# “Nano Technology”

## Rekayasa dan Aplikasi dalam Bidang Energi dan Medis

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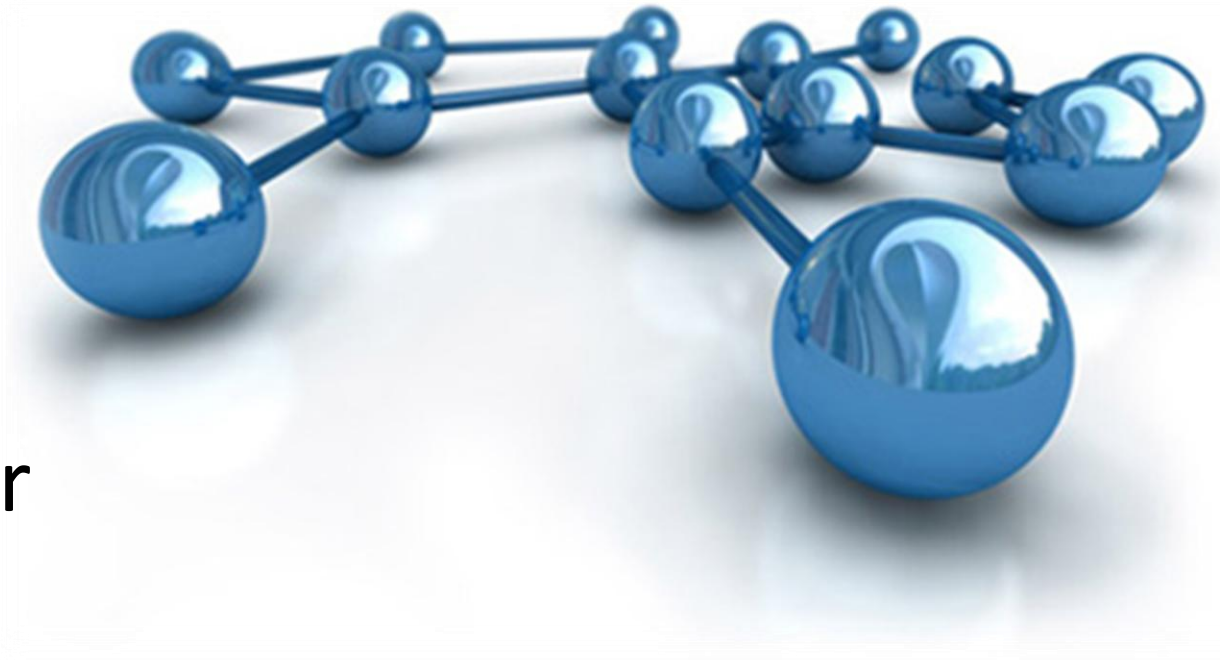


# *Outline*

- Overview
- Kosep Dasar
- Material
- Proses
- Karakterisasi
- Aplikasi Medis
- Tantangan dan Peluang

# Overview


# Our Research [*Renewable Energy*]

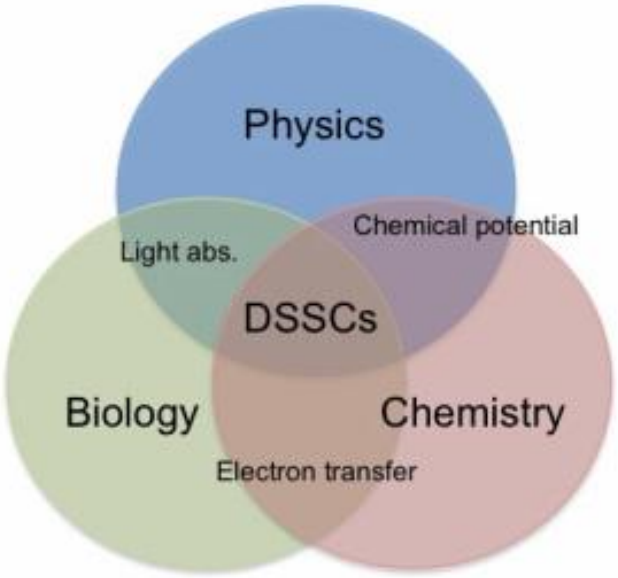
**Silicon-Based Material Solar Cell**
Efficiency up to 14-25% (*market*)
High cost material
High cost processing
Long life time

TDK Co. Japan – Rechargable Stand

DSSC

**Dye-Sensitized Solar Cell** *(Sintetic dye)*
Efficiency up to 12% (lab)
High cost materials
Low cost processing
Flexible substrate

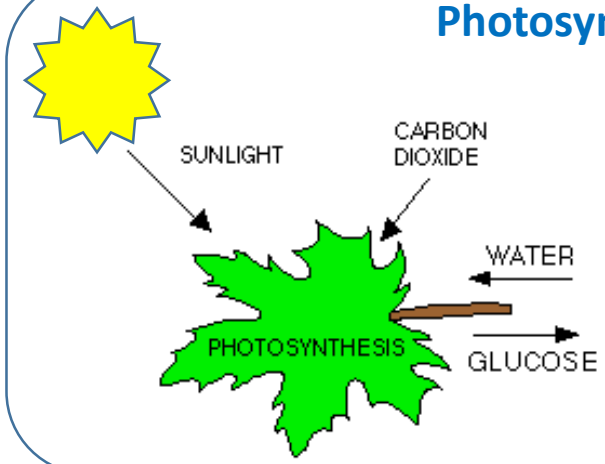
# Our Research: DSSC (Dye-Sensitized Solar Cell) Berbasis $TiO_2$




