

Nanobiotechnology and Its Applications

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Introduction

Nanobiotechnology is considered to be the unique fusion of biotechnology and nanotechnology by which classical micro-technology can be merged to a molecular biological approach in real.

Nanobiotechnology= Nano + Biotechnology

Nanobiotechnology is basically application of nanotechnology in biological field. Nanobiotechnology is a multidisciplinary field that currently recruits approach, technology and facility available in conventional as well as advanced avenues of medicine, agriculture, food industry and cosmetics. Nanotechnology is science technology that deals with study of materials at nanoscale (1-100 nm)

Father of Nanotechnology

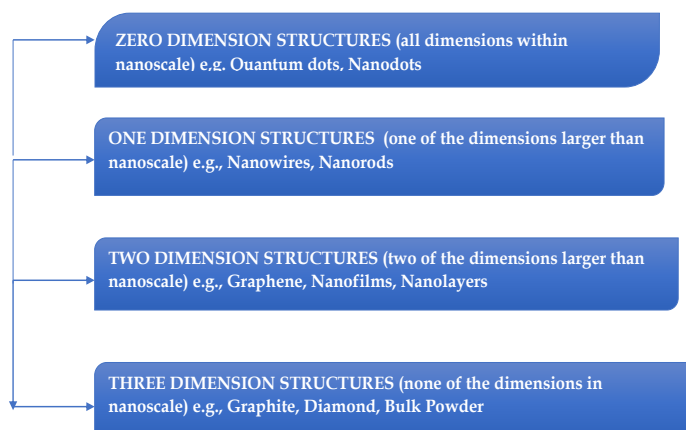
Sir Richard Feynman is called Father of Nanotechnology. He gave the concept of nanotechnology with the idea "There's plenty of room at bottom".

What are Nanomaterials?

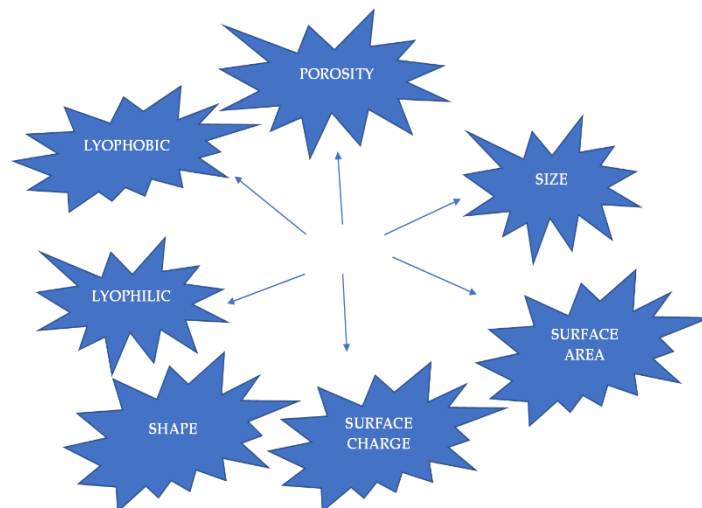
- ✓ Any material that comes in the range of nanometer scale (1-100nm) can be counted as a nanomaterial.
- ✓ One of the three dimensions of material should stand at the nanoscale (1-100nm).
- ✓ Some of the most common examples of nanomaterials are carbon nanotubes, silica nanoparticles, gold nanoparticles, quantum dots, nanographene.

Nanostructures

On the basis of dimensions, nanostructures can be classified as



Nanoparticle Surface Properties



- ✓ Size: Nanoparticles fall in the range of nanometer scale (1-100nm)
- ✓ Surface area: Owing to their small size, nanoparticles have large surface area.
- ✓ Shape: Nanoparticles have spherical, tubular and irregular shapes.
- ✓ Surface charge: Nanoparticles can be positively, negatively or neutral charged.
- ✓ Surface energy: Due to its large surface area, nanoparticles have high surface energy.
- ✓ Roughness: They have rough surface.
- ✓ Form: Nanoparticles are present in single, fused, agglomerated forms.
- ✓ Hydrophilicity: Nanoparticles are soluble in water or organic solvents
- ✓ Hydrophobicity: Nanoparticles are insoluble in water or organic solvents

Fabrication of Nanostructures

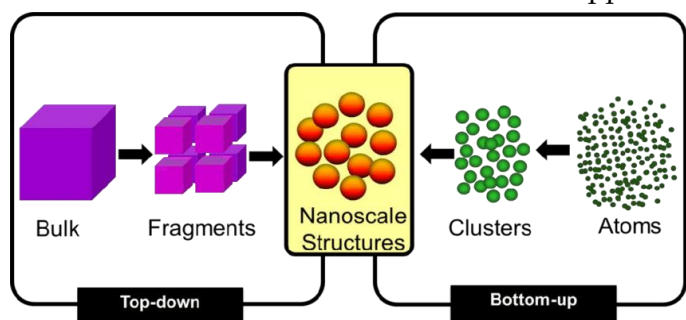
Fabrication of nanostructures can be achieved by top down or bottom-up approaches

- ✓ Top-down approach involves breaking down of bulk material into nanosized structures or devices.
- ✓ Method is time consuming and relatively costly
- ✓ It is a physical process
- ✓ Approach involves optical and electron beam lithography

For example, Quantum dots, nanowires, nanochips can be prepared by top-down approach.

