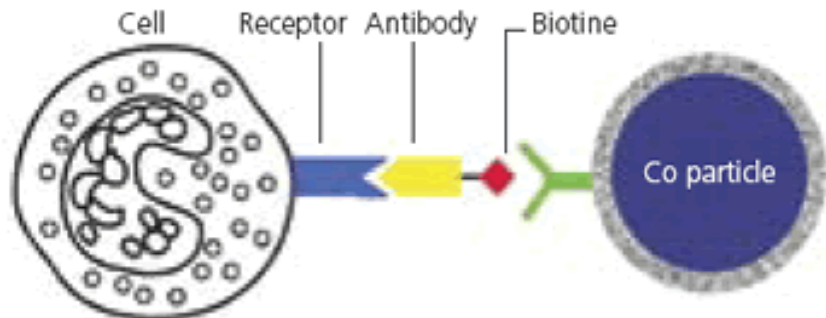
3. Pharmaceuticals

4. Materials Science

- Defense applications

Dignostics:

- How Nanotechnology Methods Can Improve Medical Diagnostics:
 - Early detection of disease remains a primary goal of the medical community. Nanotechnology holds great promise for enabling the achievement of this goal. Nanoparticles in particular have exhibited tremendous potential for detecting fragments of viruses, pre-cancerous cells, disease markers, and indicators of radiation damage. Gold coatings have made it possible to use toxic cobalt nanoparticles for biomedical applications. Gold coated ferromagnetic nanoparticles tagged with HIV antibodies may be able to detect virus particles left after completion of conventional drug therapy. Metal nanoparticles in the form of dendrimers have also been functionalized with different biomolecules to detect specific proteins, antibodies, and other disease indicators. Fluorescent markers can also be attached to the dendrimers.



- **Early Cancer Detection Using Superparamagnetic Iron Oxide (USPIO) Particles and Magnetic Resonance Imaging (MRI)**

- Biomolecule coated ultra small superparamagnetic iron oxide (USPIO) particles injected in the blood stream recognize target molecular markers present inside cells and induce a specific signal for detection by magnetic resonance imaging (MRI). This technology may allow for detection of individual cancer cells months or years earlier than traditional diagnostic tools, which require the presence of hundreds of cancer cells.

Targeted Drug Delivery

- **How Nanotechnology Can Improve Targeted Drug Delivery Methods**

Targeted drug delivery systems can convey drugs more effectively and/or more conveniently, increase patient compliance, extend the product life cycle, provide product differentiation, and reduce health care costs. Drug delivery systems that rely on nanomaterials also allow for targeted delivery of compounds characterized by low oral bioavailability due to poor water solubility, permeability and/or instability and provide for longer sustained and controlled release profiles. These technologies can increase the potency of traditional small molecule drugs in addition to potentially providing a mechanism for treating previously incurable diseases.

- **Using Magnetic Nanoparticles Targeted Drug Delivery - What This 'Tag and Drag' Process Involves**
- The use of magnetic nanoparticles in targeted drug delivery systems is under investigation by several research groups. Therapeutic drug molecules have been immobilized on the surface of magnetic nanoparticles or nanocrystals and directed to a specific target tissue using a magnetic field gradient. The drug is released by applying a radio frequency (RF) pulse. Gold coated iron, nickel and cobalt ferromagnetic nanoparticles have been employed in this "tag and drag" approach. In hypothermal treatment, magnetic nanoparticles are directed to diseased tissue containing heat sensitive tumors. An AC magnetic field is applied such that the nanoparticles become heated, causing destruction of the cancerous cells. More effective radiation therapy for tumor treatment can also be expected using metallic nanoparticles instead of, for example, magnetite. The nanoparticles allow the application of higher dosages of radiation at the tumor while sparing normal tissue.

