NANOBIOTECHNOLOGY FROM LAB TO APP

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PhD. Applied Bionanotechnology
HD and MSc Genetic engineering

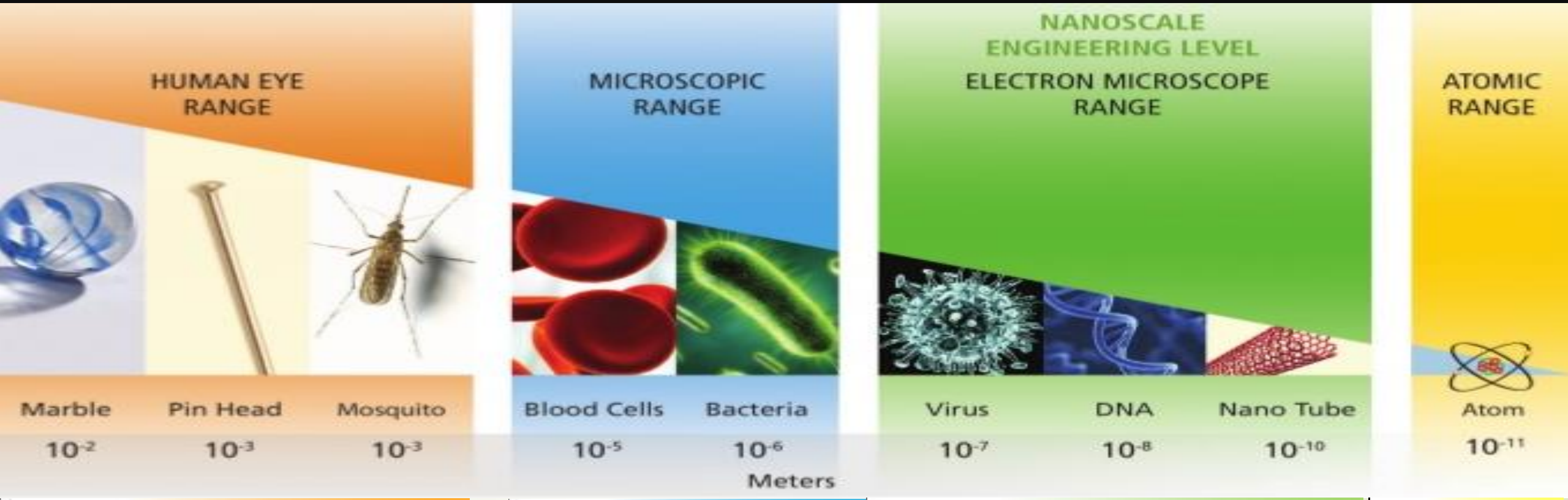
Agenda

BRIEFLY REVIEW

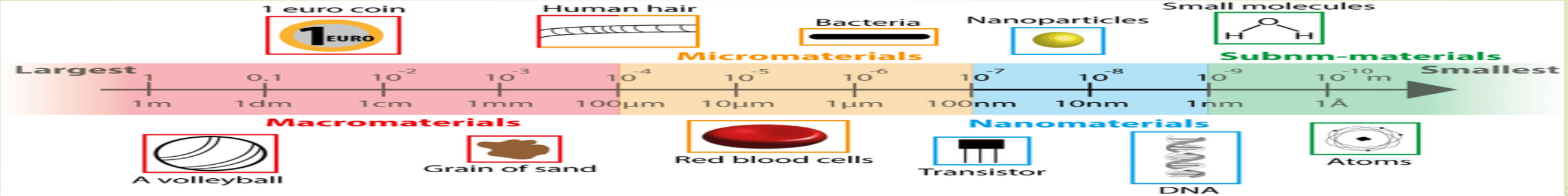
METHODOLOGY

APPLICATION

Materials scale

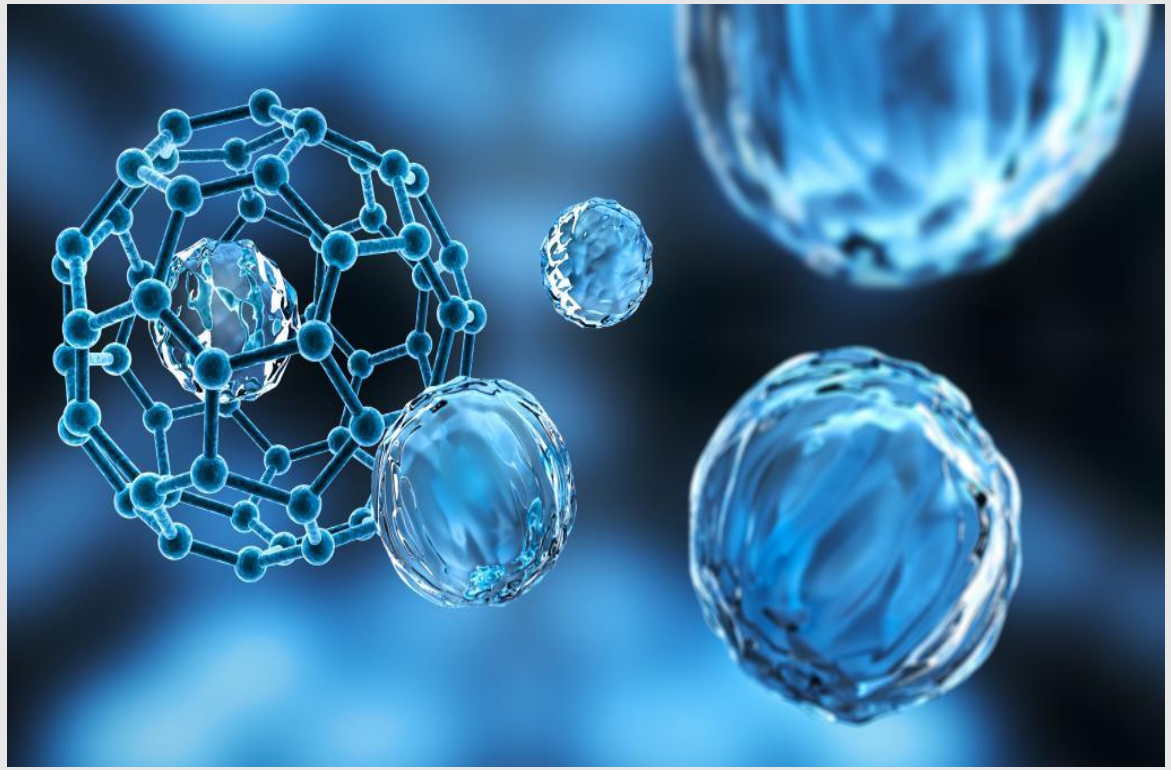


Macrometer | **Micrometer** | **Nanometer** | **Sub nano**



What is Nano mean's

- The prefix nano comes from the Greek word *nanos,* which means one-billionth part of something. So, nanotechnology can be described as engineering and manufacturing at the scale of a nanometer or nanoscale (nanometer = 10^{-9} meter).
- Examples of nano-substance are- Atom diameter 0.15 nm, diameter of double strand DNA 2 nm, and cell1000 nm.



Fact !

