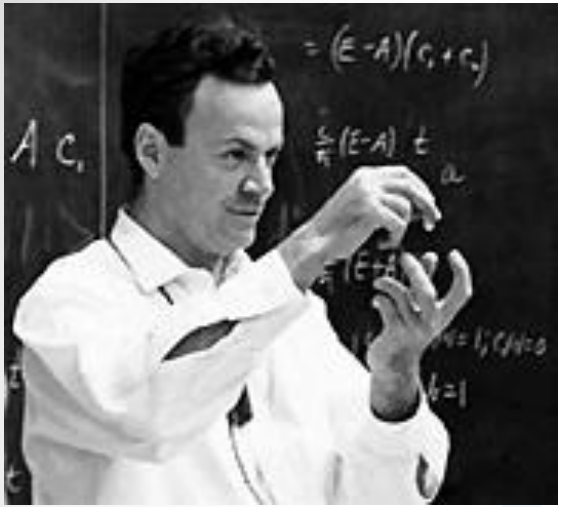
# Nanotechnology

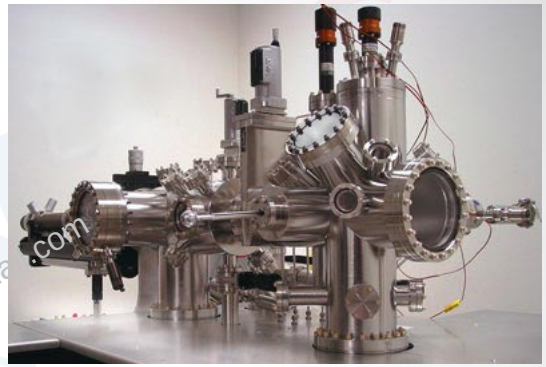
# History



**Physicist Richard Feynman, the father of nanotechnology.**

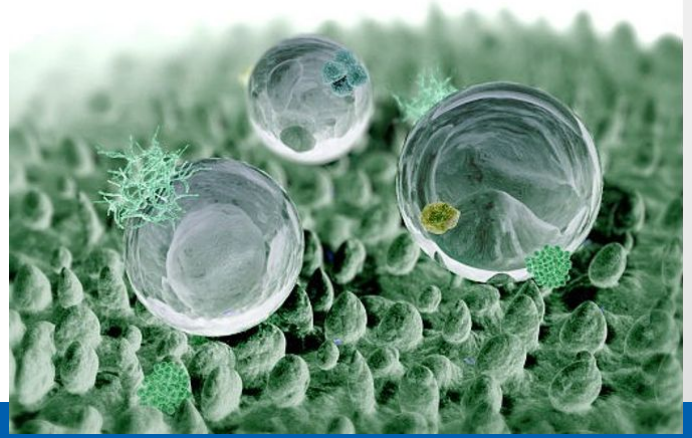
- In **1959**, described a process in which scientists would be able to manipulate and control individual atoms and molecules.

Professor **Norio Taniguchi** coined the term nanotechnology in **1974**.