**Natural Dye-Sensitized**
Efficiency under 5% (lab)
low cost materials
Low cost processing
Flexible substrates

**Biomimic Approach**

**Photosynthesis**




chemical energy

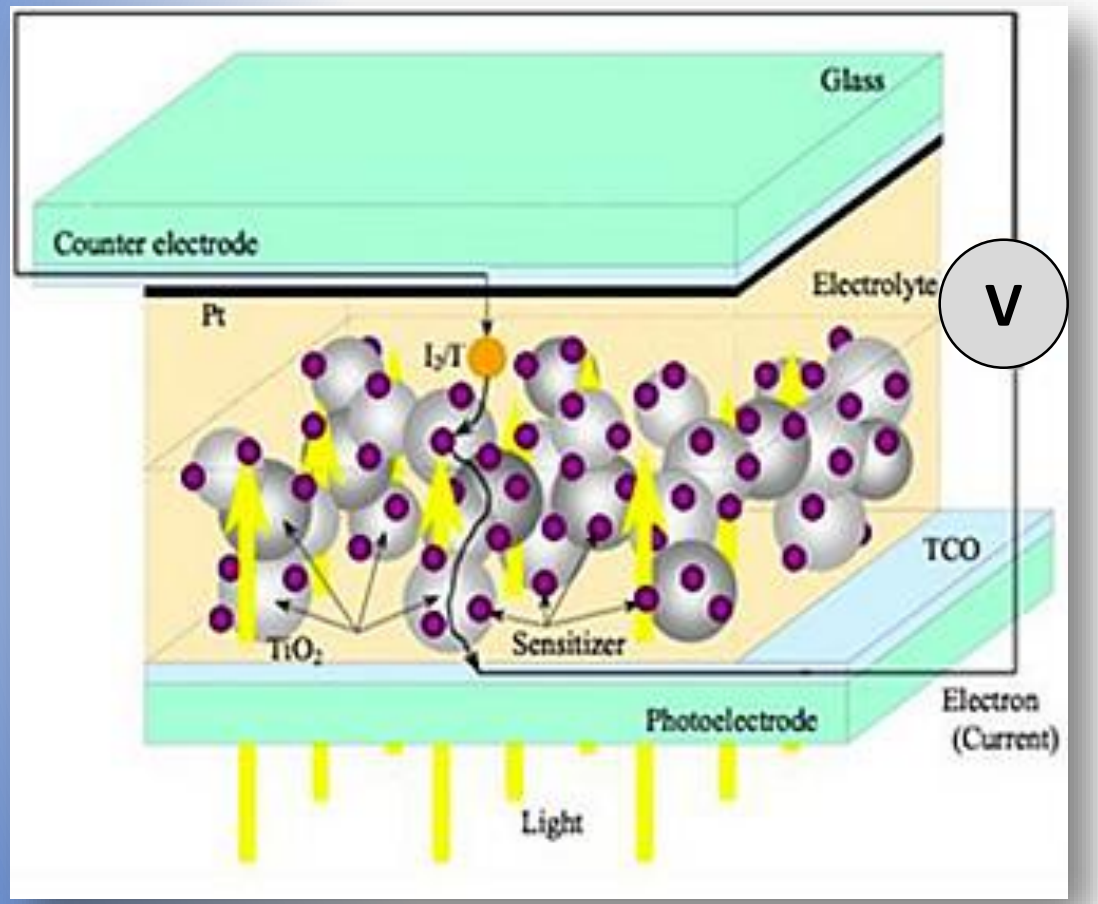
**Energy Conversion to Electricity**

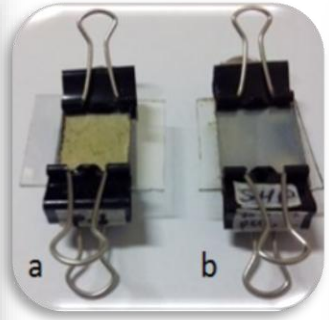

Sunlight

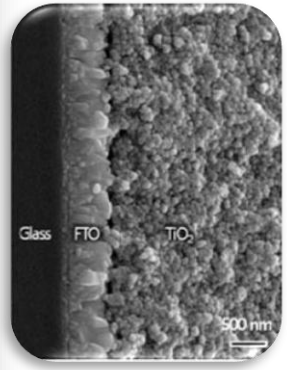
Electric energy

Sholeh HP, Eka Maulana, et.al. Organic Solar Cell in DSSC 2013

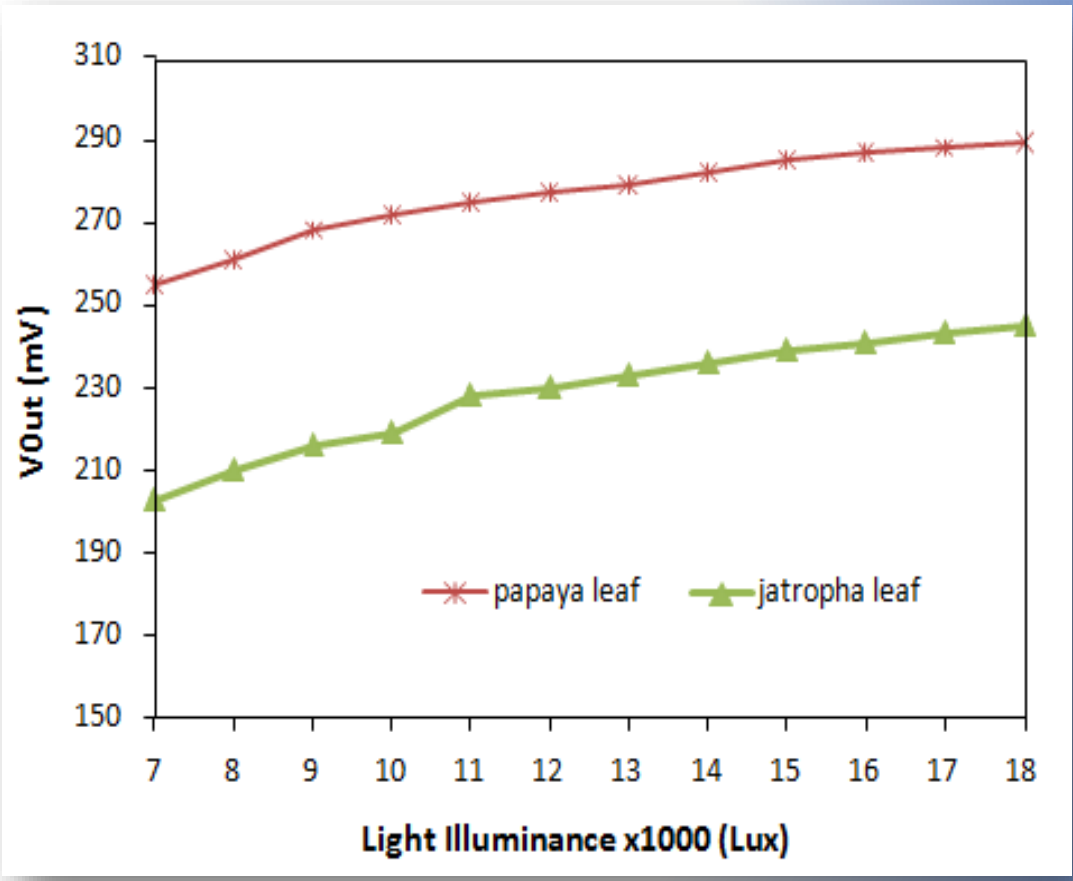
# Chlorophyll extraction of papaya and jatropha leaves in DSSC