Why we can’t write and entire the British

Encyclopaedia which include 24 volume on the pin head

Dr. Richard P. Feynmam

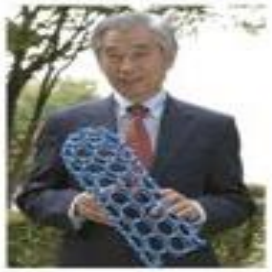
29/9/1959

Nobel Prize 1965

History of Nanotechnology

1959:
Richard Feynman
gave a talk on
Nanotechnology

1974:
Norio Taniguchi
coined the term
Nanotechnology



1991:
Sumio Iijima
discovered the
Carbon Nanotube

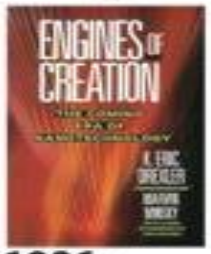
2006:
Naomi Halas and
Jennifer West
are leading the
field in Nanoparticles
combating Cancer

1959

2010

1960:
William McLellan
constructed the first
250-microgram motor

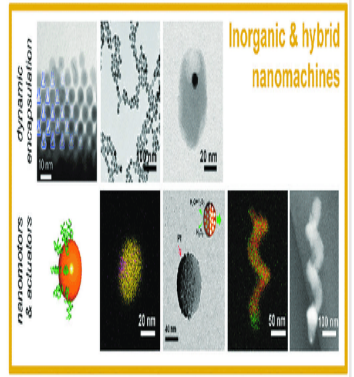
1985:
Researchers at
Rice University
discovered fullerenes or
more commonly know as
buckyballs

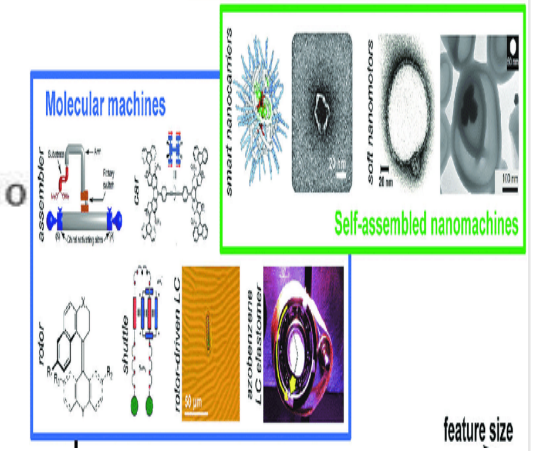


1986:
Eric Drexler
made the concept
popular with his
book *"Engines of*
Creation"

1997:
Zyvex
is founded and is
the first company
to research
Nanotechnology

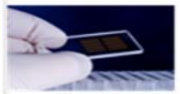
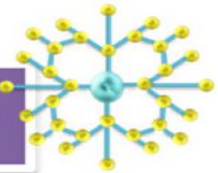
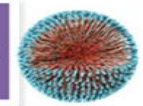
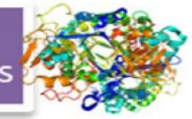
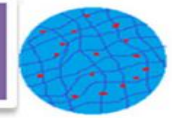
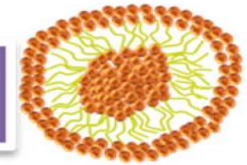
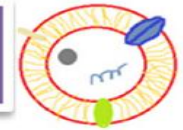
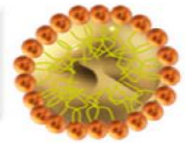
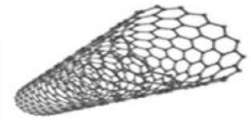
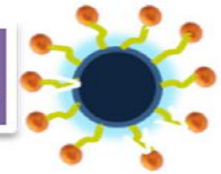
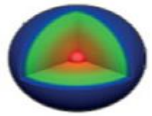
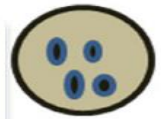
2005:
Günter Oberdörster
coined the term
"Nanotoxicology"

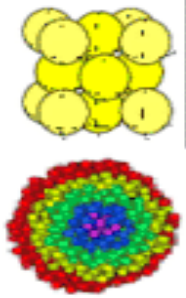




feature size

Nanotechnology

- Nanodevices
  - Microarrays 
  - Microscopic devices 
  - Intelligent machines 
- Nanomaterials
  - Nanostructured
    - Polymer-based
      - Dendrimers 
      - Nanoparticles 
      - Micelles 
      - Drug conjugates 
      - Protein nanoparticles 
      - Nanogels 
    - Lipid-based
      - Liposomes 
      - Exosomes 
      - Solid lipid nanoparticles 
    - Non polymeric
      - Carbon nanotubes 
      - Nanodiamond 
      - Metallic nanoparticles 
      - Quantum dots 
      - Silica based nanoparticles 
  - Nanocrystalline

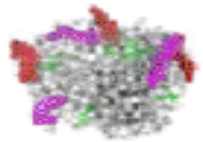


1st: Passive nanostructures **(1st generation products)**

a. *Dispersed and contact nanostructures.* Ex: aerosols, colloids

b. *Products incorporating nanostructures.* Ex: coatings; nanoparticle reinforced composites; nanostructured metals, polymers, ceramics

~ 2000

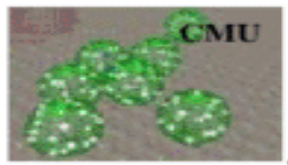


2nd: Active nanostructures

a. *Bio-active, health effects.* Ex: targeted drugs, biodevices

b. *Physico-chemical active.* Ex: 3D transistors, amplifiers, actuators, adaptive structures

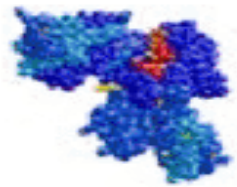
~ 2005



3rd: Systems of nanosystems

Ex: guided assembling; 3D networking and new hierarchical architectures, robotics, evolutionary

~ 2010



4th: Molecular nanosystems

Ex: molecular devices 'by design', atomic design, emerging functions

~ 2015-2020

Risk Governance Frame 1

Risk Governance Frame 2

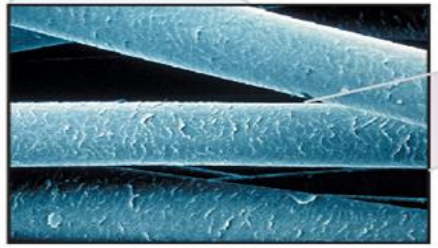
ant
5 mm

10^{-2} metre =
1 cm =
10 mm

10^{-3} metre =
1 mm =
1,000 microns (μm)

