University of Diyala
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NANOTECHNOLOGY AND ITS APPLICATION

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6-12-2016

Presentation Layout

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Introduction to Nanotechnology

- **Nanoscience** is the study of phenomena and manipulation of materials at atomic, molecular and macro-molecule scales, where properties differ significantly from those at a larger scale.

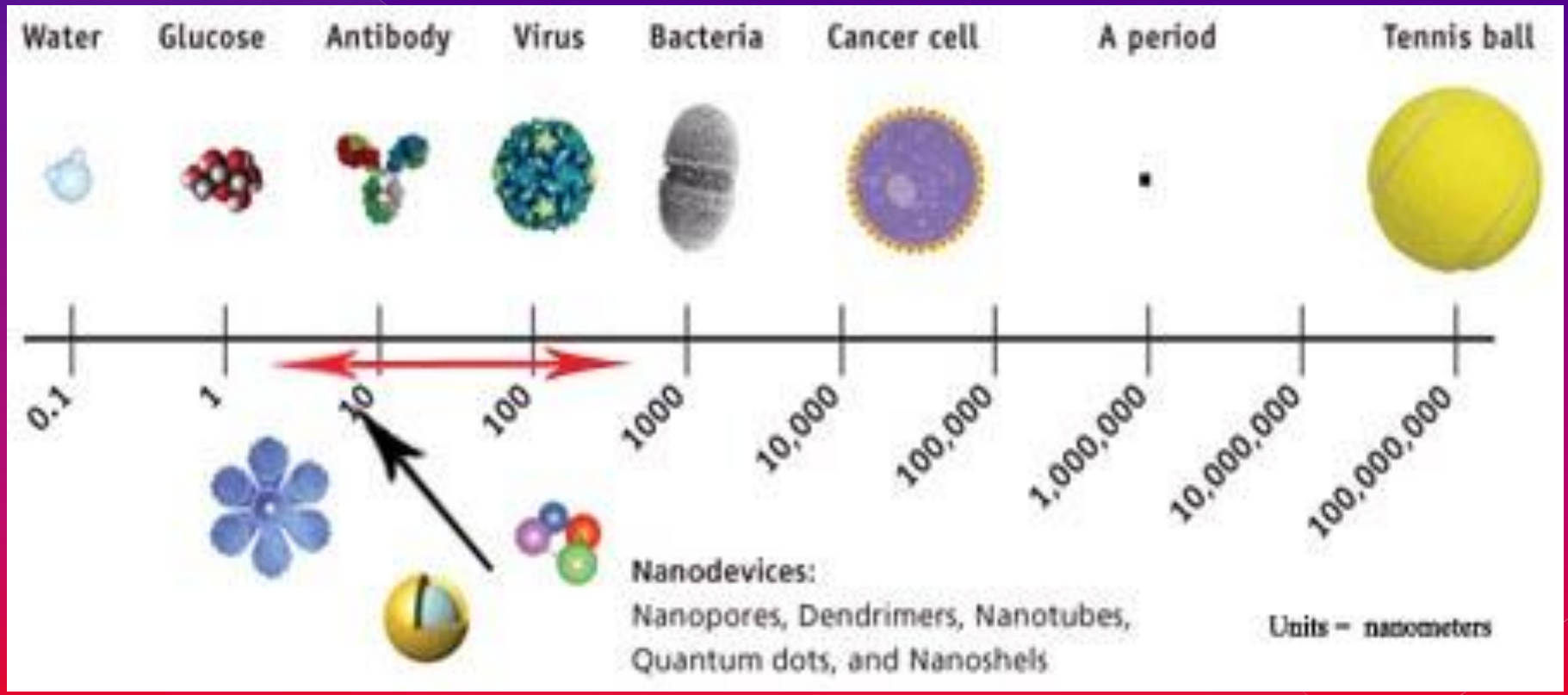
- **Nanotechnology** is the branch of science and engineering which deals with creation of materials, devices, and systems through the manipulation of individual atoms and molecules. The original definition is technology that is built from single atoms and which depends on individual atoms for function.

- The goal of nanotechnology is to control individual atoms and molecules to create computer chips and other devices that are thousands of times smaller than current technologies permit. Current manufacturing processes use lithography to imprint circuits on semiconductor materials.