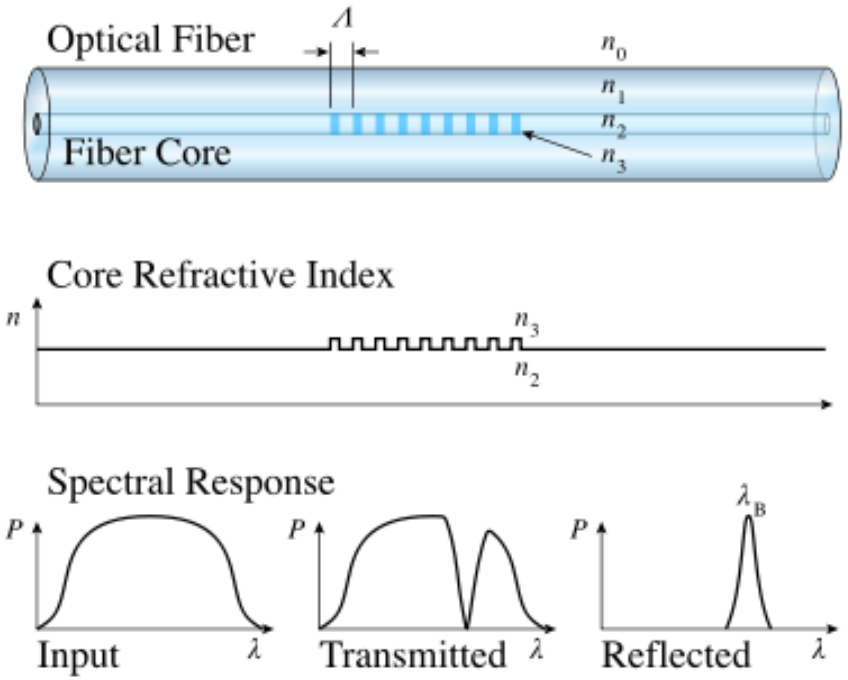



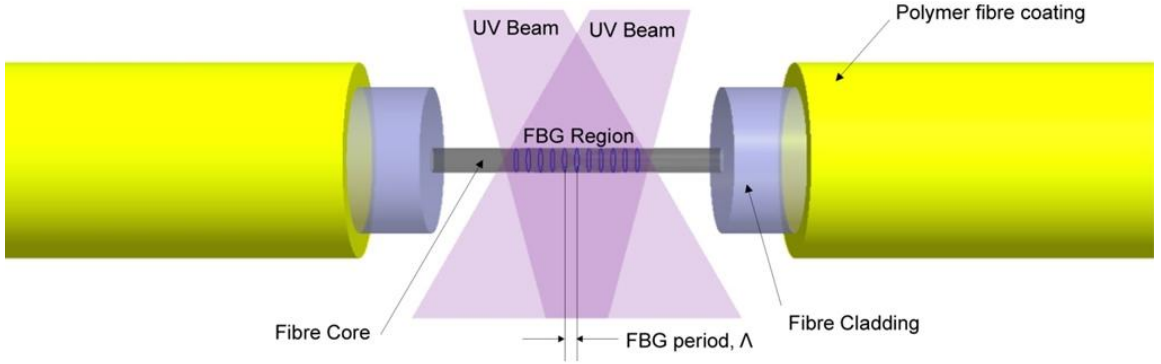

Output Voltage of DSSC

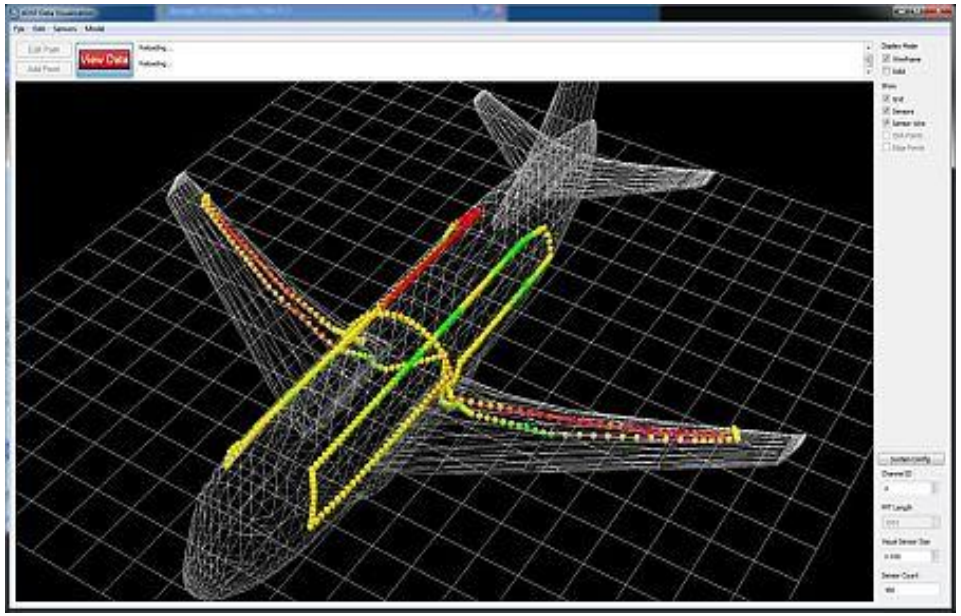



Sholeh HP, Eka Maulana, et.al. Organic Solar Cell in DSSC 2013

# 2nd Research - Optical Fiber Sensor: FBG/TFBG

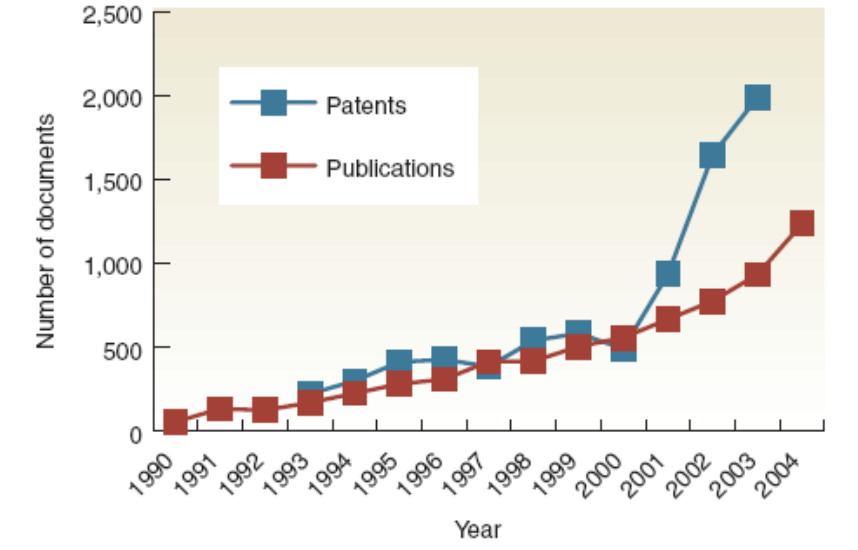


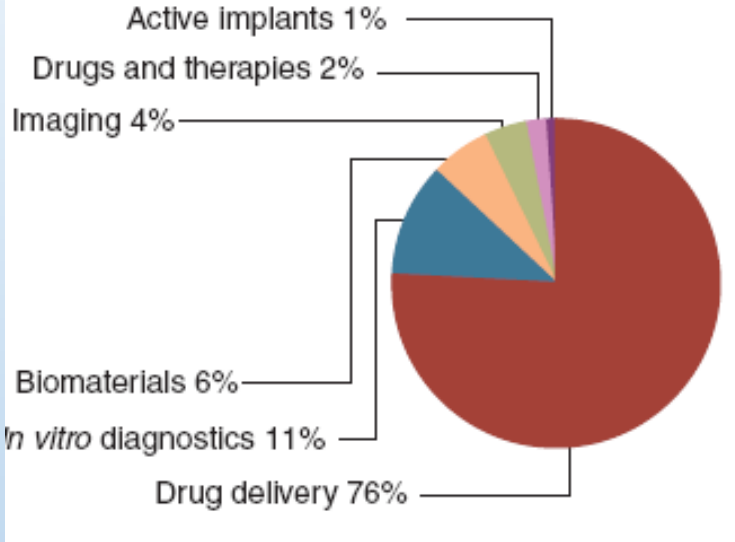



# Interesting facts about nanomedicine

**A**. Interest in the area has grown exponentially




**B**. Drug delivery is the most productive area




**C**. Drug delivery is the most established technology in the nanomedicine market

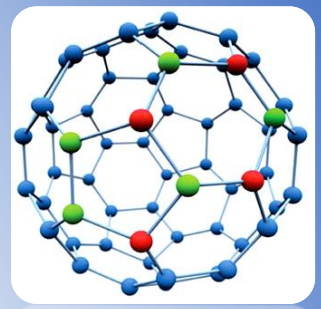
**Table 1 Commercial efforts in nanomedicine**[a]

| | | | Product pipeline | | |
|---|---|---|---|---|---|
| Healthcare sector | Number of products | Sales ($ billions) | Total | Advanced stages[b] | Companies |
| Drug delivery | 23 | 5.4 | 98 | 9 | 113 |
| Biomaterials | 9 | 0.07 | 9 | 6 | 32 |
| *In vivo* imaging | 3 | 0.02 | 8 | 2 | 13 |
| *In vitro* diagnostics | 2 | 0.78 | 30 | 4 | 35 |
| Active implants | 1 | 0.65 | 5 | 1 | 7 |
| Drugs & therapy | 0 | 0 | 7 | 1 | 7 |
| Total | 38 | 6.8 | 157 | 23 | 207 |

[a]Sales numbers of nanomedicines are estimates for the year 2004. [b]Drugs where the product is in clinical phase 2/3 or 3 and for all other products where market introduction is expected within two years.

**Nature Biotechnology 2006, Vol. 4, pp.1212-1217**

# Definisi Kunci Teknologi Nano



## Dimensional Scale

- "nano" meaning **dwarf** (reduced size)
- Atomic and Molecules levels
- refer to $10^{-9}$ times
- Length **1-100** nm range

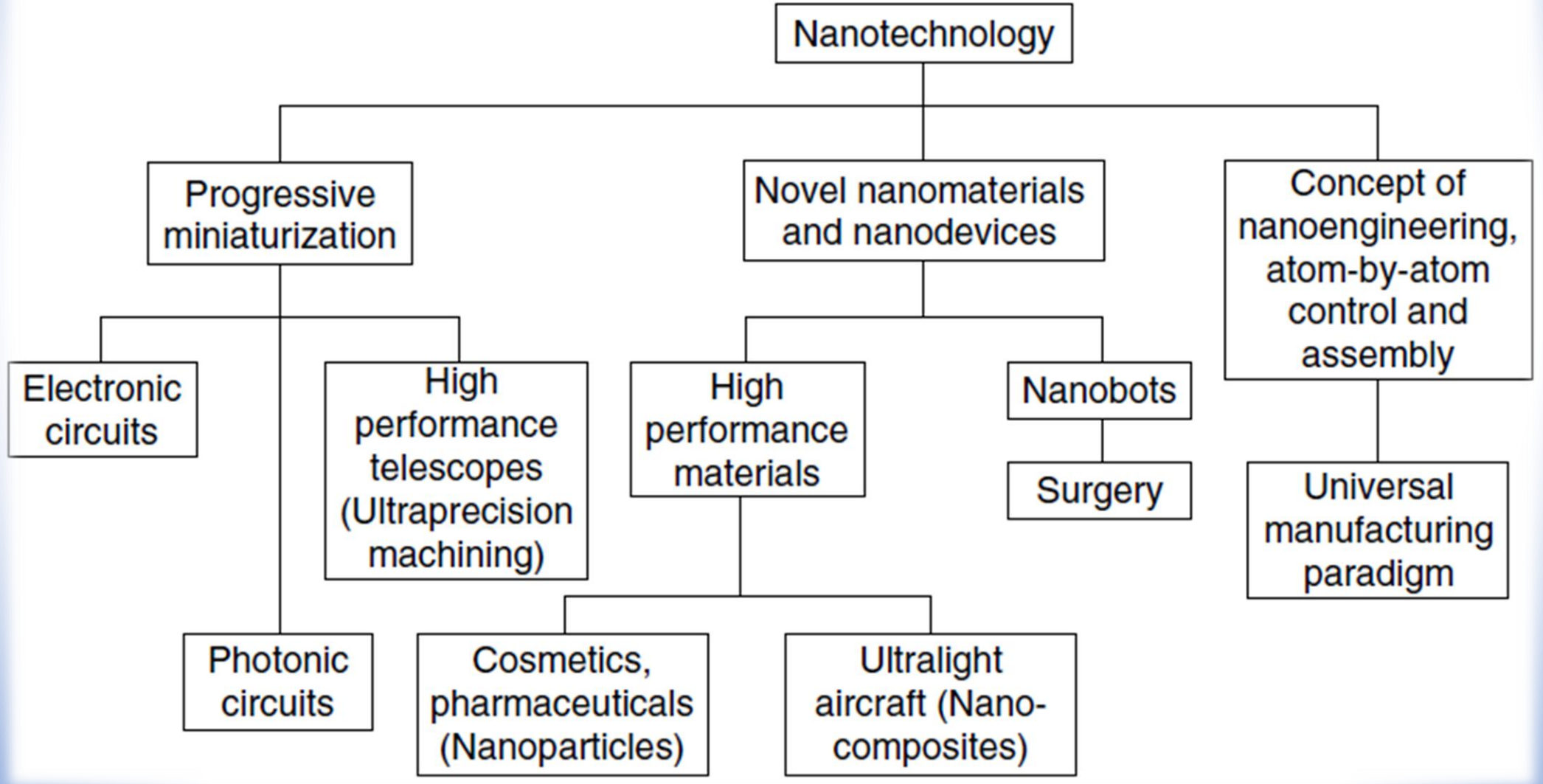
## Processing

- Design, manipulated & analysis at fundamental control
- Physical, chemical attributes
- Electrical, mechanical, and optical characteristics