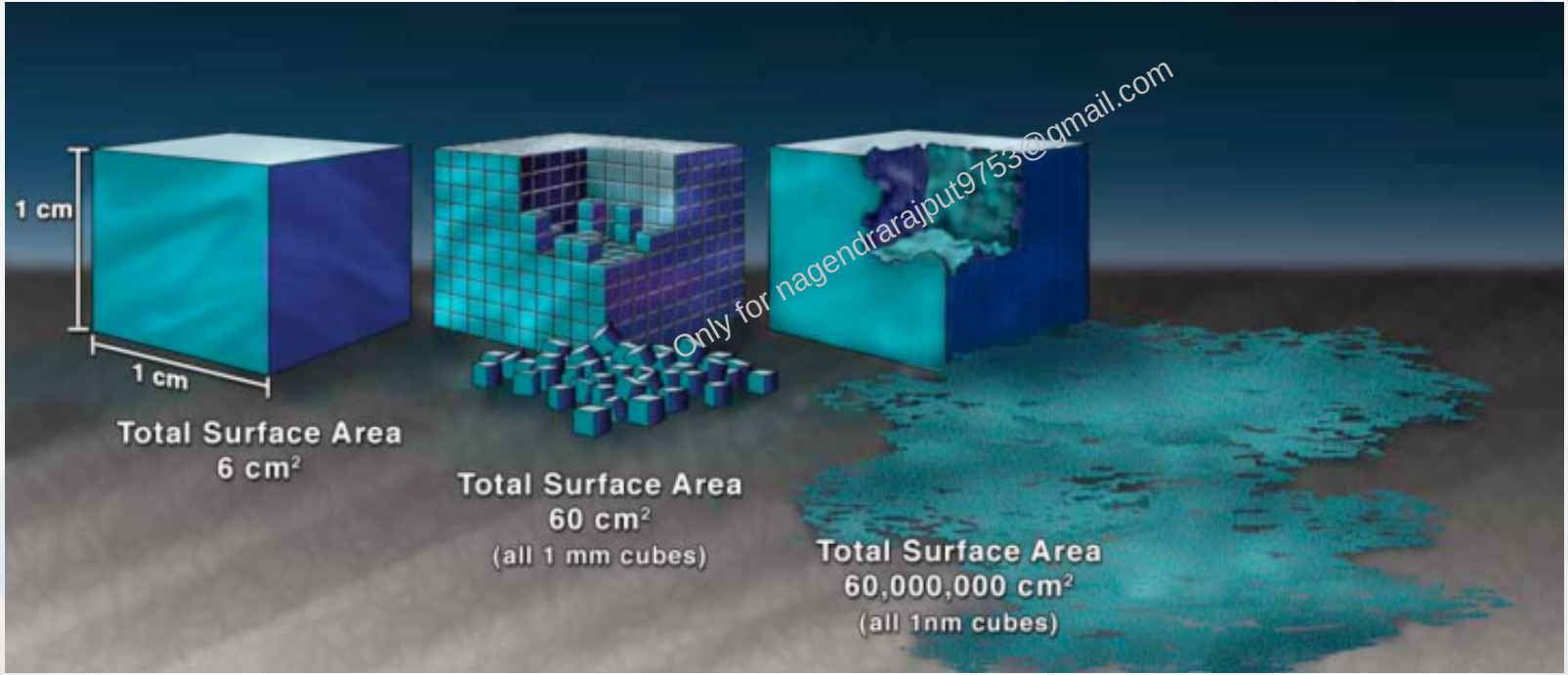
**In 1981**, with the development of the scanning tunneling microscope that could "see" individual atoms, that modern nanotechnology began.

