



# Nanoscience's Dual Heritage: Unveiling the Past to Propel the Future of Tiny Tech



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# Contents

- **Natural nonomaterials (examples)**
- **Synthesis and applications of nanomaterials in our daily life**
- **Definition**
- **Synthesis routes**
- **Visualizations**  
(electron microscope invented By German Physist Earnst Ruska and electrical Engineer Max Knoll 1931)
- **Applications**
- **Challenges**
- **Adverse effects**

# Beautiful Examples of Natural Nanomaterials



Harpreet Kaur Channi 2016, TUDY OF NANOMATERIALS  
AND THEIR APPLICATIONS, International Journal of Research  
in Engineering and Applied Sciences



# Nanomaterials in Our Daily Life

Powders of turmeric and other spices



Lampblack (काजल)



Mechanical  
Thermal  
Electrical  
methods

# Definition, Types and Synthesis Routes of Nano-materials

Concept of nanomaterials Richard Phillips Feynman  
(There is plenty of room at the bottom 1959)

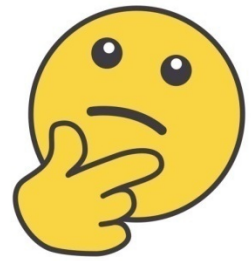
Norio Taniguchi coined the word Nanotechnology in 1974

One dimension of size 1-100 nm that is of the order of De Broglie wavelength of electron.

One dimensional nanomaterial, Two-dimensional nanomaterial, Three-dimensional nanomaterial

| Top down approach          | Bottom up approach        |
|----------------------------|---------------------------|
| Starts from bulk material  | Starts from atom/molecule |
| Ball milling               | Sol-gel                   |
| Plasma arching             | Microwave                 |
| Laser sputtering           | Hydrothermal              |
| Chemical vapour deposition | Solution phase reduction  |
| Electrochemical            |                           |
| Chemical reduction         |                           |

# Visualizations of Nanomaterials



Is it possible to see the nanoparticles with  
naked eye/optical microscope?

Answer is no

Then how can we see these particles??