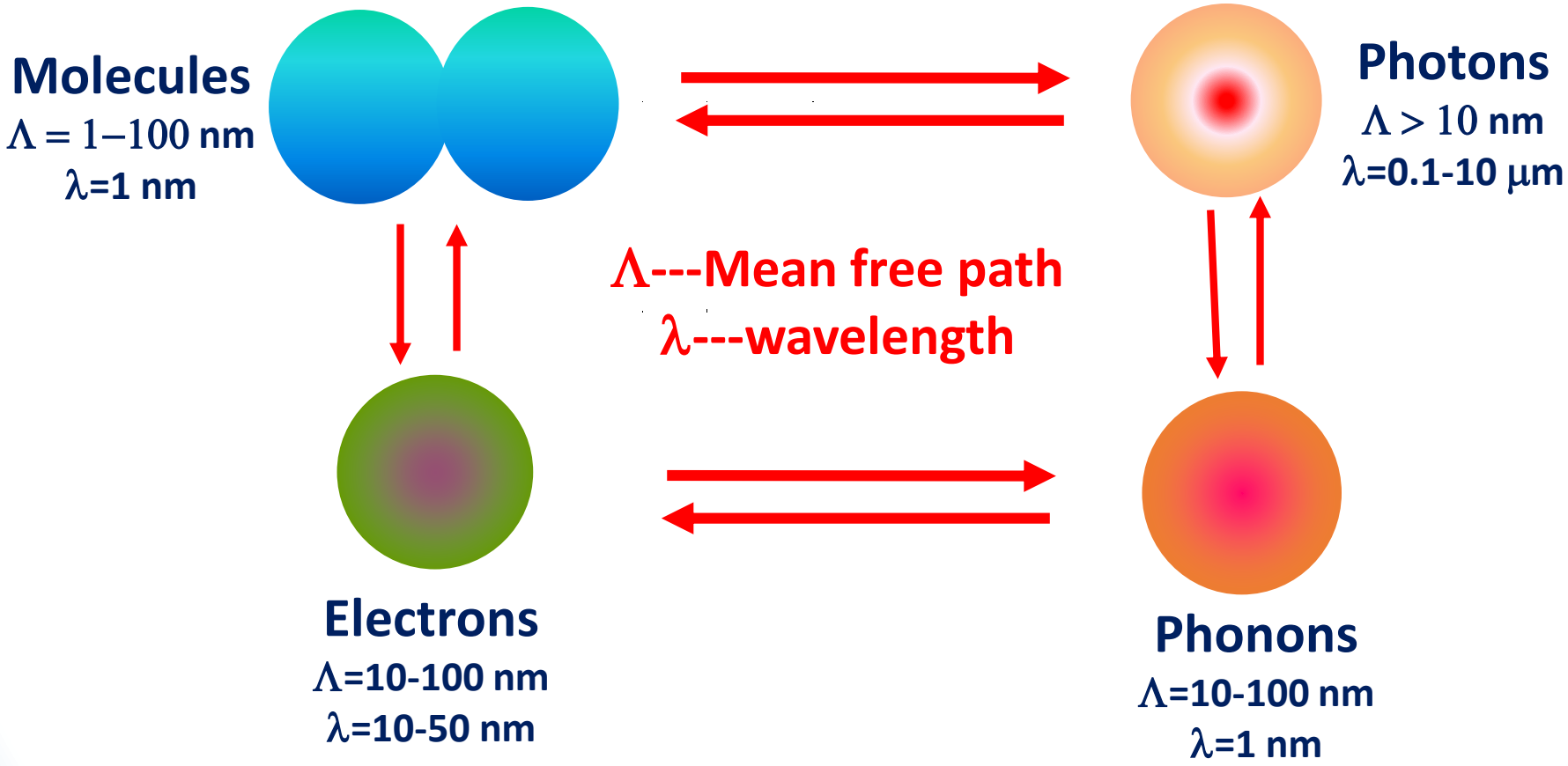
## Nanotech

Materials, Methods, phenomenon, products and devices

# Cabang Konsep Teknologi Nano

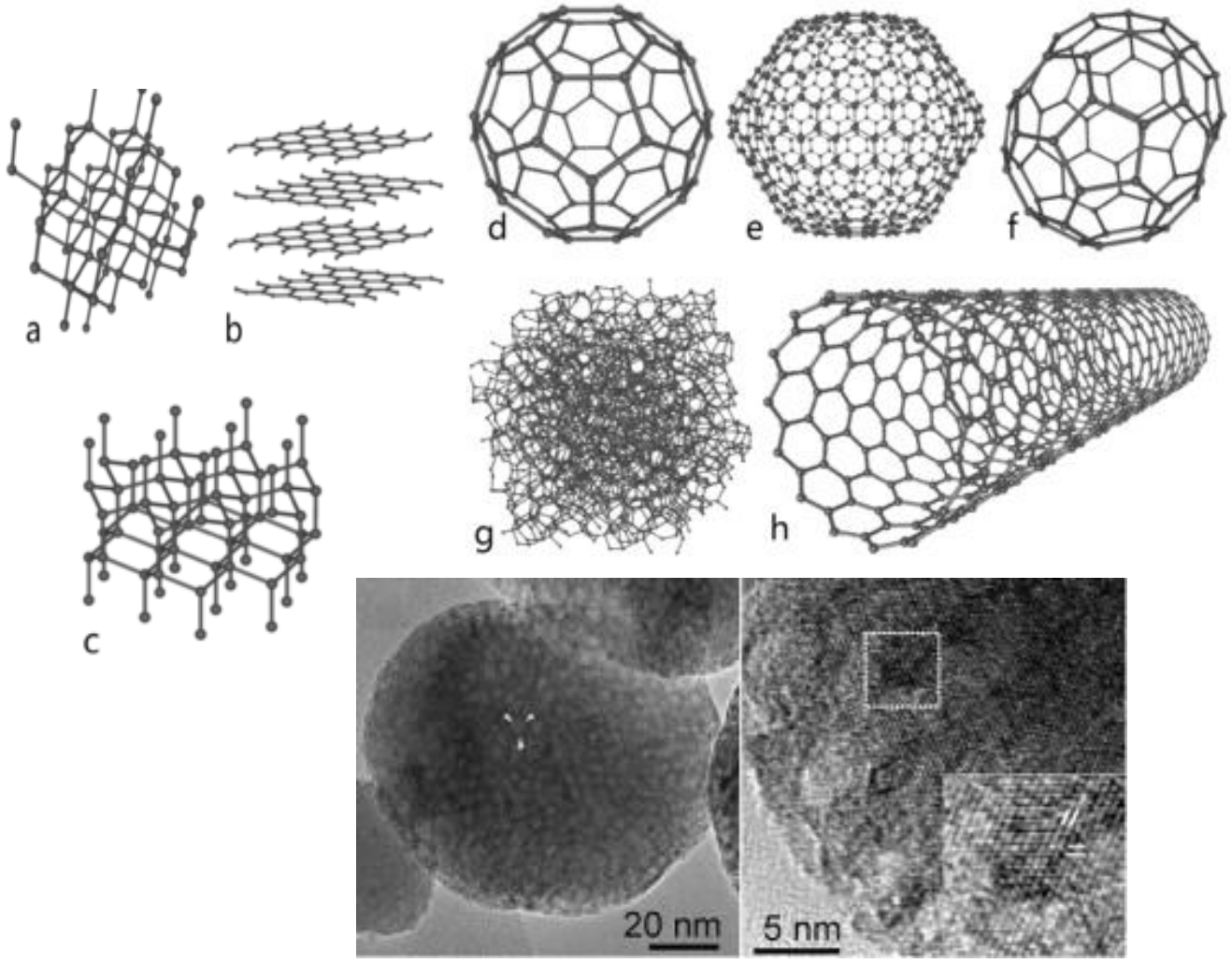


# Fenomena Dasar dalam Teknologi Nano

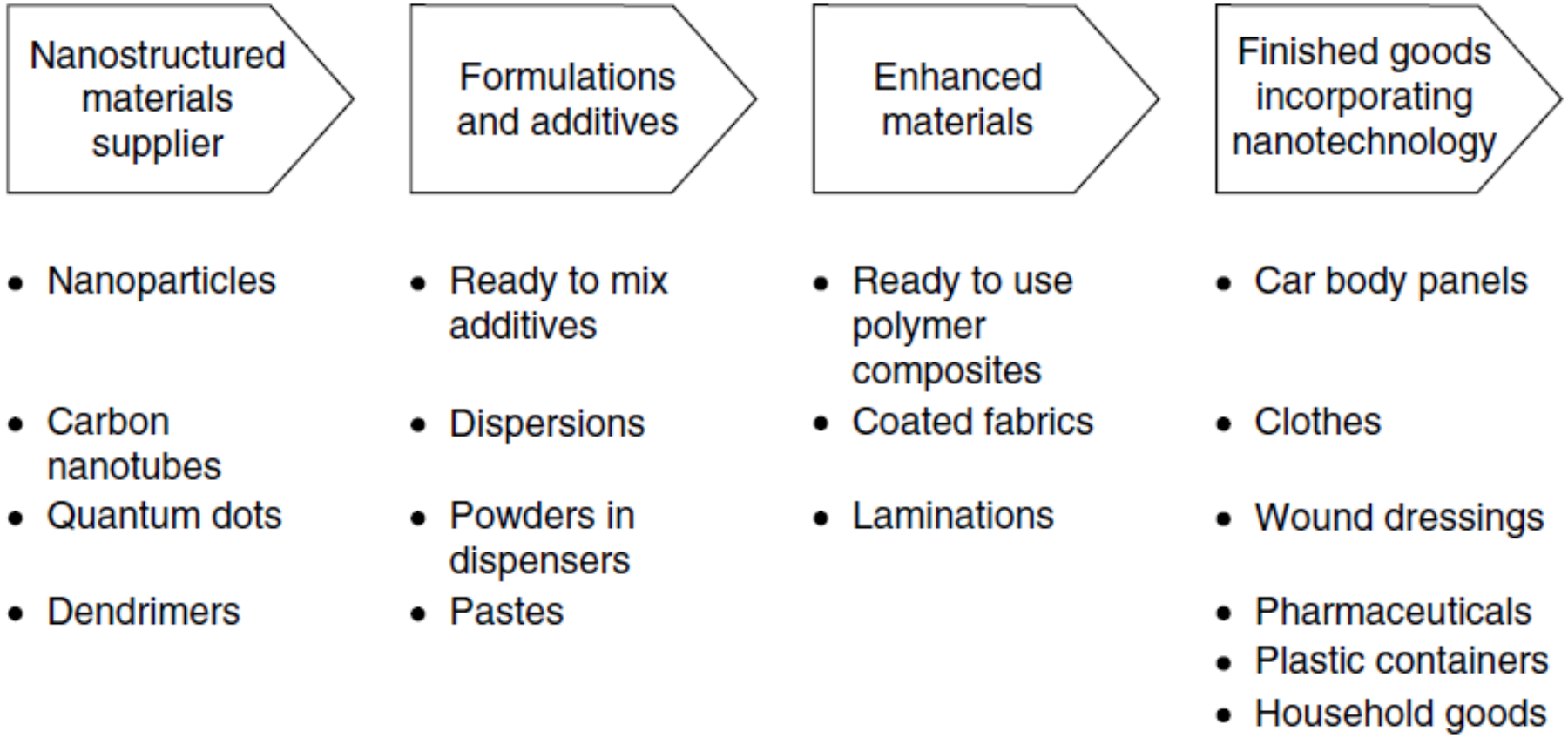


# Nano Materials and Devices

- Nano particle
- Nano rod
- Nano wire
- Nano-fiber
- Carbon nanotube
- Fullerene
- Nano-sensor
- NEMS