dust mite
200 μm

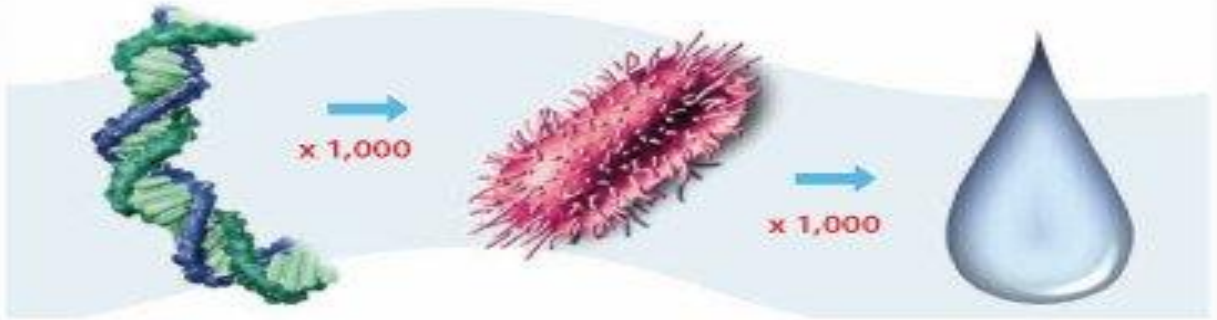
10^{-4} metre
0.1 mm =
100 μm



human hair
10–50 μm wide

red blood cells
2–5 μm wide

DNA
2–12 nm diameter



DNA
2.5 nanometers
diameter

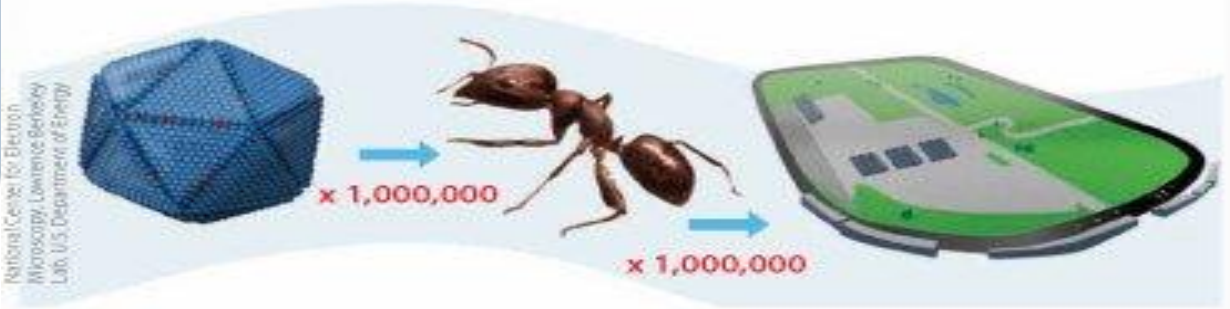
Bacterium
2.5 micrometers
long

Large Raindrop
2.5 millimeters
diameter

Single-walled Carbon Nanotube
1 nanometer diameter

Strand of Hair
100 micrometers
diameter

House
10 meters
wide

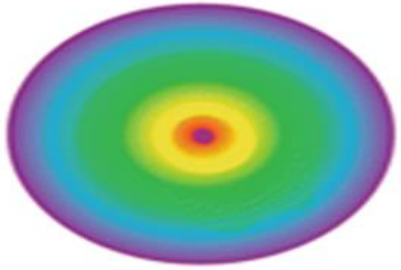


Nanoparticle
4 nanometers
diameter

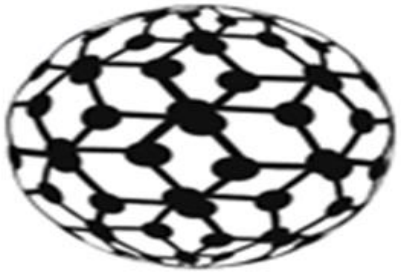
Ant
4 millimeters
long

Indianapolis Motor Speedway
4 kilometers per lap

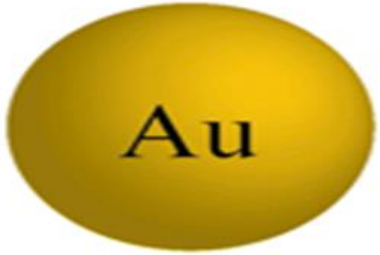
0D
Nanospheres, clusters



Quantum dots



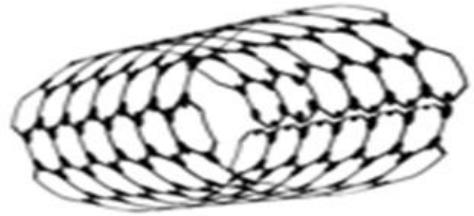
Fullerenes