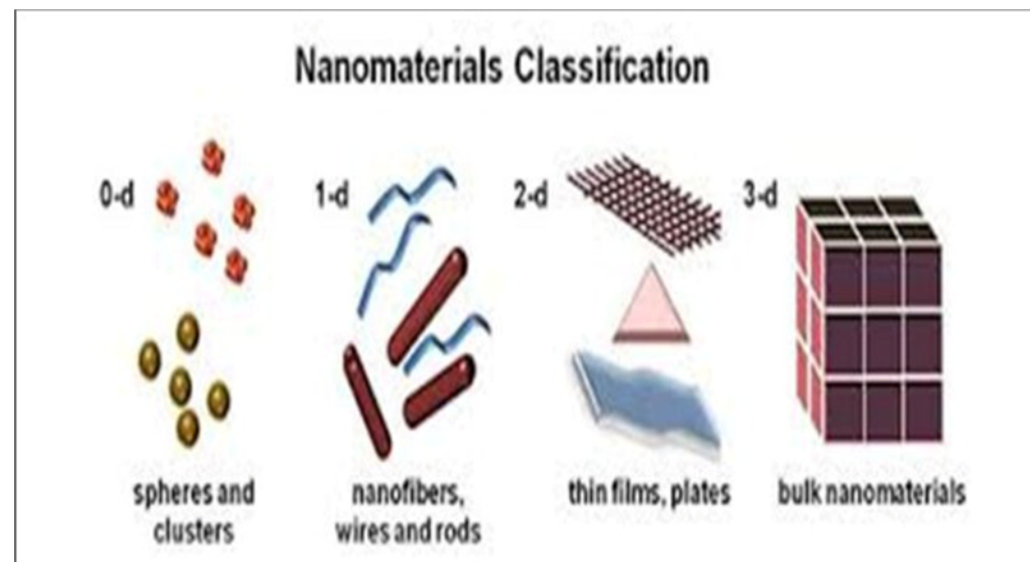
Electron microscope

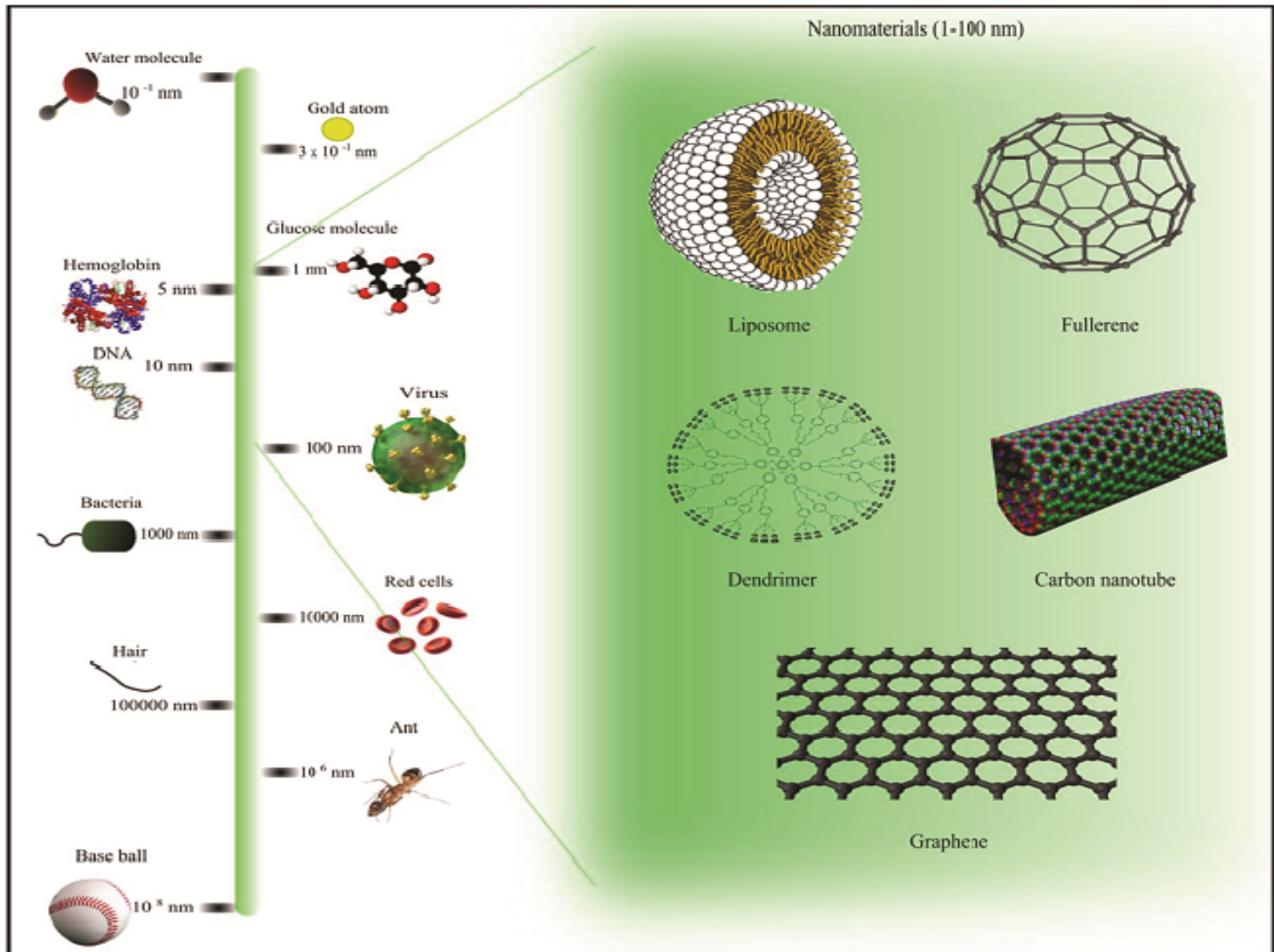
TEM (Transmission Electron Microscope)

SEM (Scanning Electron Microscope)

AFM (Atomic Force Microscope)

HRTEM (High Resolution Transmission  
Electron Microscope)