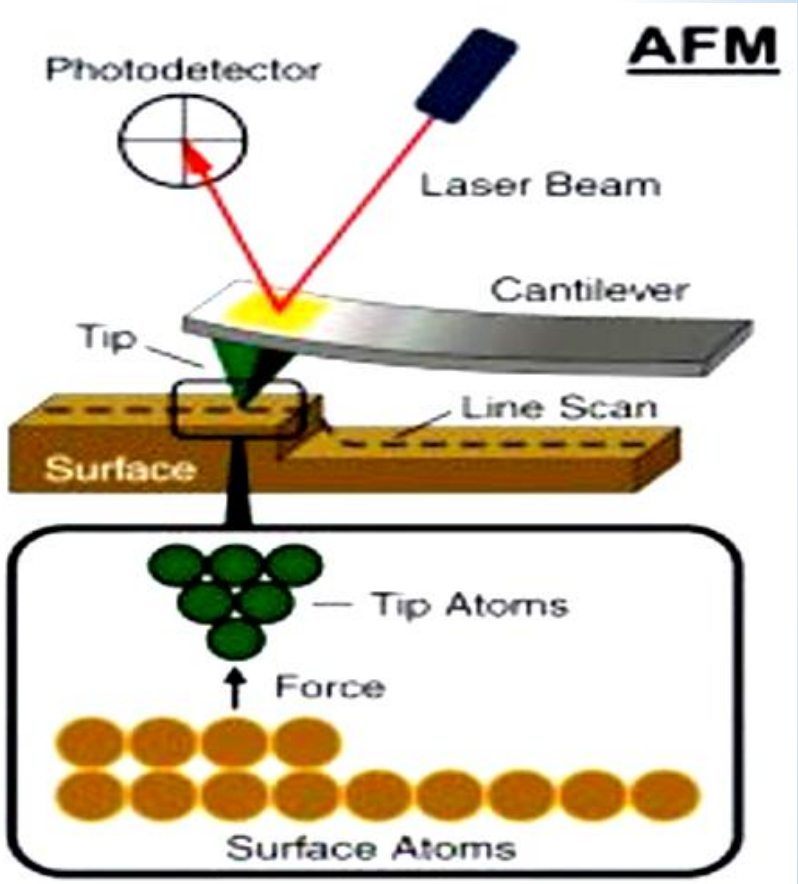


# Nanomaterial Processing

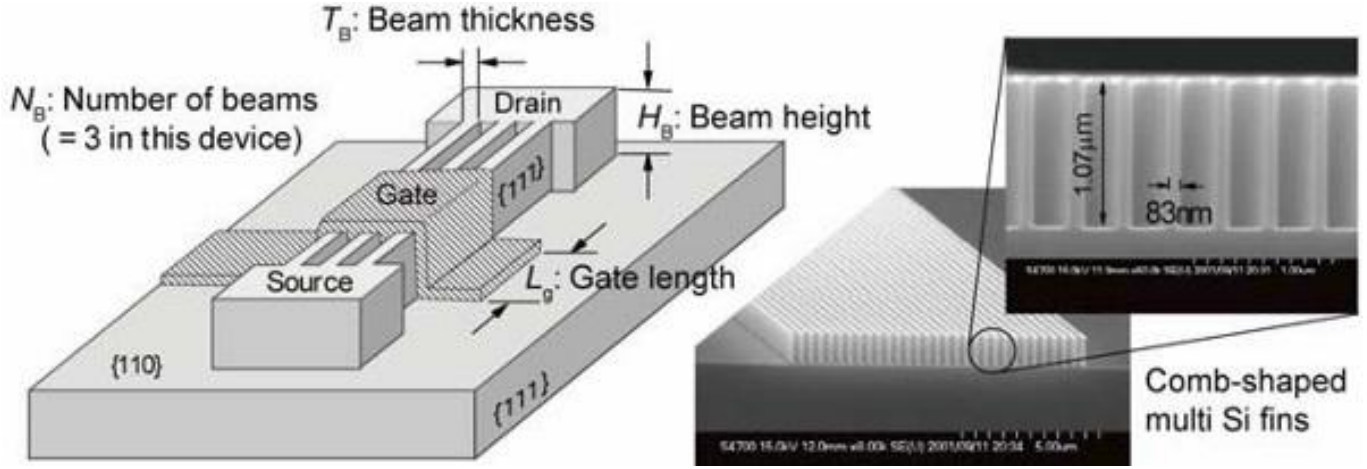


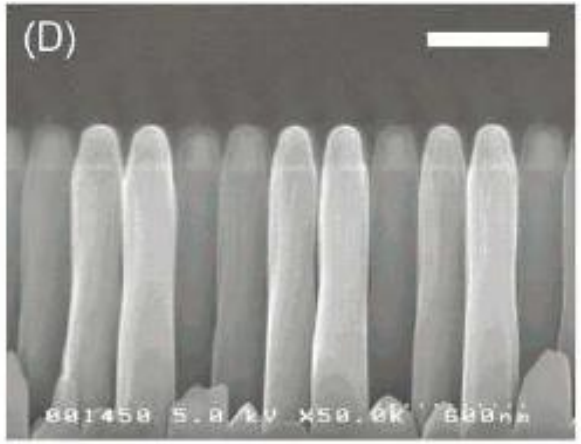
# Investigating and Manipulating Materials in the Nanoscale

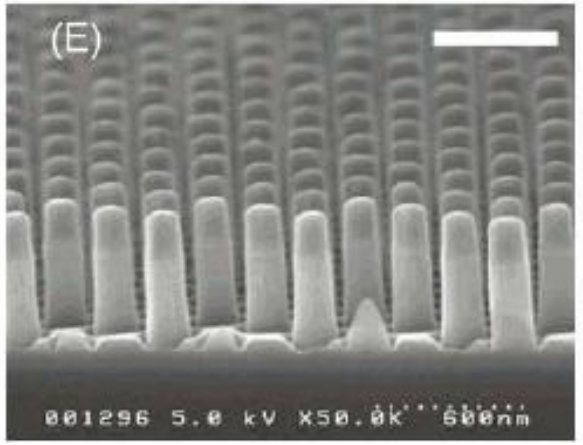
- Scanning Electron Microscopy
- Transmission Electron Microscopy
- Atomic Force Microscopy
- X-Ray Diffraction
- FFIR
- Other Kinds of Microscopies