- ✓ Bottom-up approach involves fabrication and synthesis of nano structures: atom by atom, molecule by molecule, cluster by cluster.
- ✓ Nanostructures obtained have less defects, homogeneous chemical composition
- ✓ It is a chemical process

For example, Carbon nanotubes & Si Nanowires have been prepared by bottom-up approach.



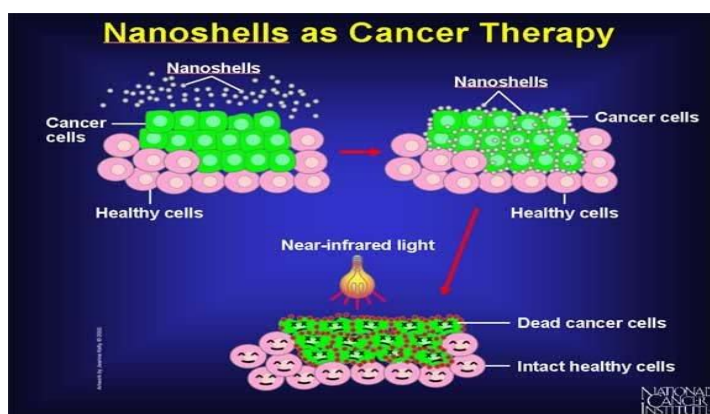
Source: Patra et al., 2014

Applications of Nanotechnology

Nanomedicine

Cancer Cell treatment

Nanotechnology can provide rapid and sensitive detection of cancer related molecules. Nanoshells are nowadays used as cancer therapy treatment. Nanoshells linked to antibodies are used to recognize cancer cells. Doctors use gold nanoshells which on exposure to near infrared rays are used to kill tumor cells.



Source: www.cancer.gov

Covid-19 vaccines

Nanoencapsulations of solid lipid nanoparticles are used in mRNA covid 19 vaccines like Pfizer/ BioNTech covid -19 vaccines. These nanoencapsulations play a vital role in transporting mRNA effectively to the target cell and protect RNA from ribonuclease degradation. Solid lipid nanoparticle surface has been modified with

antibodies which allow nanoparticle to recognize and bind to specific receptors on cells. Thus, enhancing their tissue targeting. (Khurana et al. 2021)

Nano-food industry

- ✓ Nano additives & Nutraceuticals: Metallic oxides such as silicon dioxide (SiO_2) and titanium dioxide (TiO_2) have been used as coloring and fragrance additives.
- ✓ Nanoencapsulation: Polymeric nanoparticles are preferred for encapsulation of bioactive compounds e.g. flavonoids and vitamins. Beta carotene encapsulated by solid lipid nanoparticles is one such example. Ferritin nanocages encapsulation has been used for rutin - common dietary flavonoid. Thus, enhancing their solubility.
- ✓ Nanocoating: Shelf life of fruits, vegetables, nuts has been increased by use of polymeric, solid lipid nanoparticles. Shelf life of tomato has been increased by bio nano encapsulated quercetin. Curcumin, least stable bioactive component of turmeric was found to be stable under nanoencapsulation.

Agri nanotechnology

Nano fertilizers

- ✓ Nanomaterials-based fertilizers and nanomaterials functionalized nutrients are used. NPs are diffused through 'nano holes' on seed coats, resulting in improved germination condition.
- ✓ Nanomaterials-based fertilizers have advantages as compared to conventional fertilizers such as crop improvement, specifically targeted, slow release of nutrients that regulate plant growth, less eco-toxicity, remotely regulated
- ✓ Nano urea is one of the classical examples of nanotechnology used in agriculture sector. It is developed and patented by IFFCO.
- ✓ Nano urea is used in its liquid form and is the only nano fertilizer approved by Government of India.
- ✓ Nanoparticles such as copper, iron, and zinc were incorporated into urea-modified hydroxyapatite to increase the efficiency of the proposed fertilizer.

Cosmetics

- ✓ Face powders, moisturizers and sunscreens contain nanoparticles in powdered form. Due

to their small size and large surface area, they are easily absorbed by skin.

- ✓ Moisturizers and sunscreens have TiO_2 and ZnO nanoparticles which block the entry of UV rays into the skin.
- ✓ Gold facial masks are used these days in beauty clinics to improve blood circulation, skin elasticity and reduce formation of wrinkles.
- ✓ Nano capsules are used for delivering Vitamin A, Vitamin C and other antioxidants into skin. Vitamin C encourages collagen synthesis, destroy free radicals and suppress pigmentation.

Conclusion

Nanobiotechnology is a wide field and has immense scope in diverse spheres of life. It has been a guiding force in various disciplines like drug delivery, food industry, cosmetics, agriculture. Nanobiotechnology is field of research and emerging science which is expected to have rapid and strong

future developments. Universities and researchers should be promoted to work in this field. Advances in nanobiotechnology sector can contribute significantly to economic growth and job opportunities.

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