# Drastic change in the properties of nano-materials

Physical properties

Mechanical properties

Magnetic properties

Optical properties

Thermal properties

Surface area

Catalytic activity

Electrical properties

Semiconductors

Superconductor

Surface area/Volume

Free electron density at the surface

Quantum confinement



**Top down method.....**

**Starting material was Graphite oxide**

**Graphene oxide**

**&**

**Reduced Graphene oxide**

**Electrochemical sensor: Excellent  
storage stability and sensitive  
detection of neurotoxin  
quinolinic acid.**

**Ranjana Singh**, S. Kashyap, S. Kumar, S Abraham, T.K. Gupta, A.M. Kayastha, B.D. Malhotra, P.A. Suxena, A. Srivastava and **Ranjan K. Singh** Excellent storage stability and sensitive detection of neurotoxin quinolinic acid, Biosensors and Bioelectronics 90 (2017) 224–229. (Impact factor 10.257)

**Bottom up approach.....**

**Starting material were citric acid and urea  
(microwave route)**

**Kept at -4° C observed to be optically stable  
for more than three years**

**QPRTase modified N-doped carbon  
quantum dots: A fluorescent bioprobe  
for selective detection of neurotoxin  
quinolinic acid in real serum**

**Ranjana Singh**, Sunayana Kashayap, Vimal Singh, Arvind M. Kayastha, Hridyesh Mishra, Preeti Suman Saxena, Anchal Srivastava, **Ranjan K. Singh** QPRTase modified N-doped carbon quantum dots: A fluorescent bioprobe for selective detection of neurotoxin quinolinic acid in human serum, Biosensors and Bioelectronics 101 (2018) 103-109. (Impact factor 10.257)

# Continued.....



**Bottom up approach.....**

**Starting material were citric acid and urea  
(microwave route)**

**Detection of Malachite Green in Water  
Using Edge Excited Label Free  
Fluorescent Probe NCQDs**

**Ranjana** Singh and Ranjan K. Singh Detection of Malachite Green in Water Using Edge Excited Label Free Fluorescent Probe NCQDs Journal of Fluorescence 30(6): 2020 1281-1285 (Impact factor 2.093)

**Bottom up approach.....**

**Starting material were citric acid and urea**

**(Hydrothermal Route)**

**Nitrogen Doped Carbon Quantum Dots  
Modified by *Lens culinaris*  $\beta$ -  
Galactosidase as a Fluorescent Probe for  
Detection of Lactose**

**Ranjana Singh**, Anjali Yadav, Shashank Shekhar, Ranjan K. Ajad, **Ranjan K. Singh**, Arvind M. Kayastha, Nitrogen Doped Carbon Quantum Dots Modified by *Lens culinaris*  $\beta$ -Galactosidase as a Fluorescent Probe for Detection of Lactose Journal of Fluorescence (2019) 29:1213–1219. (Impact factor 2.093)

# Bottom up approach.....

## Curcumin Quantum Dots Mediated Degradation of Bacterial Biofilms

Ashish K. Singh, P. Prakash, **Ranjana Singh**, N. Nandy, Zeba Firdaus, M. Bansal, Ranjan K. Singh, Anchal Srivastava, J.K. Roy, B. Mishra Ranjan K. Singh Curcumin quantum dots mediated degradation of bacterial biofilms, *Frontiers in Microbiology*, 2017, 8, 1517. (Impact factor 4.235)