# Dimension in Metal-Oxide-Semiconductor




N. Kaji *et al., Anal. Chem., 76, 15, 2004* & Hideo Sunami, Hiroshima University, Japan

# Aplikasi Bidang Medis

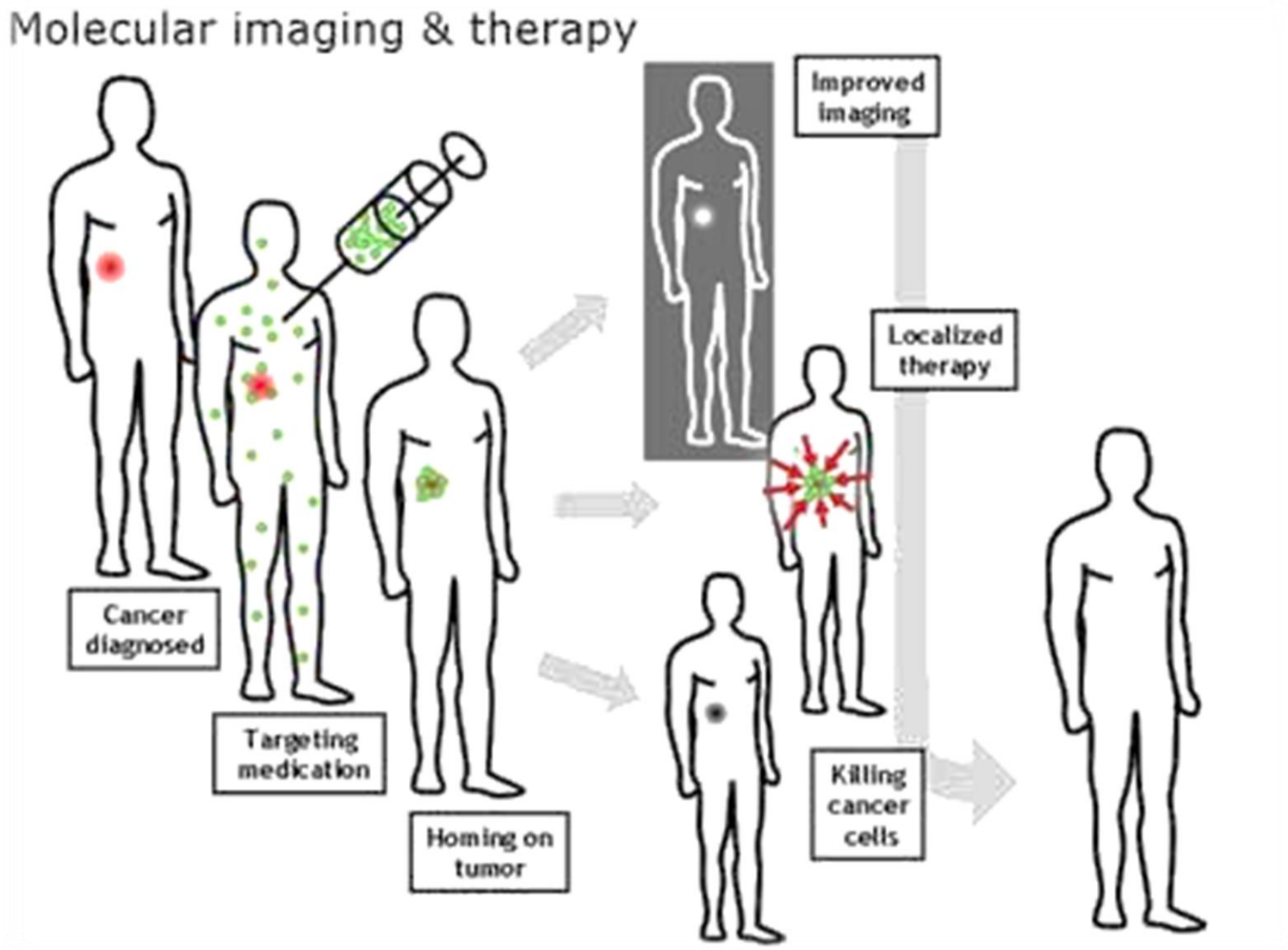
Nano medicine

Drug Delivery

Detection

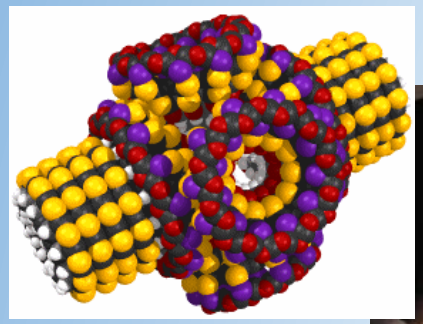
Cancer Therapy

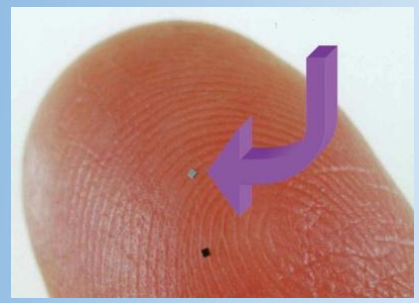
Imaging

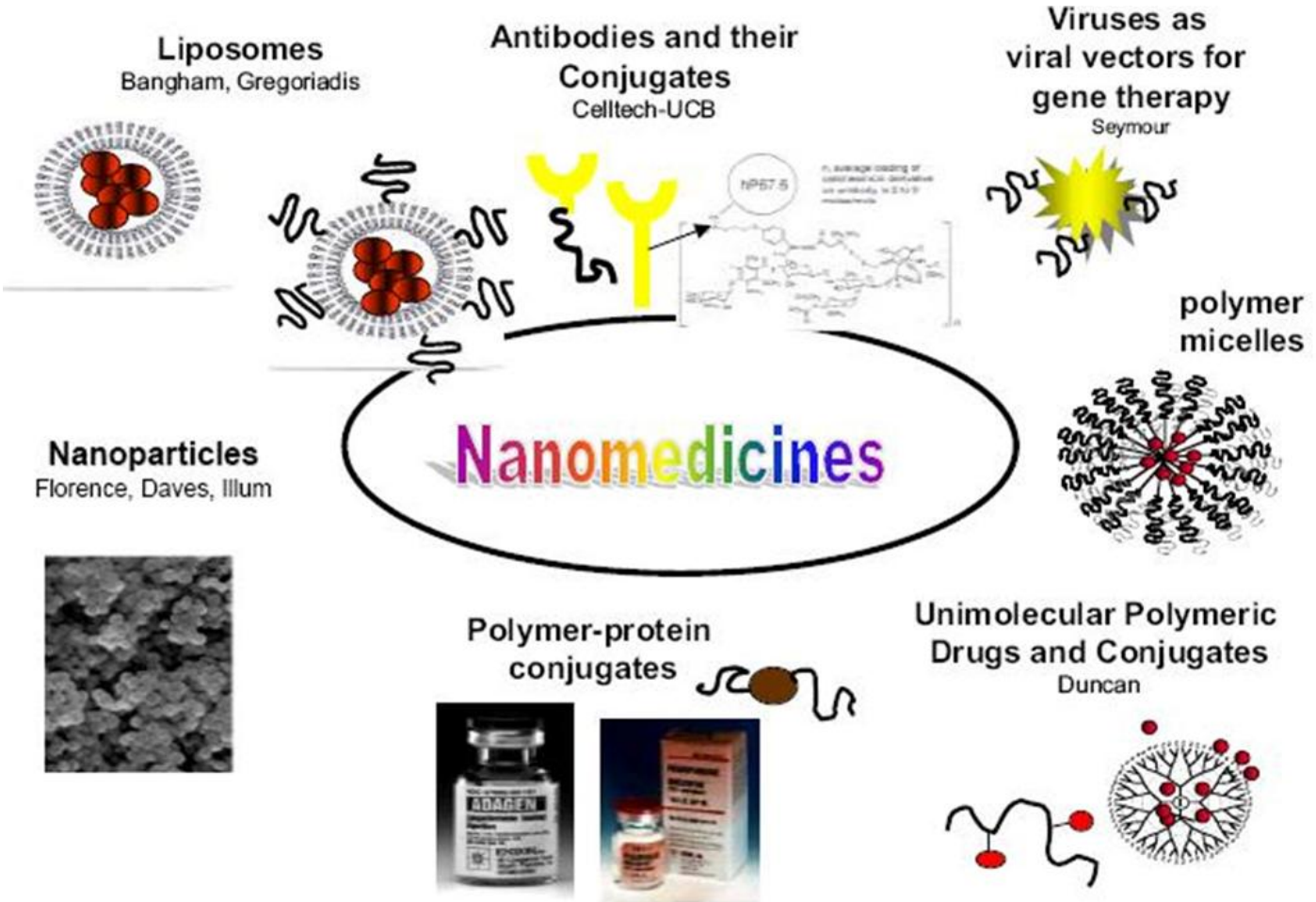


# Nano medicine

- New breakthroughs in medicine
  - Advanced biomedical research tools
  - Study of DNA and its component genes
  - Diagnostic tests
  - In bone implants etc…