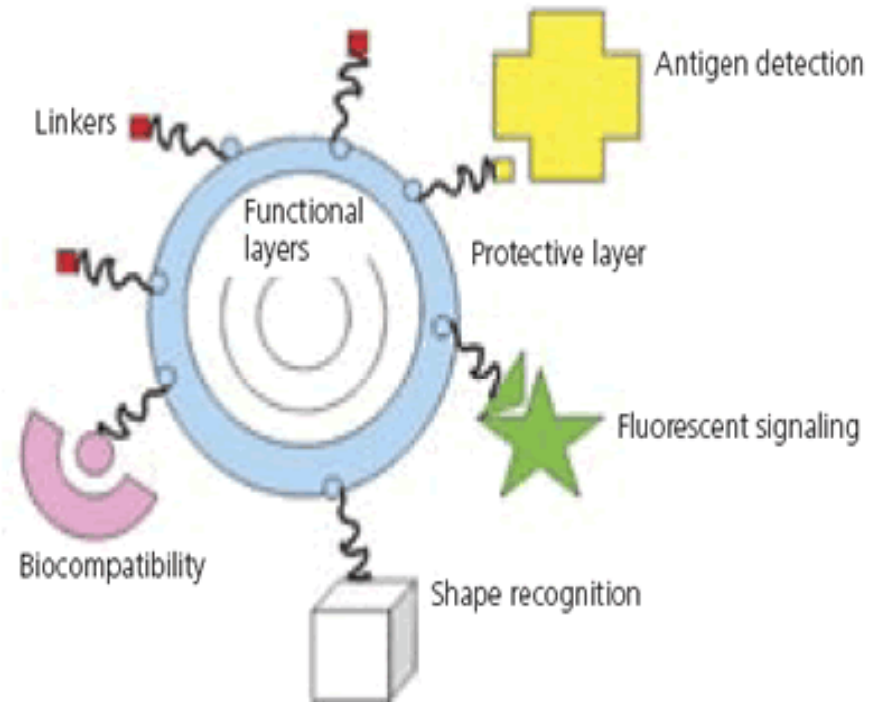
- **Other Applications for Nanomaterials in the Medical and Pharmaceutical Sector**
- Numerous other potential applications exist in the medical and pharmaceutical field for nanomaterials from [Strem](#). Areas currently under investigation include gene therapy, antibacterial/antimicrobial agents for burn and wound dressings, repair of damaged retinas, artificial tissues, prosthetics, enhancing signals for magnetic resonance imaging examinations, and as radio frequency controlled switching of complex biochemical processes.

- **List of Nanomaterials that Strem Can Supply to All Types of Industry**

- A listing of specific metal nanoclusters, metal nanocolloids (organosols and hydrosols), metal nanopowders, metal nanoparticles, and magnetic fluids offered by [Strem](#) is available upon request or via our website. Application sheets discussing the potential use of these products in the medical and pharmaceutical, defense and security, chemical, automotive, and energy fields, and as magnetic fluids, can also be obtained from [Strem](#). More information is also available in the form of a reference sheet listing literature source materials.

Biosensors and Biolabels

- **Using Biosensors and Biolabels to Understand Living Cells**
- Nanotechnology has the potential to increase our ability to understand the fundamental working of living cells. Many potential applications for metal nanomaterials as biosensors and biolabels are under investigation. They have found use in cellular studies, enhanced spectroscopic techniques, biochips, and protein and enzyme analysis.



<http://www.jnanobiotechnology.com/content/2/1/3> © 2004 Salata; licensee BioMed Central Ltd

**The industries that nanotechnology will likely disruptively affect in the near term include the following
(Billion US\$)**

<ul style="list-style-type: none"> · \$1,700 Healthcare · \$600 Long TermCare · \$550 Electronics · \$550 Telecom · \$480 Packaging · \$450 U.S. Chemical · \$460 Plastics · \$182 Apparel · \$180 Pharmaceutical · \$165 Tobacco 	<ul style="list-style-type: none"> \$100 Semiconductor · \$92 Hospitality / Restaurant · \$90 US Insurance · \$80 Corrosion Removal · \$83 Printing · \$57 US Steel · \$43 Newspaper · \$42 Diet-Supplement · \$40 Diet · \$32 Publishing 	<ul style="list-style-type: none"> \$30 Catalysts · \$27 Glass · \$24 Advertising · \$18 Cosmetics · \$13 Chocolate · \$10 Battery · \$5 Blue Jeans · \$4 Khakis · \$2.8 Fluorescent Tagging · \$.70 Mouthwash
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Ref: <http://www.yashnanotech.com/nano-application.php>