# Nanotechnology in Nature

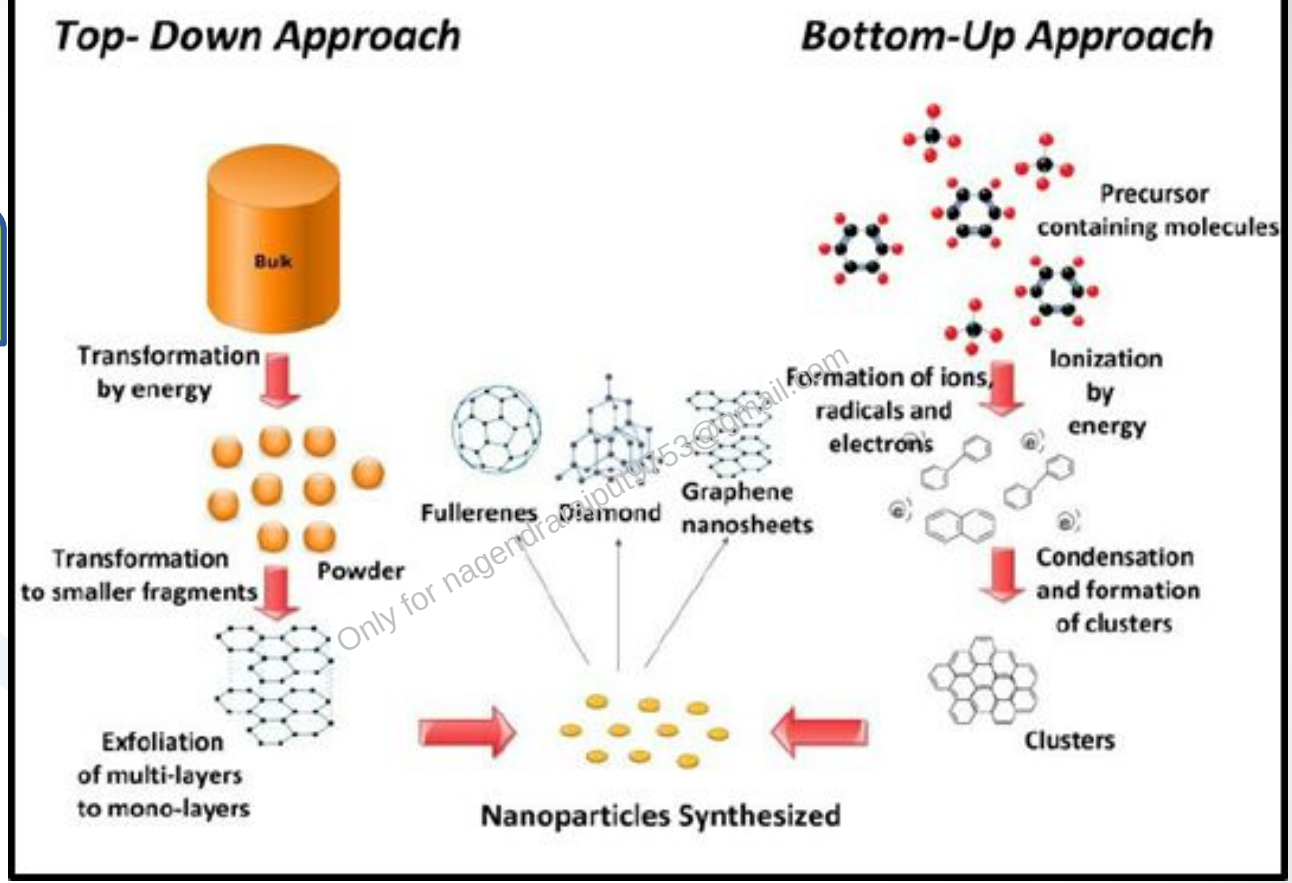


# Nanogold

# Increased Surface Area



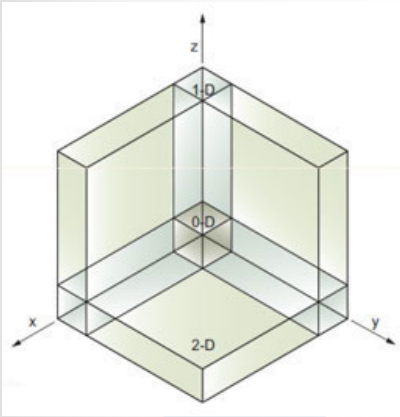
## Nanomanufacturing






https://www.youtube.com/watch?v=WW0IIyrq8z4

# Dimensions of Nanomaterials




0-D: All dimensions at the nanoscale

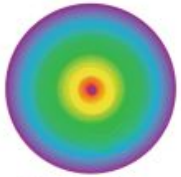
1-D: Two dimensions at the nanoscale, one dimension at the macroscale

2-D: One dimension at the nanoscale, two dimensions at the macroscale

3-D: No dimensions at the nanoscale, all dimensions at the macroscale

## NMs classification based on dimensionality

**0D**
Nanospheres, clusters


Quantum dots


Fullerenes

Gold nanoparticles

**1D**
Nanotubes, wires, rods

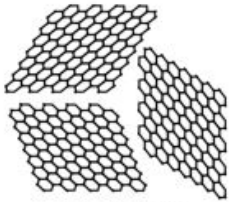

Metal nanorods, Ceramic crystals


Carbon nanotubes, Metallic nanotubes


Gold nanowires, Polymeric nanofibers, Self assembled structures

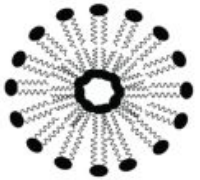
**2D**
Thin films, plates, layered structures


Carbon coated nanoplates

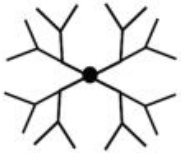

Graphene sheets


Layered nanomaterials

**3D**
Bulk NMs, polycrystals


Liposome


Polycrystalline

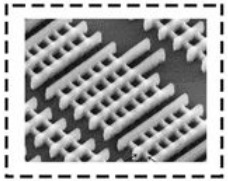

Dendrimer

# timeline of four generations of nano products

2000

## 1st passive nanostructures

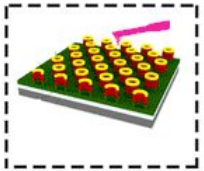
a. Dispersed and contact nanostructures such as aerosols, colloids
b. Products incorporating nanostructures such as coatings; nanoparticle reinforced composites; nanostructured metals, polymers, ceramics