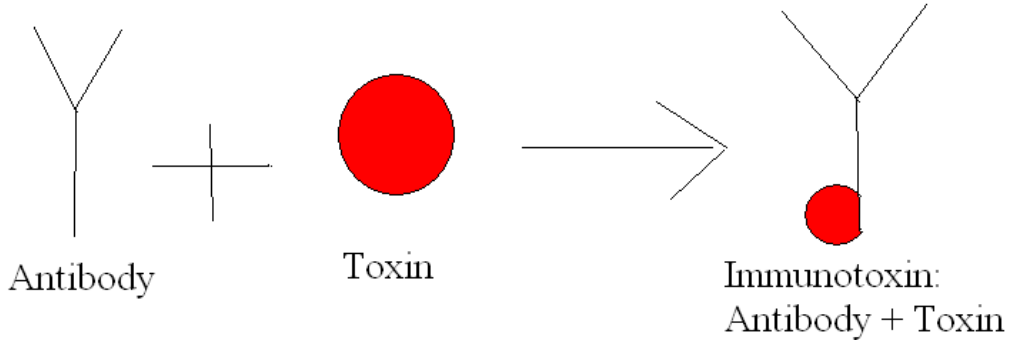


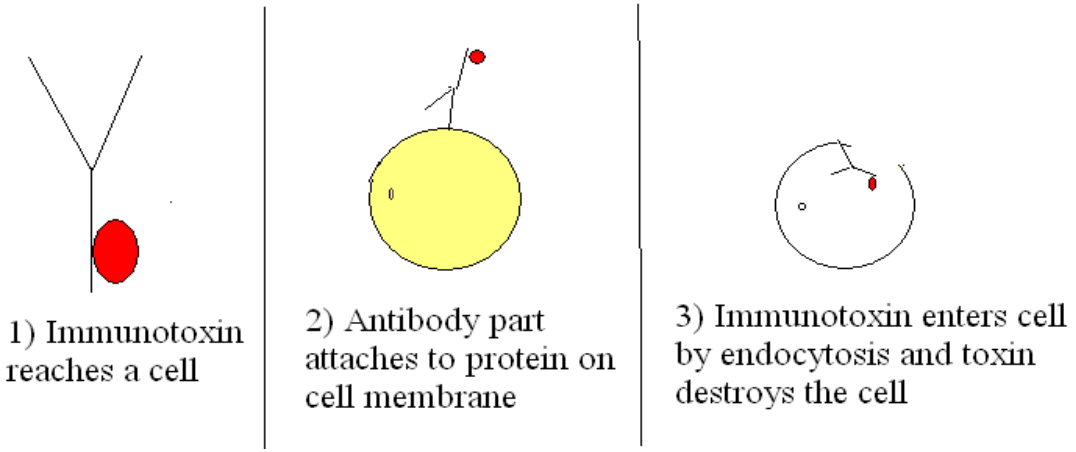


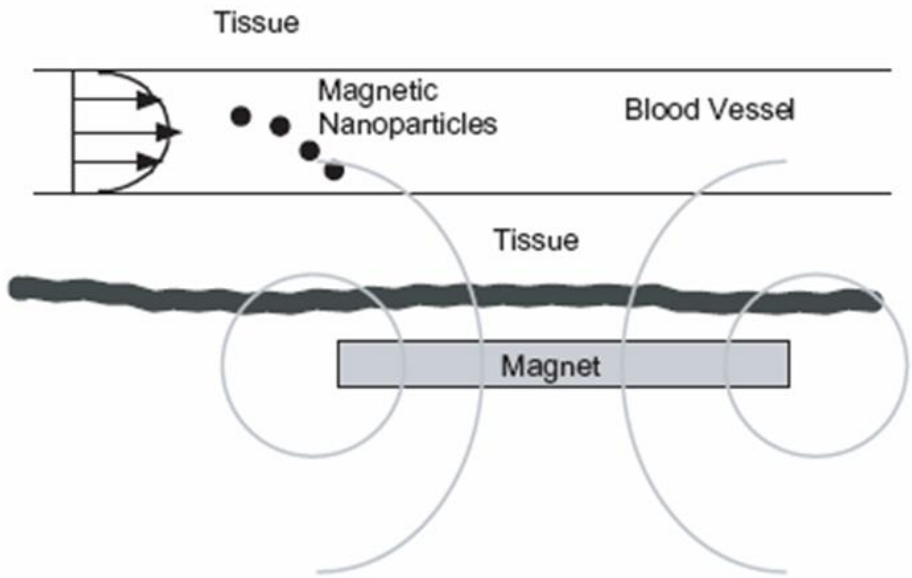


# Drug Delivery

- Systems that deliver drugs to specific sites
- **Sample Methods:**
  - Smart Drugs & Magnetic Nanoparticles
  - Nanocomposite hydrogel systems
- **Smart drugs**
  - Attack specific antigens
  - Immunotoxins that are protein in nature
  - Consist of an antibody part and toxic part
- **Magnetic Nanoparticles**
  - Drugs are bound to magnetic nanoparticles
  - Carry drugs to malignant sites with magnetic fields
  - Release the drugs by enzymatic activity



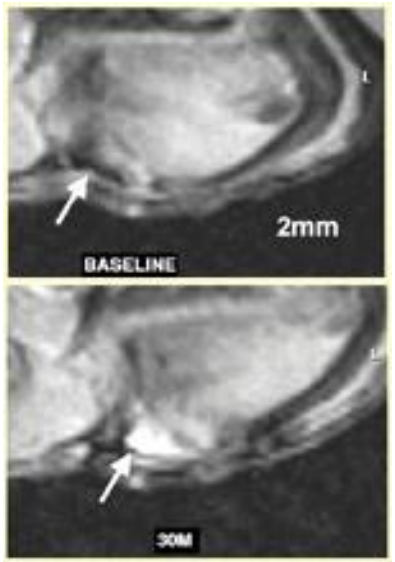
# **Callenges:** Nanoscience Research

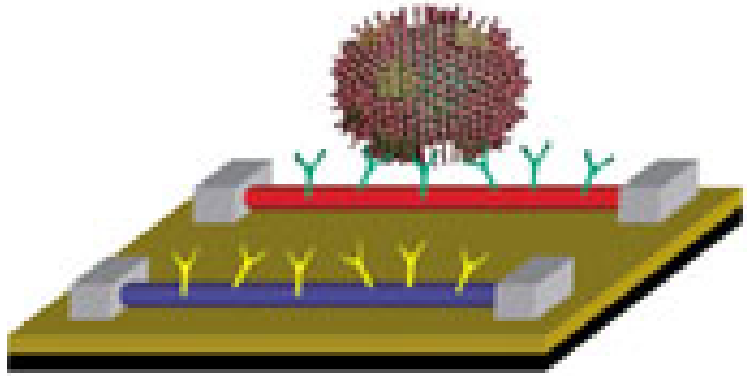
- Theory, modeling, and simulation for nano-sciences
- Assembly and architecture of nano-scale structures
- Linking structures and function at the nano-scale
- Using interfaces to manipulate object
- Catalysis by nano-scale materials
- Scalable synthesis methods

# Disease Detection

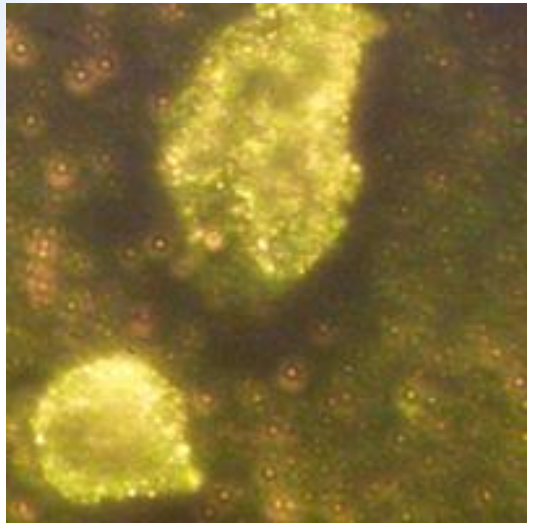
## Cancer/Virus Detection

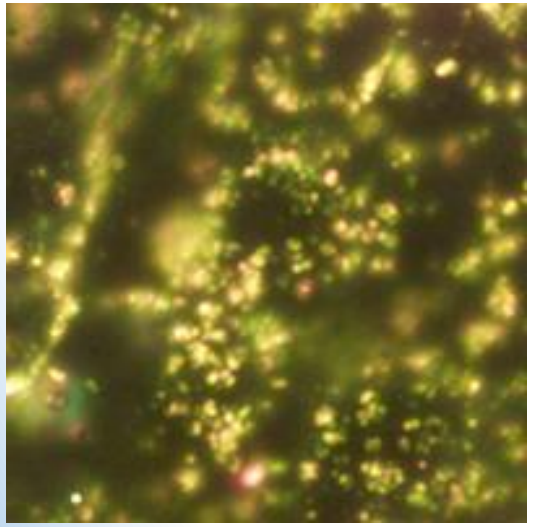
- **Carbon Nanotubes:**
  - Covered with monoclonal antibodies
  - Current increases measured
  - Antibodies for growth factor receptor in cancer cells
- **Silicon Nanowires**
  - Similar in use to nanotubes
  - Antibodies attached to wire
  - Current changes measured
  - Can be applied to cancer cells and viruses
  - Gene detection



# Cancer/Virus Detection





**Gold Nanoparticles & Nanodots**

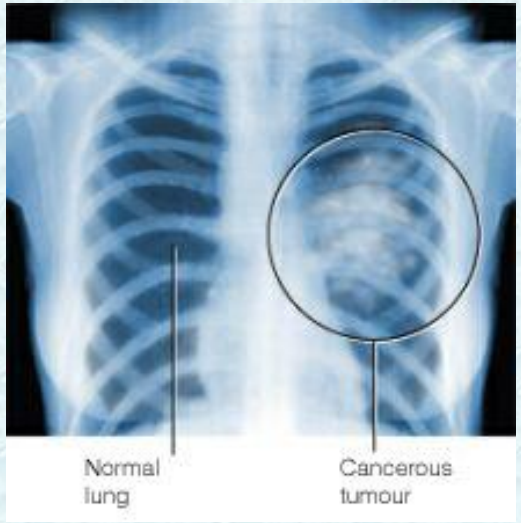
- Similar application
- Antibodies attached to nanoparticles
- Nanoparticle antibodies bind to cancer cells
- Colors reflected when light hits particles
- Shapes and sizes affect color