Some unique insights on the issue of nanotech and have devised a list of best practices:

- 1. Define a strategic imperative and foster collaboration.**
- 2. Redefine innovation**
- 3. Establish a value-based pricing strategy**
- 4. Define a supply management strategy**
- 5. Plan a solid execution**

If You're Not Already in It, You're Already Behind It

(Ref: <http://www.atkearney.com/main.taf?p=5,3,1,127>)

Major Investors:

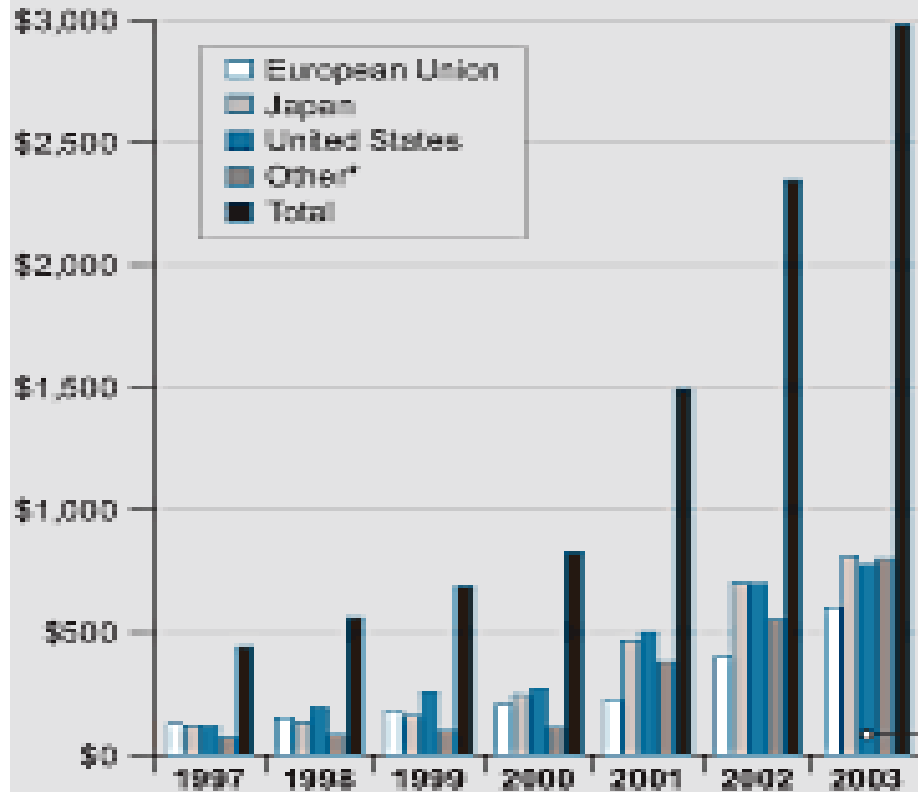
- Government
- GE, 3M and IBM (electronics)
- HP, Lucent and Motorola (major breakthroughs in semiconductor manufacturing & Carbon nanotube)
- DuPont and BASF (chemical)
- Pharma: Merck licensed Elan Corporation's NanoCrystal technology for faster drug delivery processing

FIGURE

Global government nanotech funding

Government funding, 1997–2003:
\$9 billion total

\$ millions



U.S. government funding, by agency,
2004–2006 (\$ millions)

Agency	2004 (actual)	2005 (estimate)	2006 (proposed)
National Science Foundation	\$258	\$338	\$344
Department of Energy	\$202	\$210	\$207
National Aeronautics and Space Administration	\$47	\$45	\$35
National Institute of Standards and Technology	\$77	\$75	\$75
Environmental Protection Agency	\$5	\$5	\$5
Total	\$587	\$673	\$666

*Includes Australia, Canada, China, Israel, Korea, Singapore, Taiwan and others.

Sources: National Science Foundation, and the National Nanotechnology Research and Development Program

Thank You