What is Nanotechnology?

- The design, characterization, and application of structures, devices, and systems by controlled manipulation of size and shape of materials at the nanometer scale (atomic, molecular, and macromolecular scale) ,
- the study of the controlling of matter on an atomic and molecular scale. Generally nanotechnology deals with structures sized between 1 to 100 nanometer in at least one dimension, and involves developing or modifying materials or devices within that size.
- These nanoparticles have unique, and superior properties which have a great difference in chemical ,optical ,magnetic and electric properties from the bulk material ,the most important property is the ratio of surface area to volume which inversely proportional with the size of NPs (i.e.) the number of surface atoms or ions becomes a significant fraction of the total number of atoms or ions therefore they can be used these nanoparticles in various physical, biological, and biomedical applications.

How small is Nano - small?



Units in nanometers (μm)

What is nanomaterial?

- Is defined as any material that has unique, and superior properties which have a great difference in chemical ,optical ,magnetic and electric properties from the bulk material ,
- These are formed by incorporation or structuring of nanoparticles.
- They are subdivided into nanocrystals, nanopowders, and nanotubes. A sequence of nanoscale of C60 atoms arranged in a long thin cylindrical structure.
- Nanotubes are extremely strong mechanically and very pure conductors of electric current.
- Applications of the nanotube include resistors, capacitors, inductors, diodes and tran sistors.),.

Nanomaterials' Characteristics

Nanomaterials can have one, two or three dimensions in the nanoscale:

Category of nanomaterials	example
One-dimensional nanomaterials (one-dimension nanomaterials have one dimension that is outside the nanoscale).	layers, multi-layers, thin films, platelets and surface coatings. They have been developed and used for decades, particularly in the electronics industry.
Two-dimensional nanomaterials (Two-dimensional nanomaterials are materials in which two of the dimensions are not confined to the nanoscale)	nanowires, nanofibres made from a variety of elements other than carbon, nanotubes and, a subset of this group, carbon nanotubes.
Three-dimensional nanomaterials (Three-dimensional nanomaterials, also known as bulk nanomaterials, are relatively difficult to classify)	are known as nanoparticles and include precipitates, colloids and quantum dots (tiny particles of semiconductor materials), and Nanocrystalline materials

Approaches of Nanotechnology

- Bottom-up approaches seek to have smaller components built up into more complex assemblies, while top-down approaches seek to create nanoscale devices by using larger, externally controlled ones to direct their assembly.
- The top-down approach often uses the traditional workshop or microfabrication methods where externally controlled tools are used to cut, mill, and shape materials into the desired shape and order.

Nanoparticle synthesis techniques

Top-down processes:

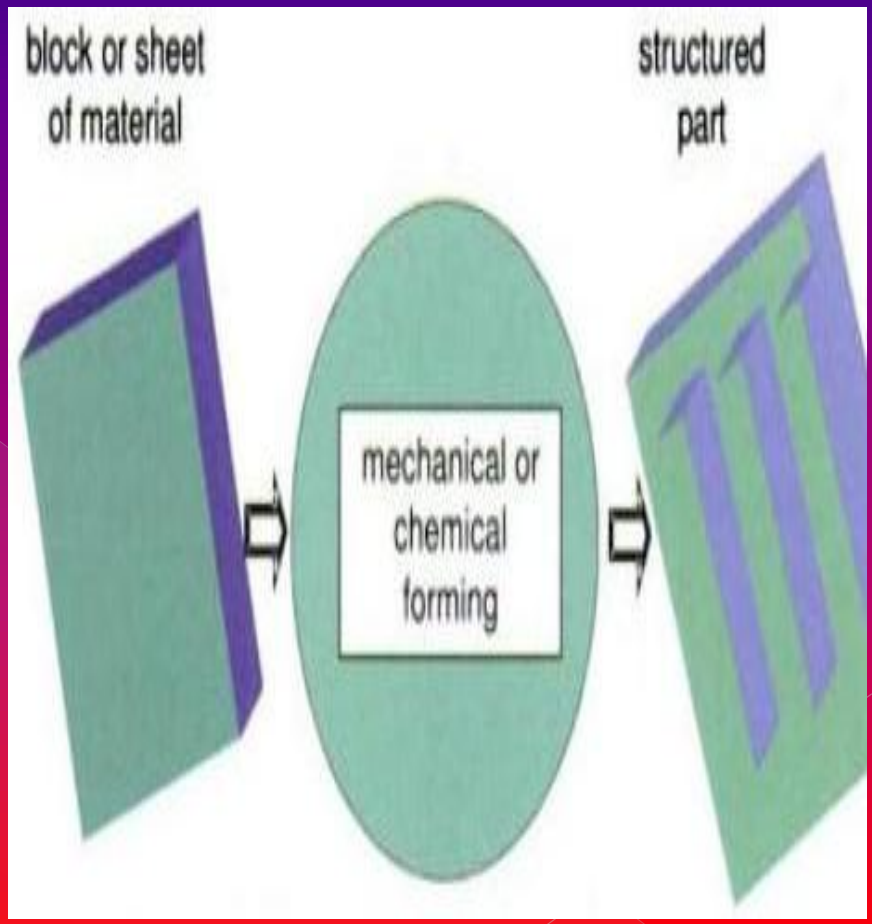
-In this method material is removed from the bulk material, leaving only the desired nanostructures