# Challenges in the Fabrication of Nanostructured Materials

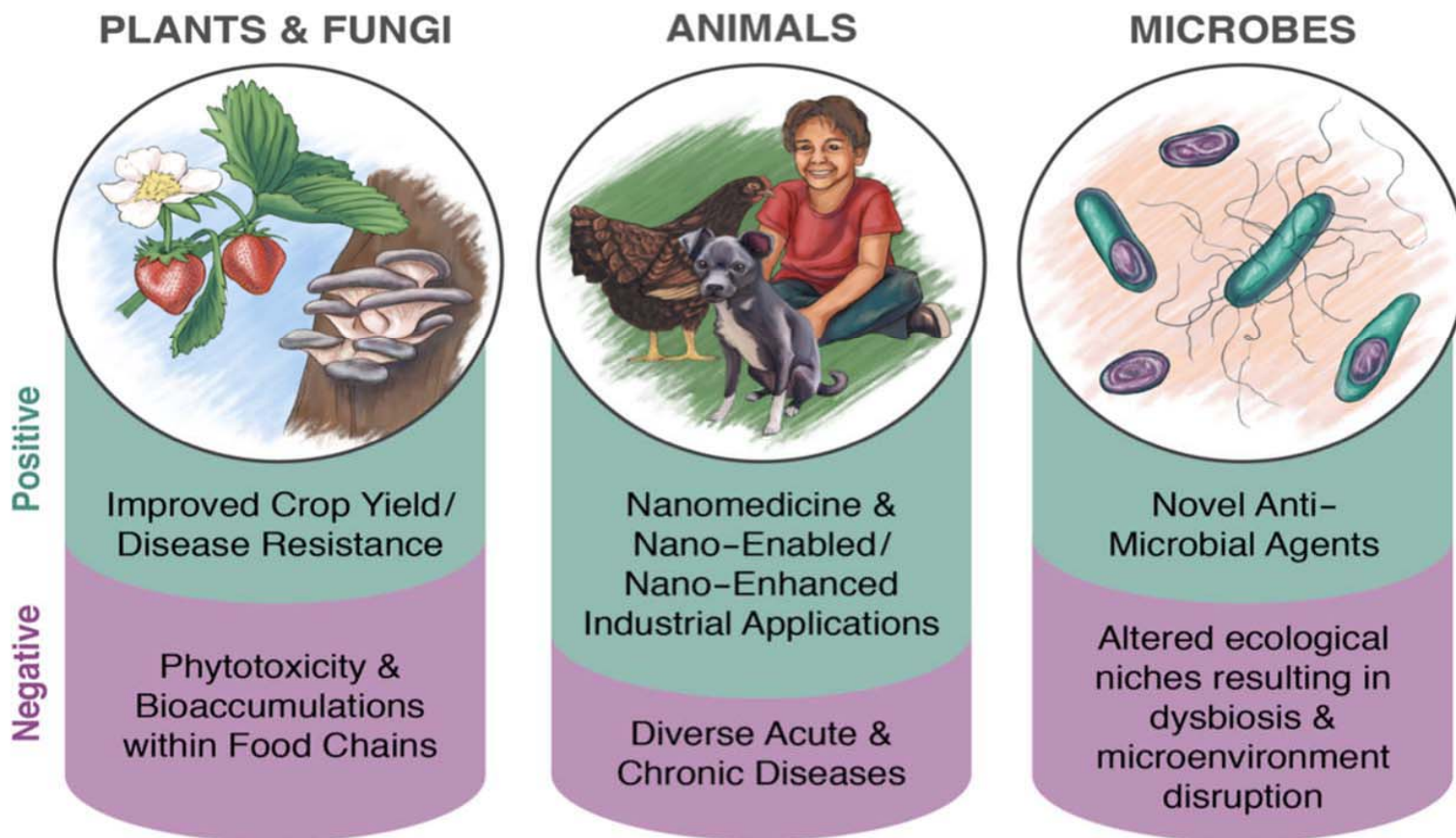
- ☐ Can you Control the particle size ?
- ☐ Can you control the shape of nanoparticles ?
- ☐ Can you control the structure either crystalline or amorphous?
- ☐ Particle size distribution (monodispersive: all particles are of same size)

# Application of nano-materials.....

- ❑ Nanosensors can be utilized to check the soil condition, pesticides, herbicides, Fertilizers, insecticides, pathogens and growth of the crop.
- ❑ Food contamination and environmental conditions at the farm can be monitored using nanosensors.
- ❑ Nanocapsules can be used for the delivery of pesticides, herbicides, fertilizers as well as vaccines with reduced doses.
- ❑ Bio-nanosensor can be used to detect metabolites like (lactate, glucose and ATP) within the animals.
- ❑ Aptasensors are available to detect the heavy metals in drinking water and various food.