Gold nanoparticles

1D
Nanotubes, wires, rods

Metal nanorods, Ceramic crystals

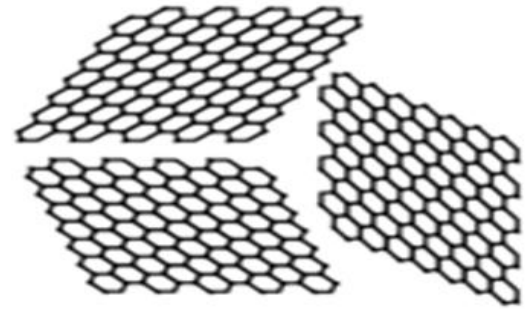


Carbon nanotubes, Metallic nanotubes

Gold nanowires, Polymeric nanofibers, Self assembled structures

2D
Thin films, plates, layered structures

Carbon coated nanoplates



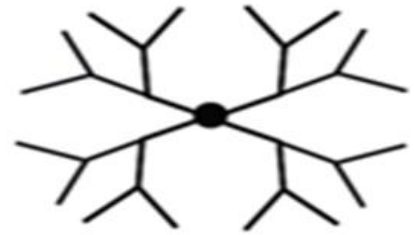
Graphene sheets

Layered nanomaterials

3D
Bulk NMs, polycrystals

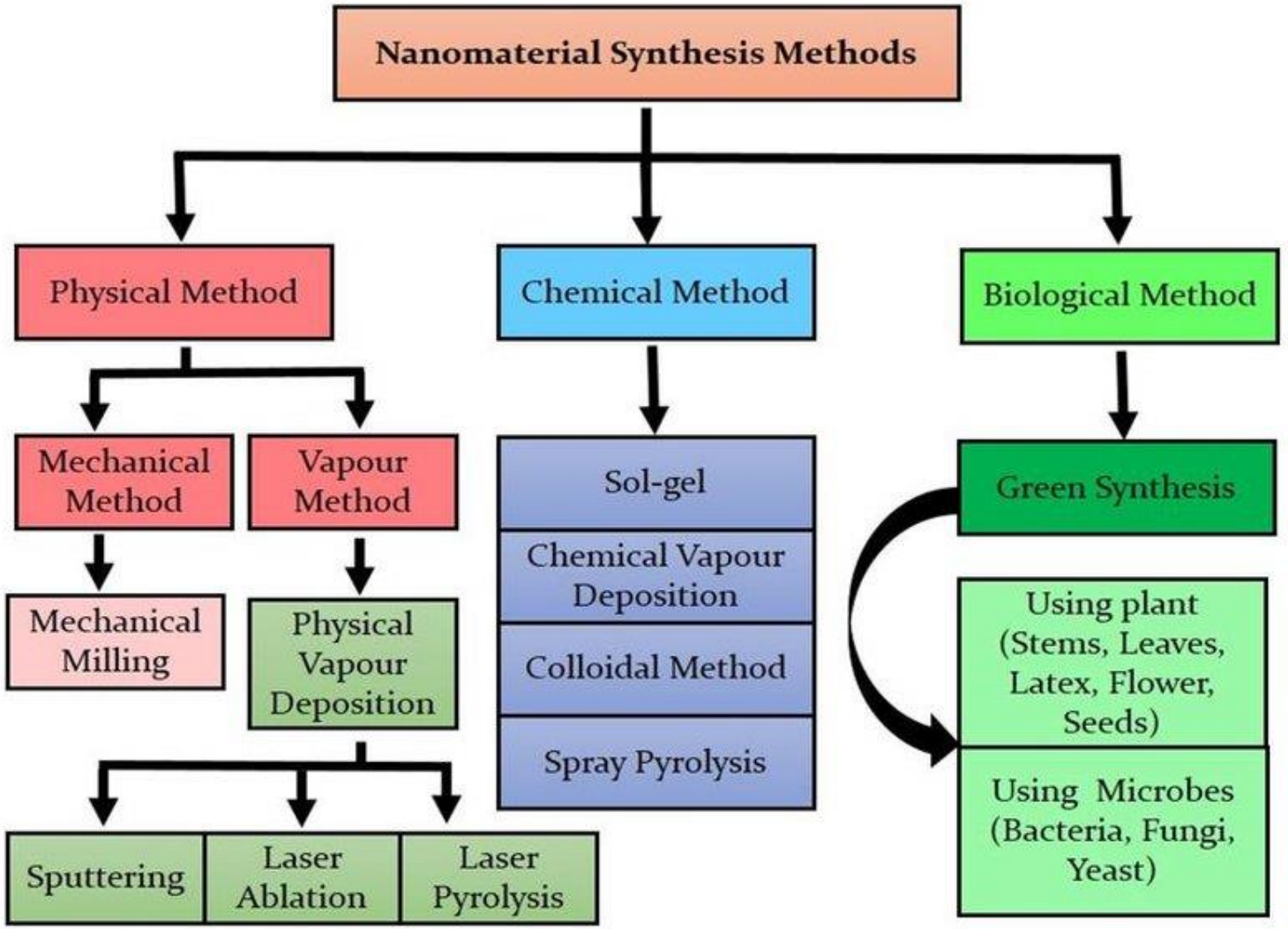
Liposome

Polycrystalline



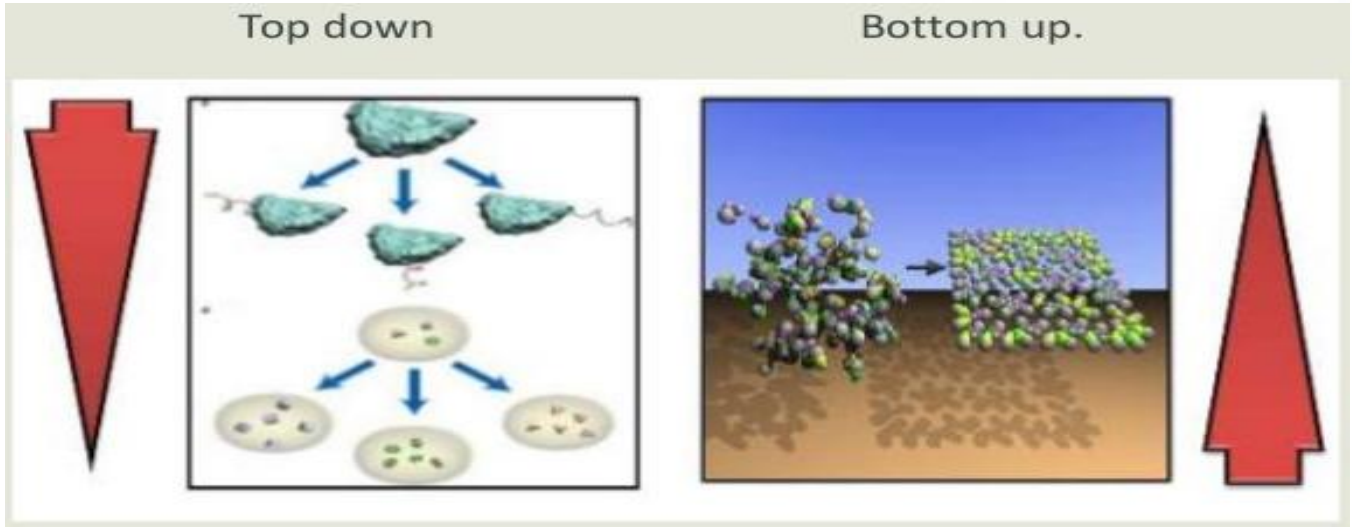
Dendrimer

METHODOLOGY

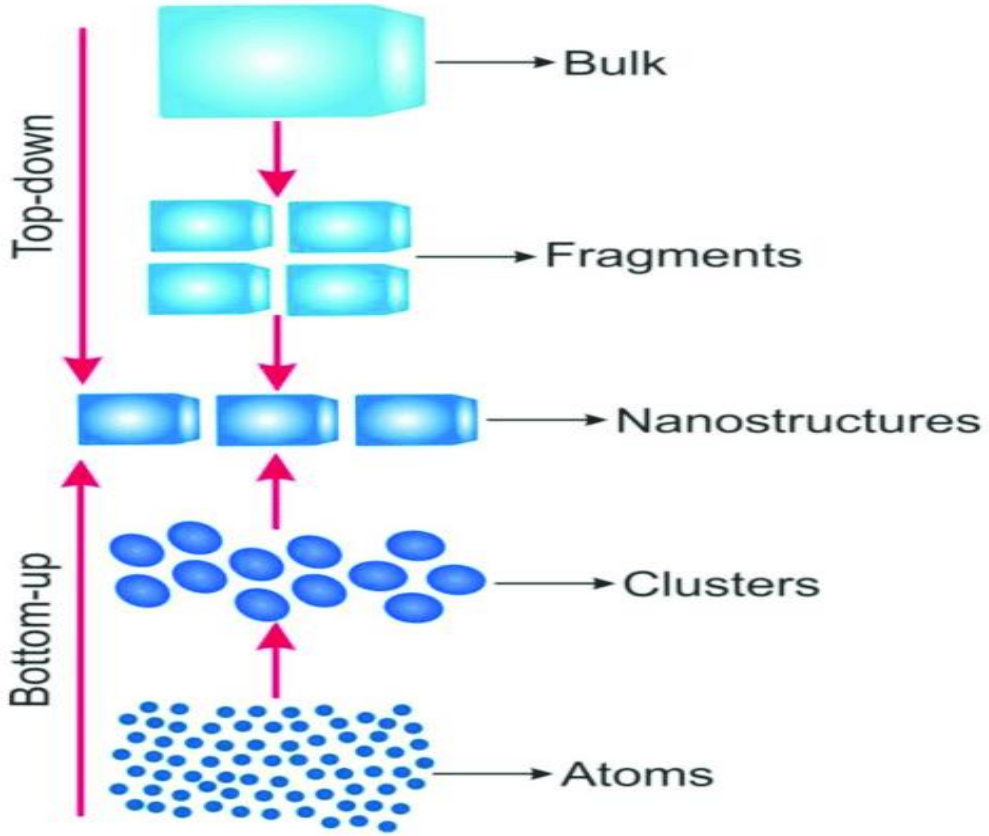


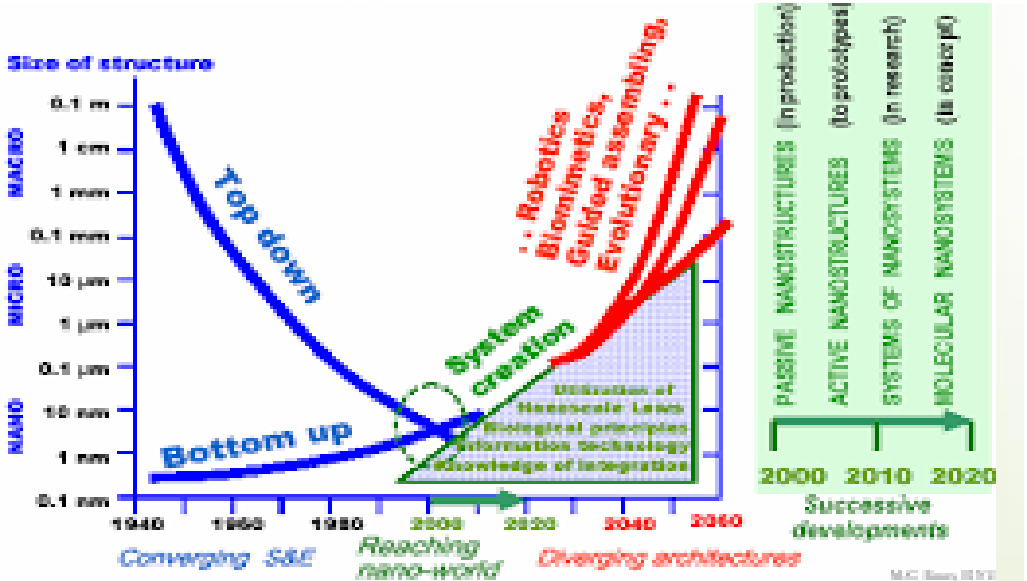
Fabrication of Nanomaterials

* 2 approaches
  - bottom up approach
  - top down approach



Nanomaterials Fabrication





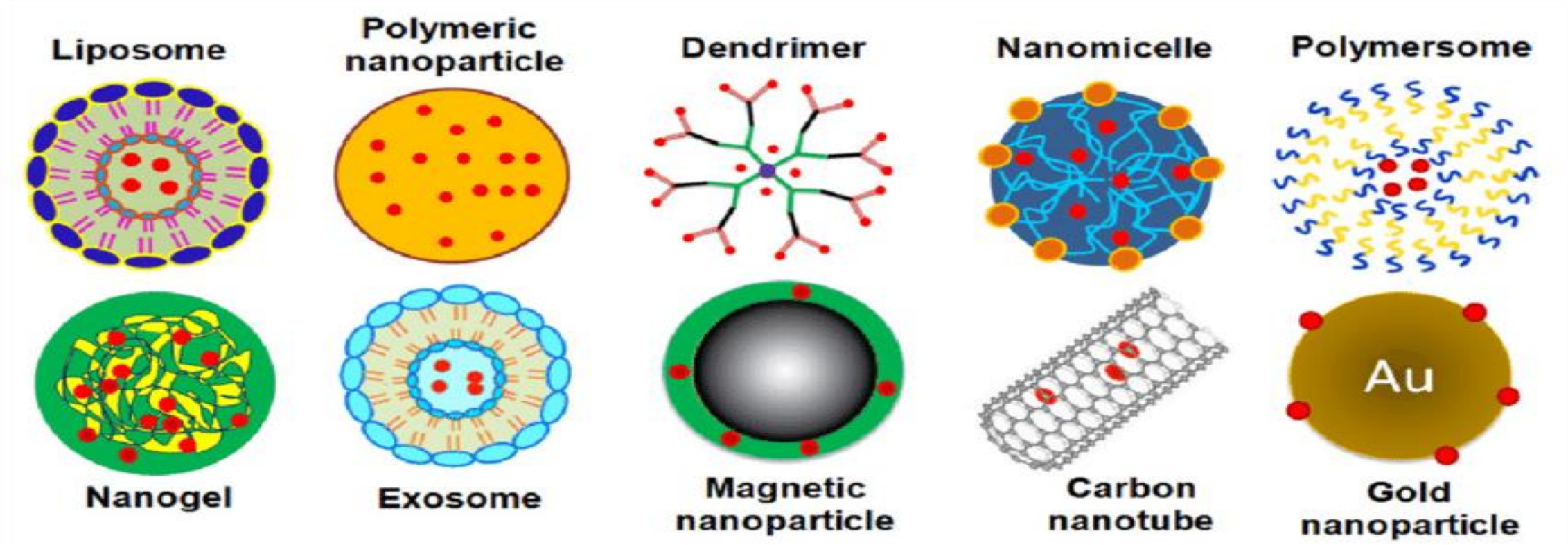