2005

## 2nd active nanostructures

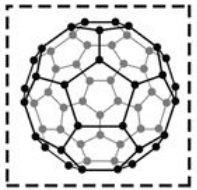
a. bio-active, health effects such as targeted drugs, biodevices
b. physico-chemical active such as 3D transistors, amplifiers, actuators, adaptive structures



2010

## 3rd systems of nanosystems

such as guided assembling; 3D networking & new hierarchical architectures, robotics, evolutionary



2015-2020

## 4th molecular nanosystems

such as molecular devices 'by design' , atomic design, emerging functions

frame 1

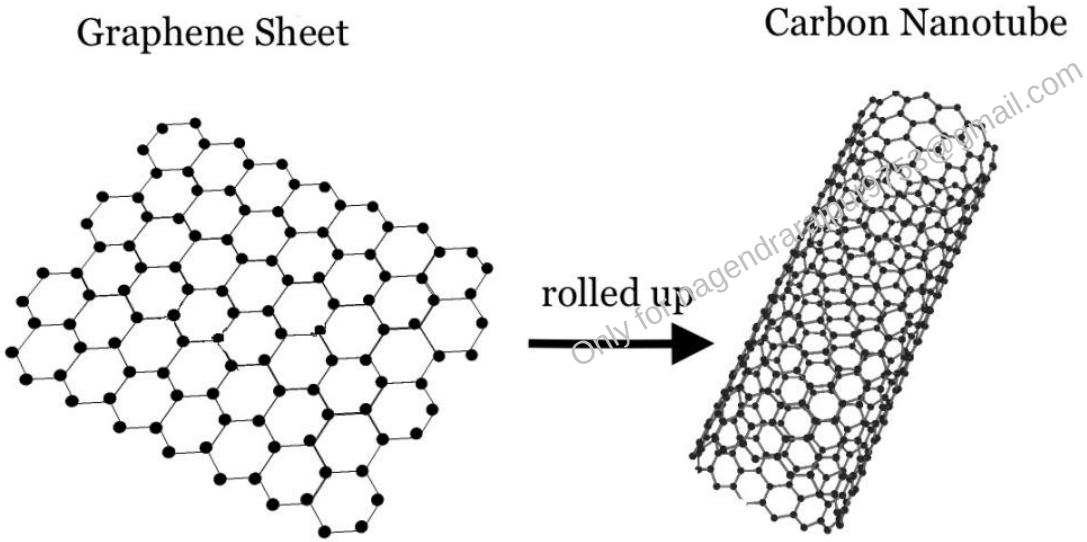
risk governance frame 2



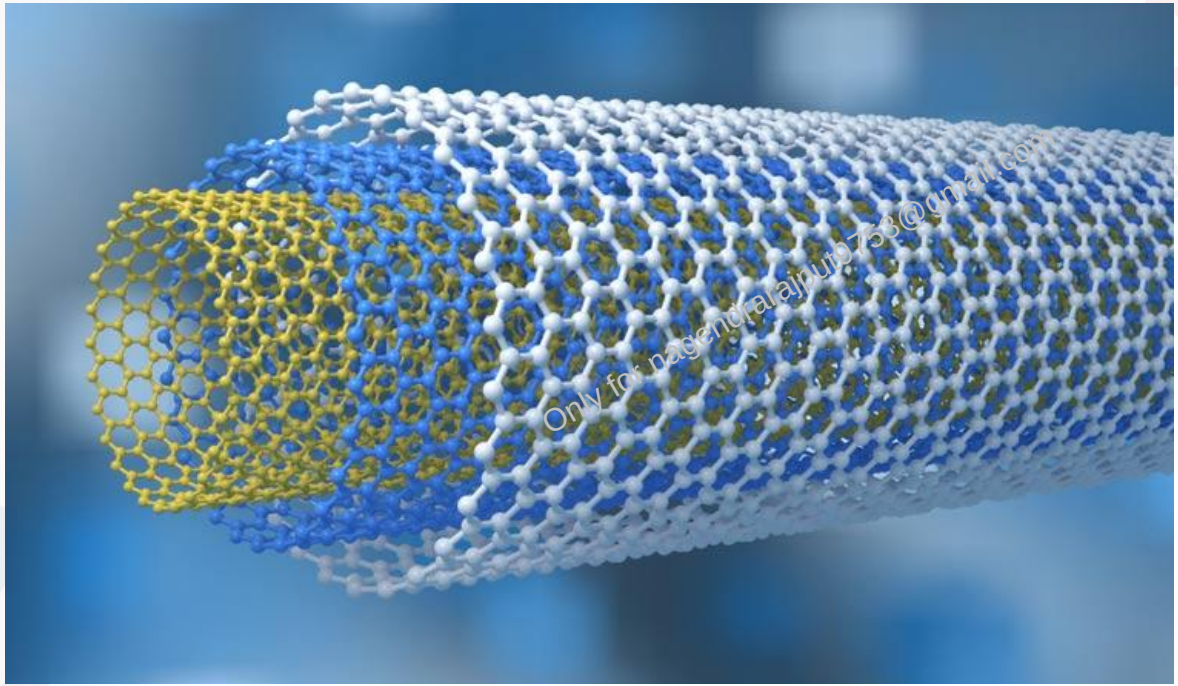
Timeline for beginning of industrial prototyping and nanotechnology commercialization: four generations of nanoproducts.