We had discussed the advantages of nanomaterials but these materials have adverse effect on our environment also for the sustainable development of our country we need to Make judicious choice to utilize these nanomaterials.....

## NANOPARTICLE IMPACT

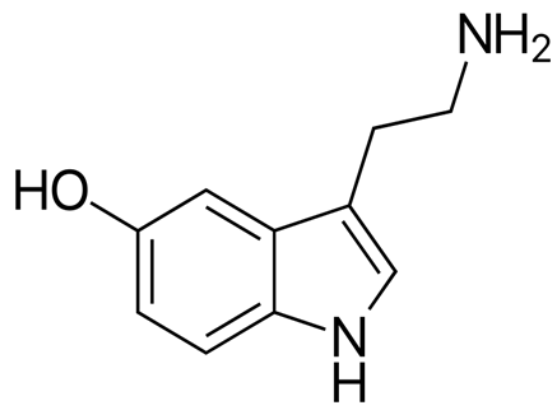


# *Acknowledgements*

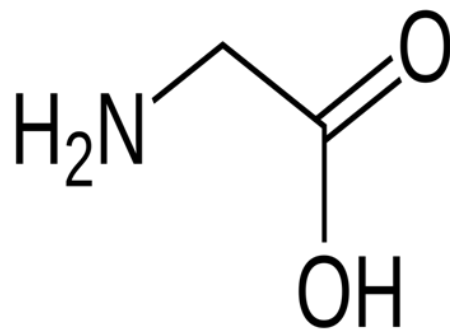
- ❖ **My supervisor, Prof. Ranjan K. Singh, Dept. of Physics  
Institute of Science, BHU, Varanasi 221005**
- ❖ **Prof. Narendra Kumar, Principal HD Jain College Ara-802301,  
Bihar**
- ❖ **All the educators**
- ❖ **Non teaching Staff BHU, Varanasi 221005**



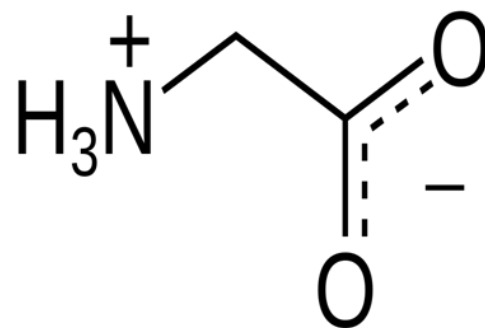
**Thank You!**



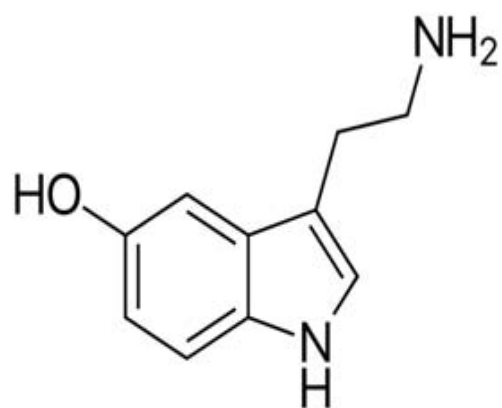
(a)



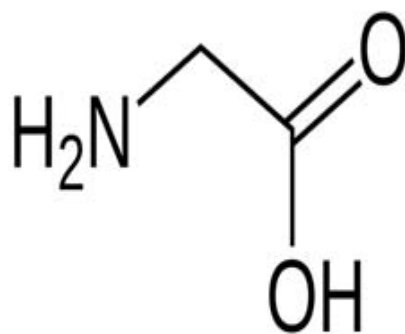
(b)



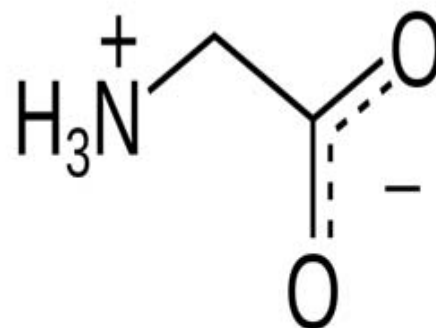
(c)



(a)



(b)



(c)