Characterization techniques

- Biomedical applications
- Antibacterial activity
- Antimalarial activity
- Antidiabetic activity
- Antioxidant activity

Equipment's for Nanoparticles

1. Homogenizer
2. Ultra Sonicator
3. Mills
4. Spray Milling
5. Supercritical Fluid Technology
6. Electrospray
7. Ultracentrifugation
8. Nanofiltration

Nanoparticles

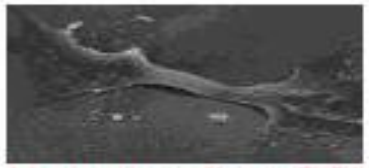


Bionanomaterials

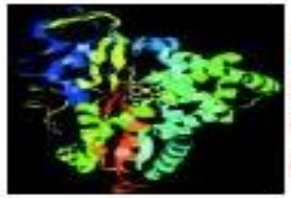
Bionanomaterials

1) **Biological materials utilized in nanotechnology**
   - Proteins, enzymes, DNA, RNA, peptides
2) **Synthetic nanomaterials utilized in biomedical applications**
   - Polymers, porous silicon, carbon nanotubes

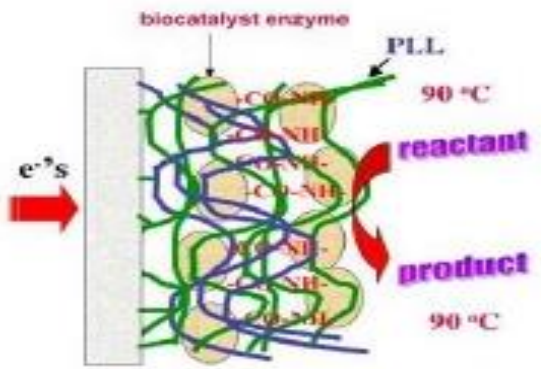
Porous silicon (PSi)