# Gene Detection

- **Silicon nanowire:**
  - Can detect specific genes
  - Nucleic acids attached to nanowires
  - Specific sequences can be created
  - Sensor capable of differentiating mutated and nonmutated genes
  - PCR not needed -> detection time lowered

# Imaging Techniques

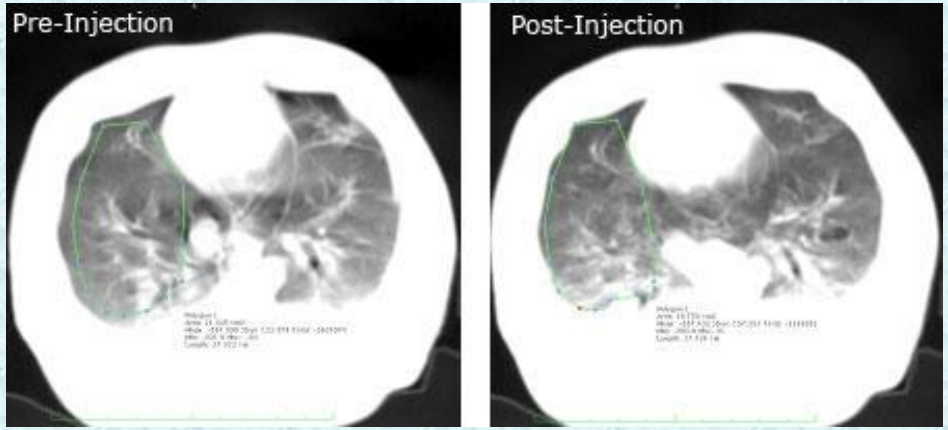
- **Conventional Techniques:**
  - X-ray, MRI, Fluoroscopy
  - CAT scan
- **Limitations**
  - Limited detail
  - Difficult to track movement




- **Molecular Tracking:**
  - Use Quantum Dots as labels
    - Dots attached to molecules before injection
  - Fluoroscopy used to track movement
    - Colors from dots seen and imaged

# Imaging Applications

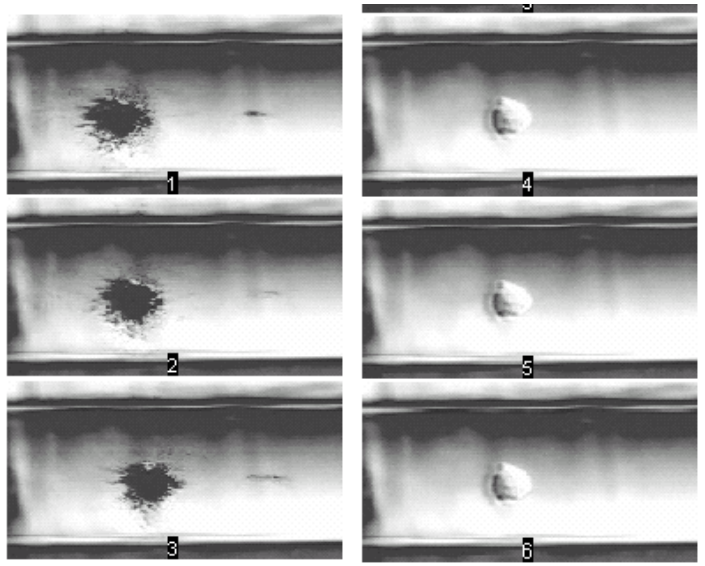
- Tracking blood flow:
  - Tag proteins of cells with gold nanoparticles
  - View process of angiogenesis
  - Important for cancer detection and imaging
- Cancer Imaging:
  - Injection of gold nanoparticles
  - Localization around tumors
  - CT scan shows cancerous regions




# Possible Concerns

- Negative biological side-effects:
  - Toxicity of quantum nanodots
  - Effects on living organisms not well known
- Gold nanoparticles safer:
  - Biologically inert
  - Won’t interact with other chemicals

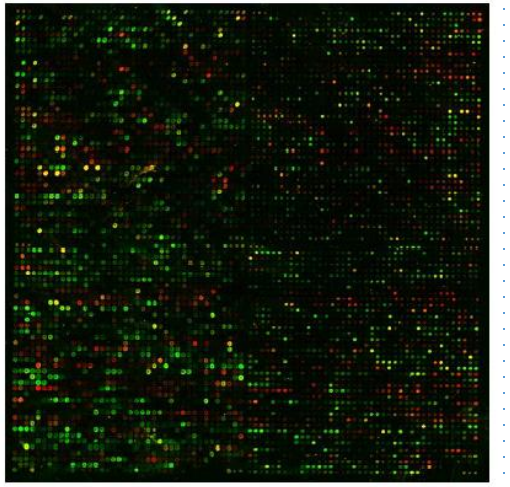
# Tissue Engineering




- Nano/micro particles, including living animal cells, bacteria, and colloidal gold (100 nm), can be optically guided and deposited in arbitrarily defined three-dimensional arrays, a process called “laser-guided direct-writing.”

# DNA Chips

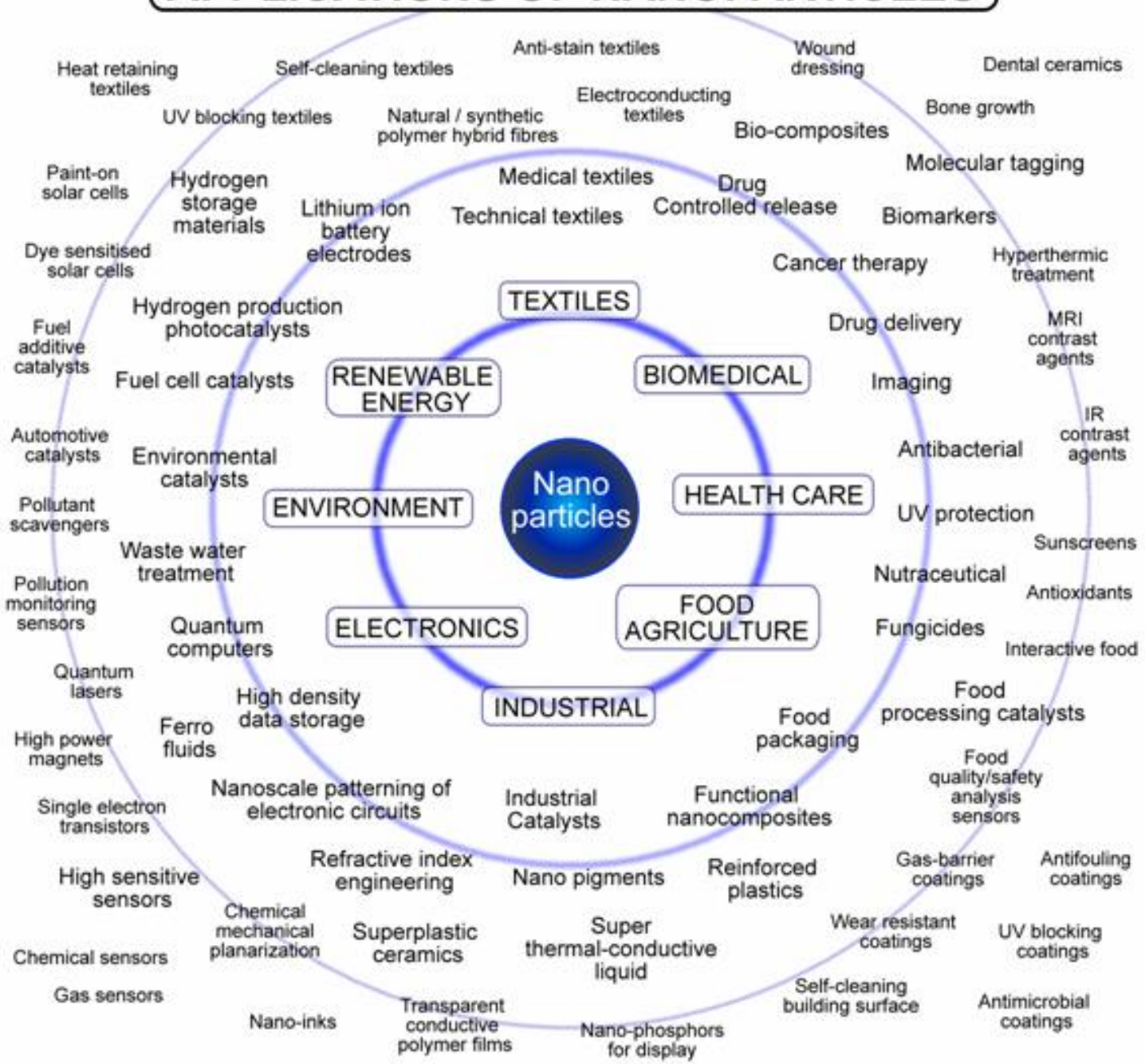
Yeast cells were grown under various conditions; the amount of red or yellow light represents the level of RNA produced from the DNA in that gene, under those conditions.



http://cmgm.stanford.edu

Odde, D.J. and M.J. Renn. 1998. Laser-based direct-write lithography of cells. *Ann. Biomed. Eng.* 26:S-141.
http://www.wtec.org/loyola/nano/IWGN.Research.Directions/chapter08.pdf

# APPLICATIONS OF NANOPARTICLES



# *Thanks…*

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