Illustrations Kenneth buddha Jeans

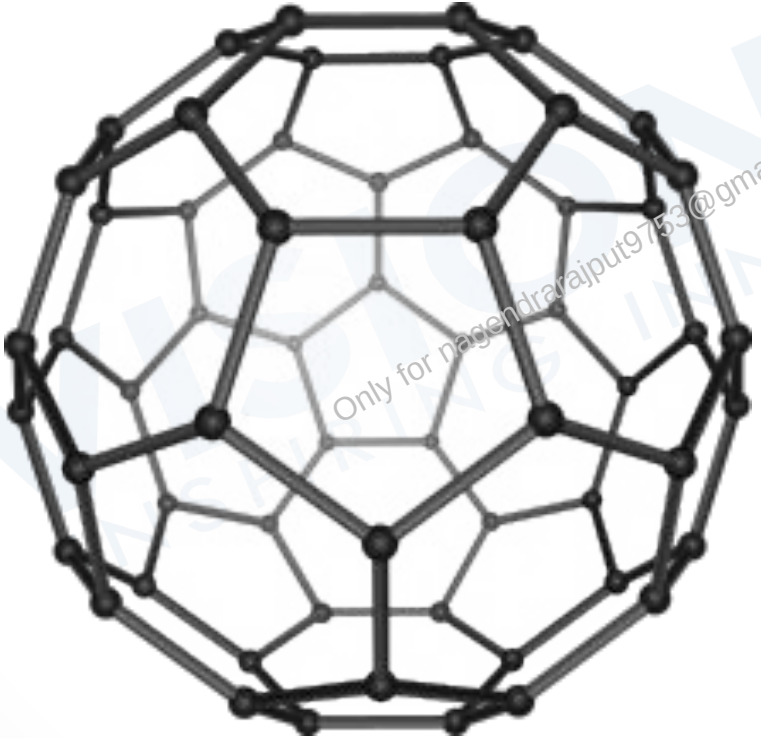
# Carbon Nanotubes



# Carbon Nanotubes



# Model of the C60 fullerene



# Quantum Dots

Q1. Why are nanomaterials and nanotechnology considered revolutionary for modern scientific and technological development:

1. Even though the physical properties of nanomaterials don't change, their chemical reactivity enhances significantly.
2. Size of Nanomaterials is directly proportional to its surface area, i.e. with increase in size the surface area increases.
3. They are considered environment friendly because of no negative impact on ecosystems.

Select the correct answer using the code given below.

(a) 1 and 2 only
(b) 2 only
(c) 2 and 3 only
(d) None

Q2. With reference to the use of nano technology in health sector, which of the following statements is/are correct?

1. Targeted drug delivery is made possible by nanotechnology.
2. Nanotechnology can largely contribute to gene therapy.

Select the correct answer using the code given below.

(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Q3. Consider the following statements:
1. Other than those made by humans, nanoparticles do not exist in nature.
2. Nanoparticles of some metallic oxides are used in the manufacture of some cosmetics.
3. Nanoparticles of some commercial products which enter the environment are unsafe for humans.
Which of the statements given above is/are correct?
(a)1 only
(b) 3 only
(c) 1 and 2
(d) 2 and 3