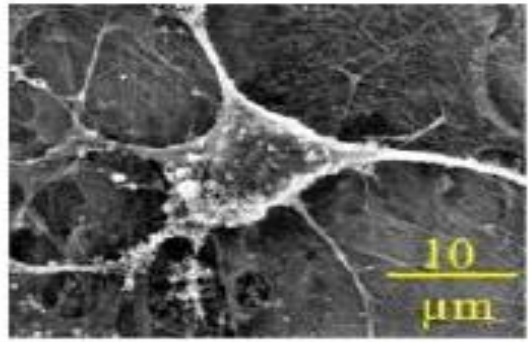
Human cell on PSi



Enzymes are used as oxidation catalysts

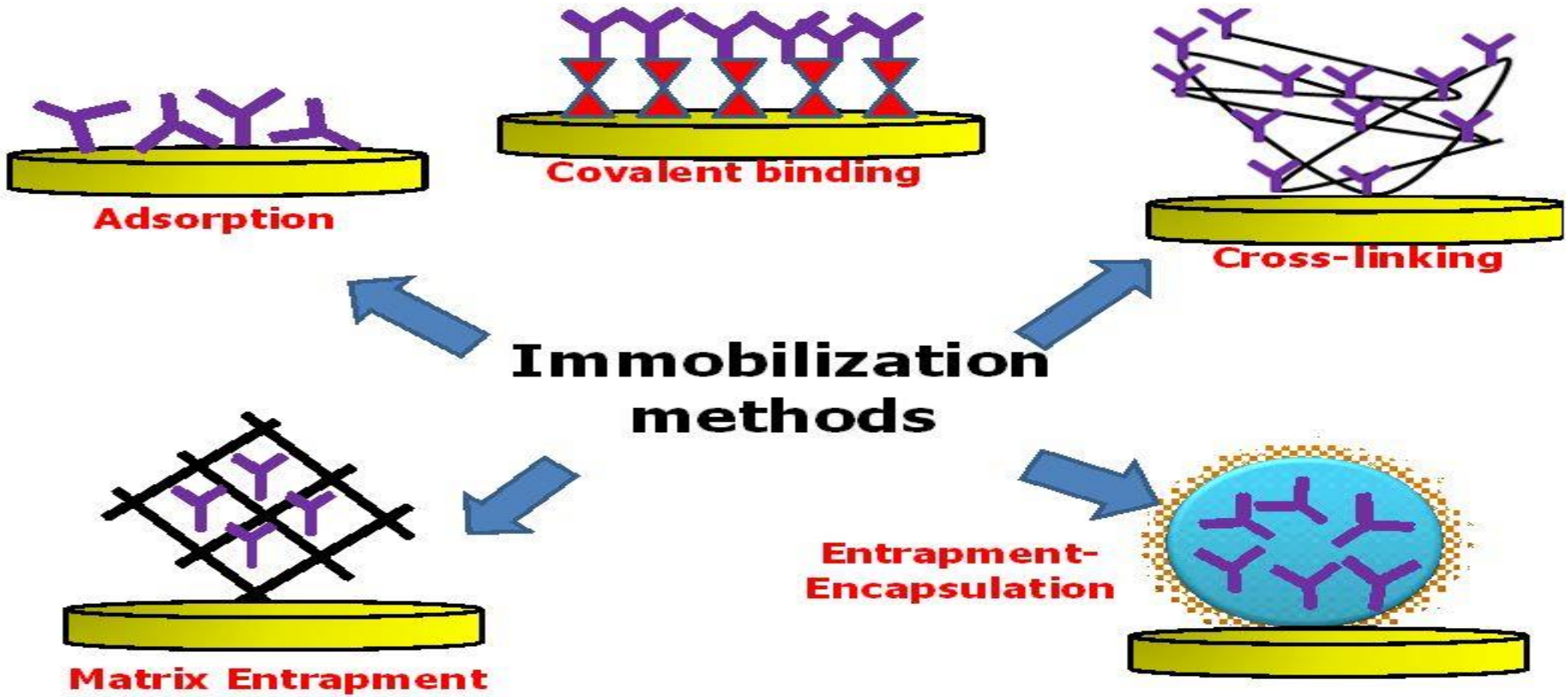


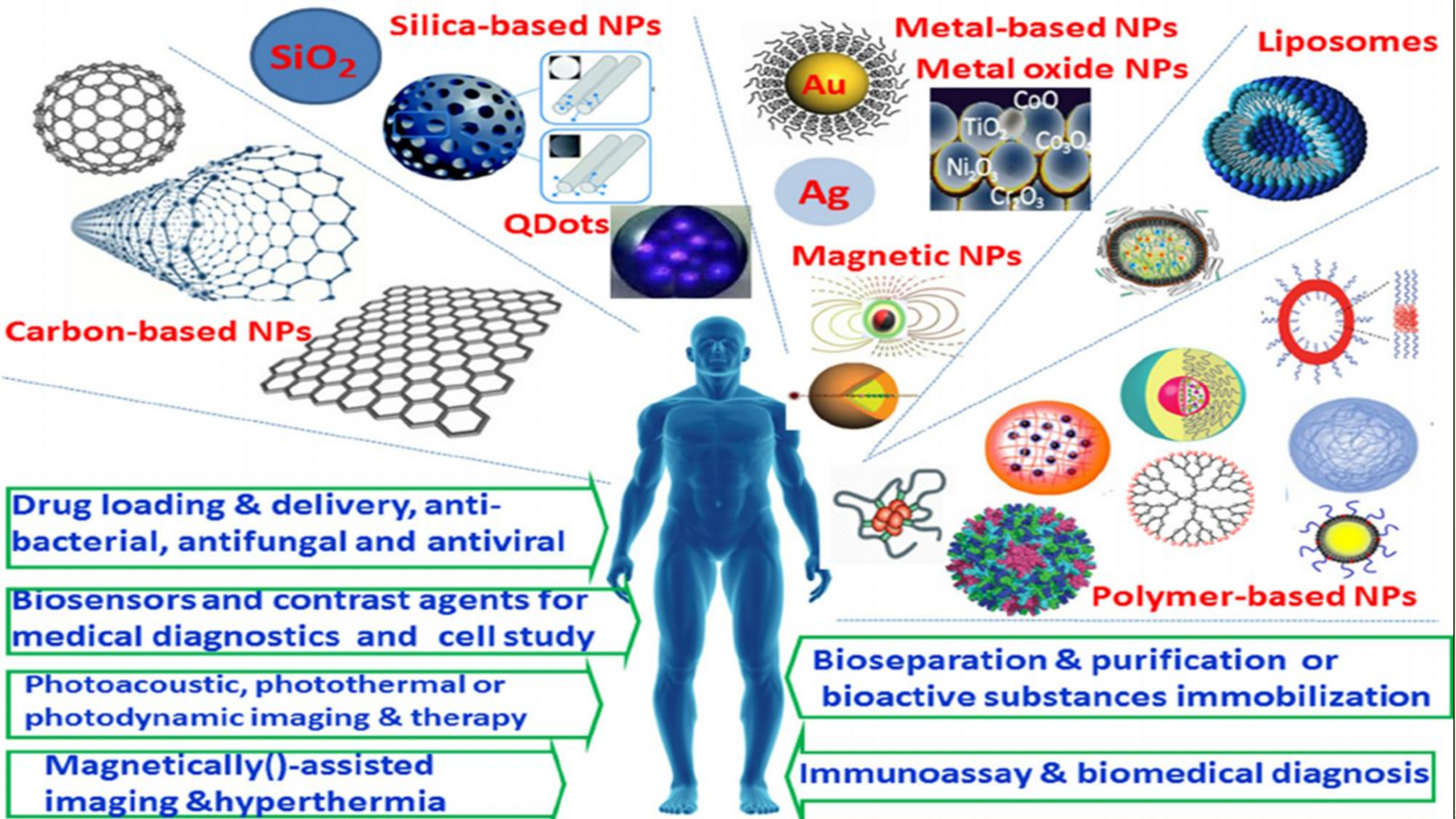
Cross-linked enzymes used as catalyst – *Univ. of Connecticut, Storrs , 2007*