-Used to manufacture conventional products

-Newly developed techniques allow for much smaller sizes (close to 1μm)

-Processes include: Milling, Grinding, Electron beam machining ,laser ablation

-Examples of products: Traditional furniture, car chassis, etc.



Nanoparticle synthesis techniques

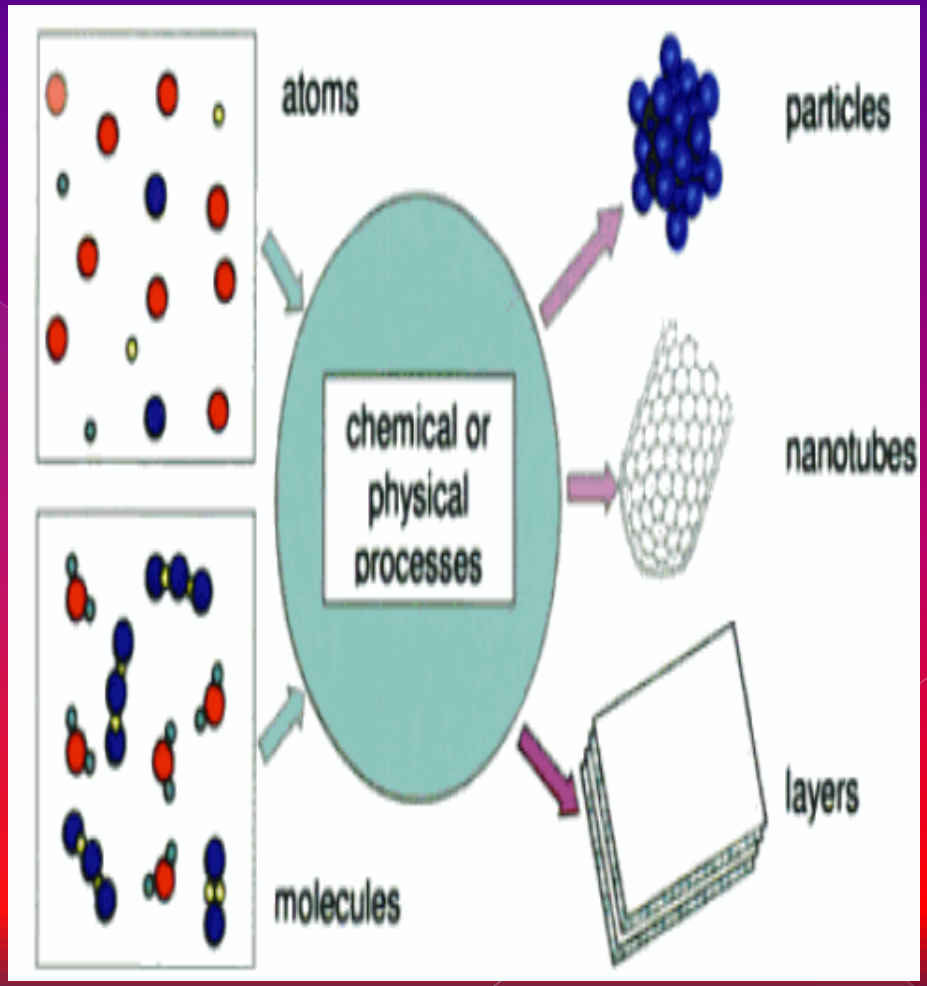
Bottom-up Process:

- In this method one where the atoms produced from reduction of ions, are assembled to generate nanostructures

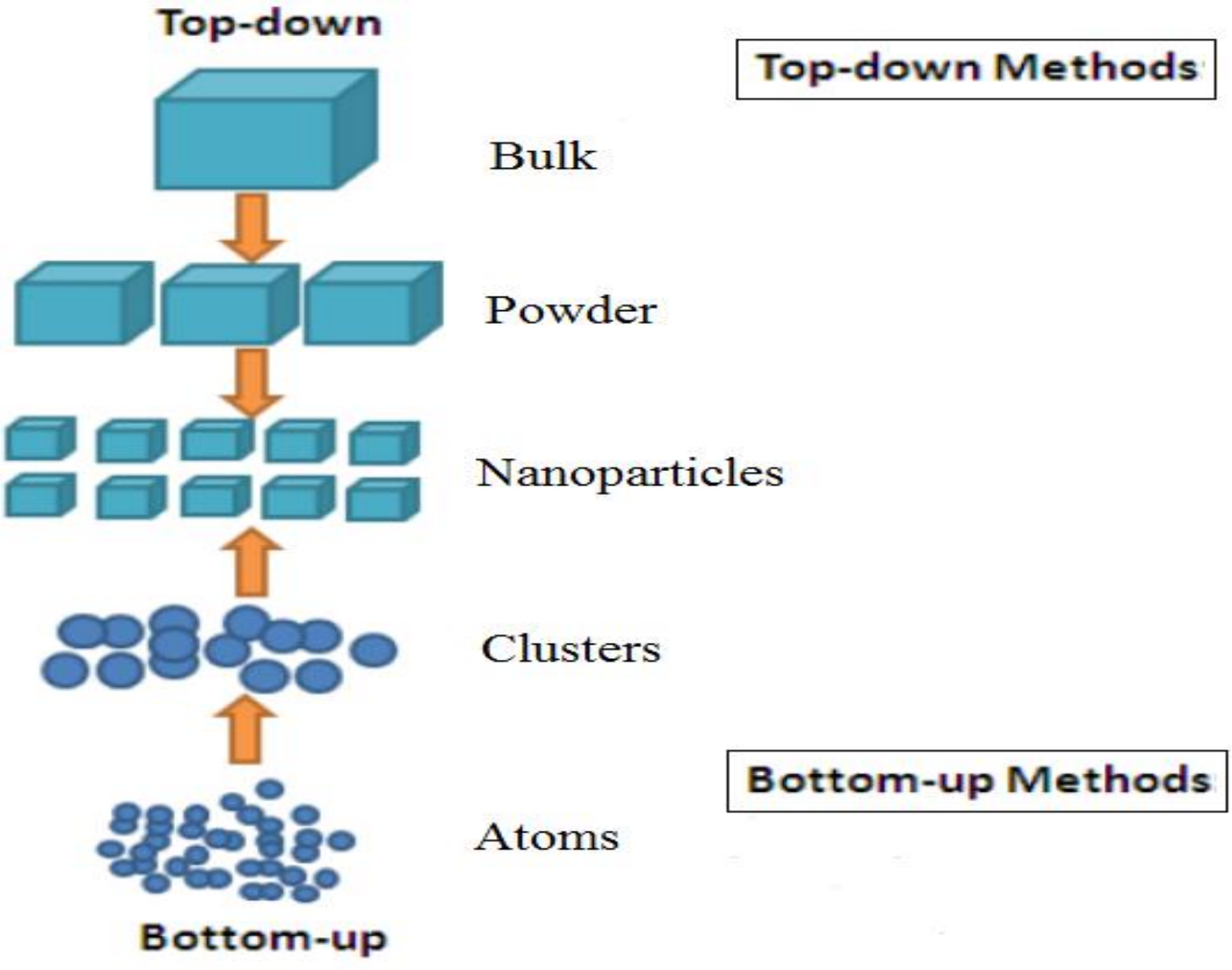
-Uses atoms and molecules as building blocks of structures