Bone cell on porous silicon – *Univ. of Rochester, 2007*

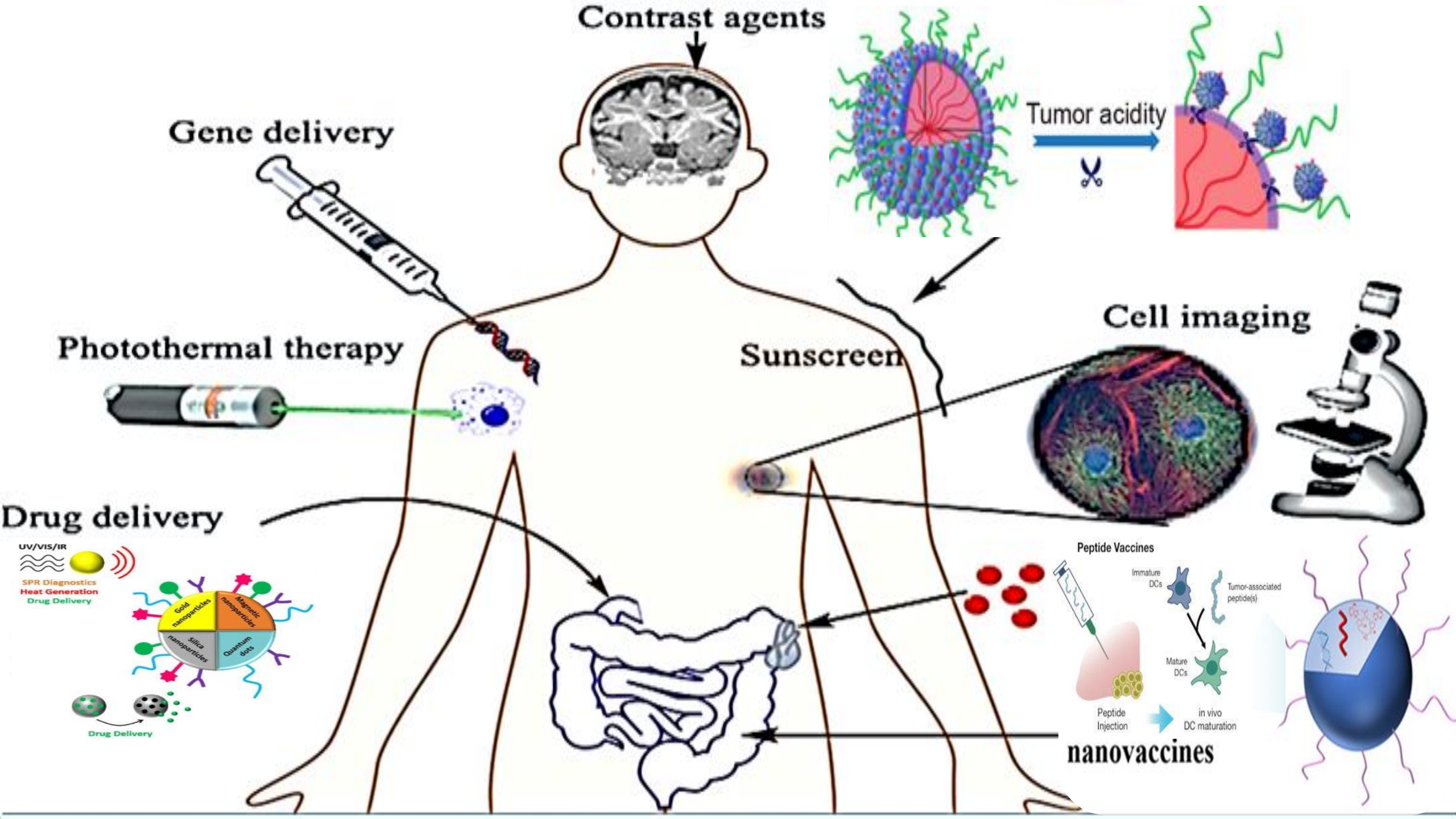
Immobilization Protocol




Silica-based NPs
SiO_2
QDots
Carbon-based NPs
Metal-based NPs
Metal oxide NPs
Au
Ag
CoO
TiO_2
Co_3O_4
Ni_2O_3
Cr_2O_3
Liposomes
Magnetic NPs
Polymer-based NPs
Drug loading & delivery, anti-bacterial, antifungal and antiviral
Biosensors and contrast agents for medical diagnostics and cell study
Photoacoustic, photothermal or photodynamic imaging & therapy
Magnetically()-assisted imaging &hyperthermia
Bioseparation & purification or bioactive substances immobilization
Immunoassay & biomedical diagnosis

Medical Applications of Nanomaterials

- Nano-medicine,
- Tissue Engineering,
- Nano-robots,
- Advance Diagnostic, As Carrier Of Diagnostic ,
- Biosensor,
- Biomarker,
- Image Enhancement.

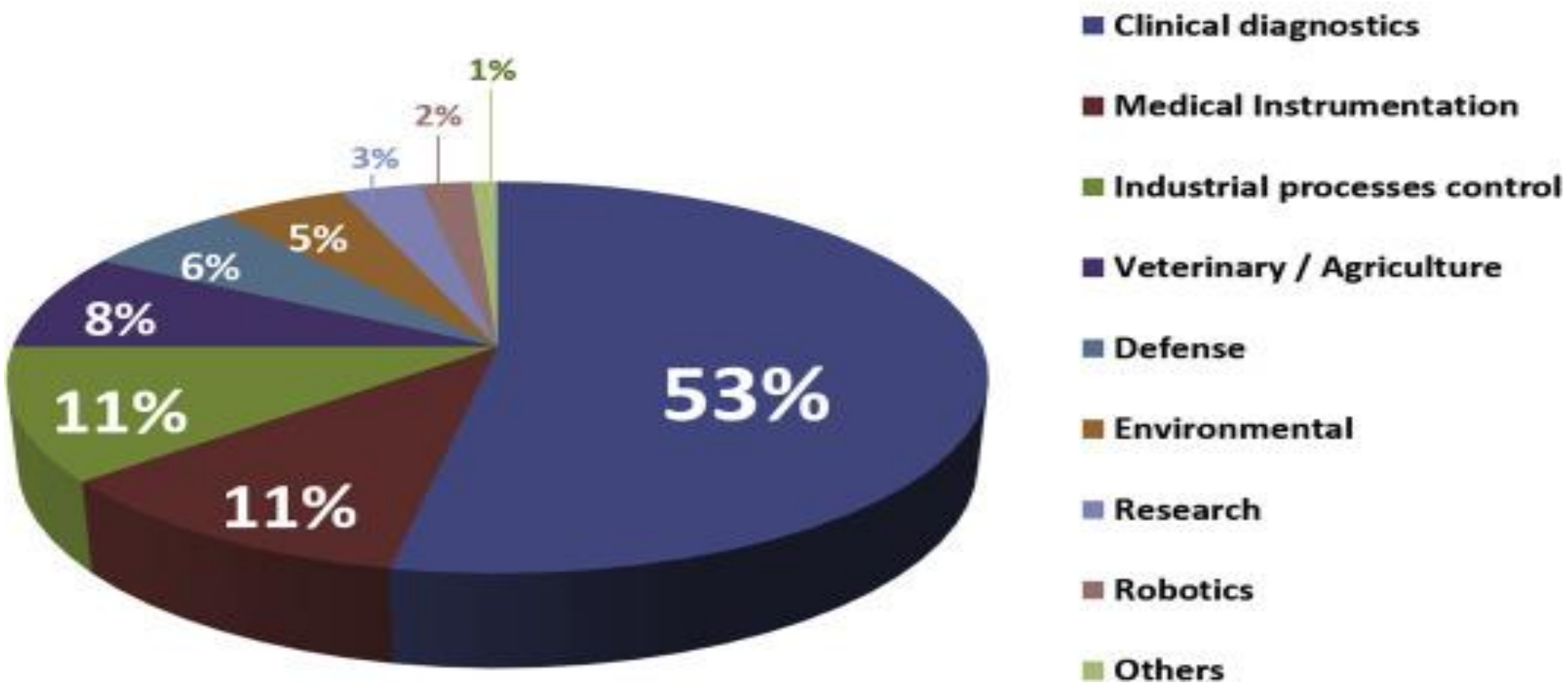

Contrast agents
Tumor acidity
Gene delivery
Photothermal therapy
Sunscreen
Cell imaging
Drug delivery
UV/VIS/IR
SPR Diagnostics
Heat Generation
Drug Delivery
Gold nanoparticles
Magnetic nanoparticles
Silica nanoparticles
Quantum dots
Drug Delivery
Peptide Vaccines
Immature DCs
Tumor-associated peptide(s)
Mature DCs
Peptide Injection
in vivo DC maturation
nanovaccines

Applications of Nanomaterial Based Products

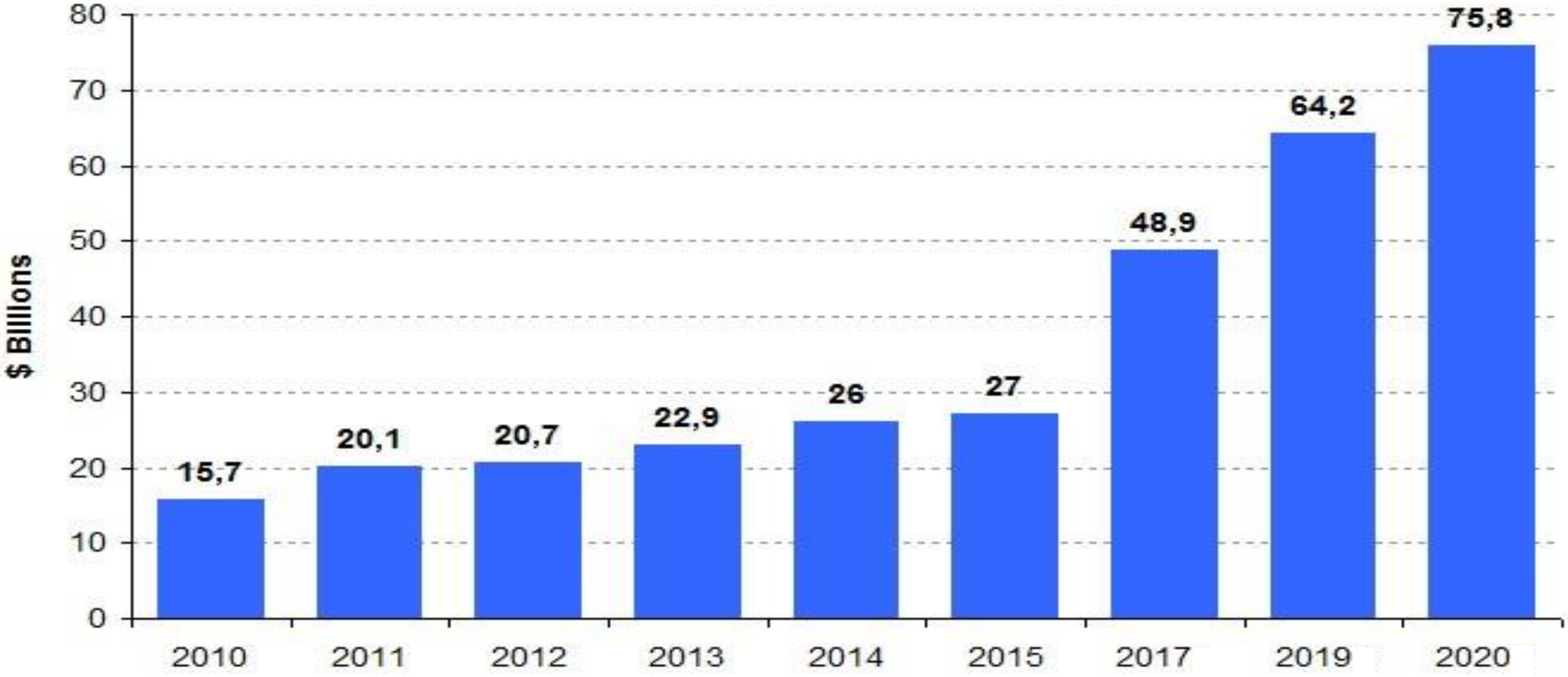
- Automotive industry
- Engineering
- Medicine
- Cosmetics
- Textile
- Sports
- Chemical industry
- Electronic industry

Examples of Nanoproducts on Market

Nanoproducts Marketing



Global nanotechnology market, 2010-2020



ADVANTAGES

☺ Nanotechnology can actually revolutionize a lot of electronic products, procedures, and applications.

☺ Nanotechnology can also benefit the energy sector.

☺ Another industry that can benefit from nanotechnology is the manufacturing sector.

☺ In the medical world, nanotechnology is also seen as a boon since these can help with creating what is called smart drugs.

DISADVANTAGES

☹ Its development is the possible loss of jobs in the traditional farming and manufacturing industry.

☹ Atomic weapons can now be more accessible and made to be more powerful and more destructive.

☹ Since these particles are very small, problems can actually arise from the inhalation of these

☹ Minute particles, much like the problems a person gets from inhaling minute asbestos particles.

☹ Presently, nanotechnology is very expensive and developing it can cost you a lot of money.

References

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