-Focus of Nano technological manufacturing processes

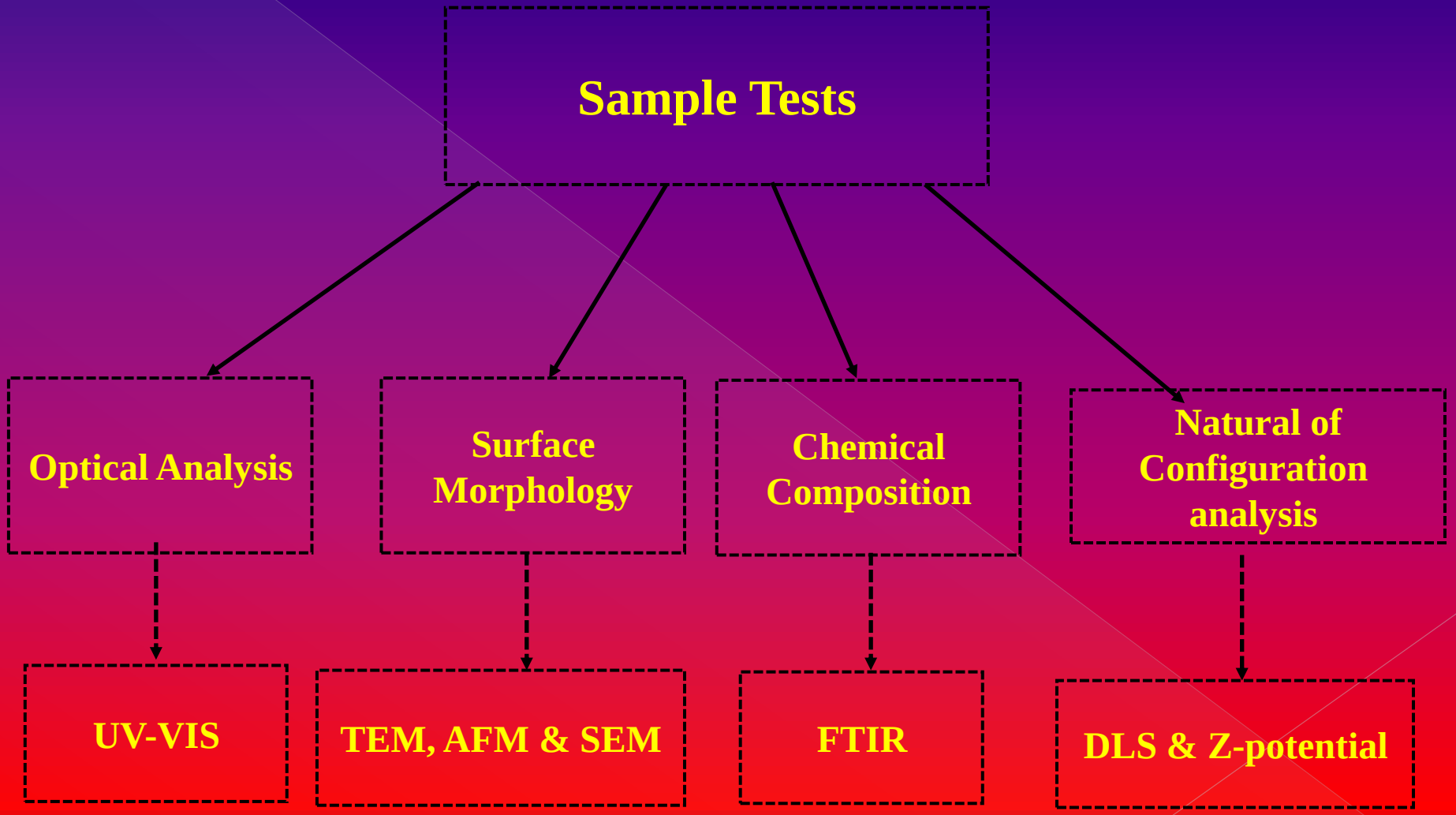
-Examples: Chemical synthesis processes



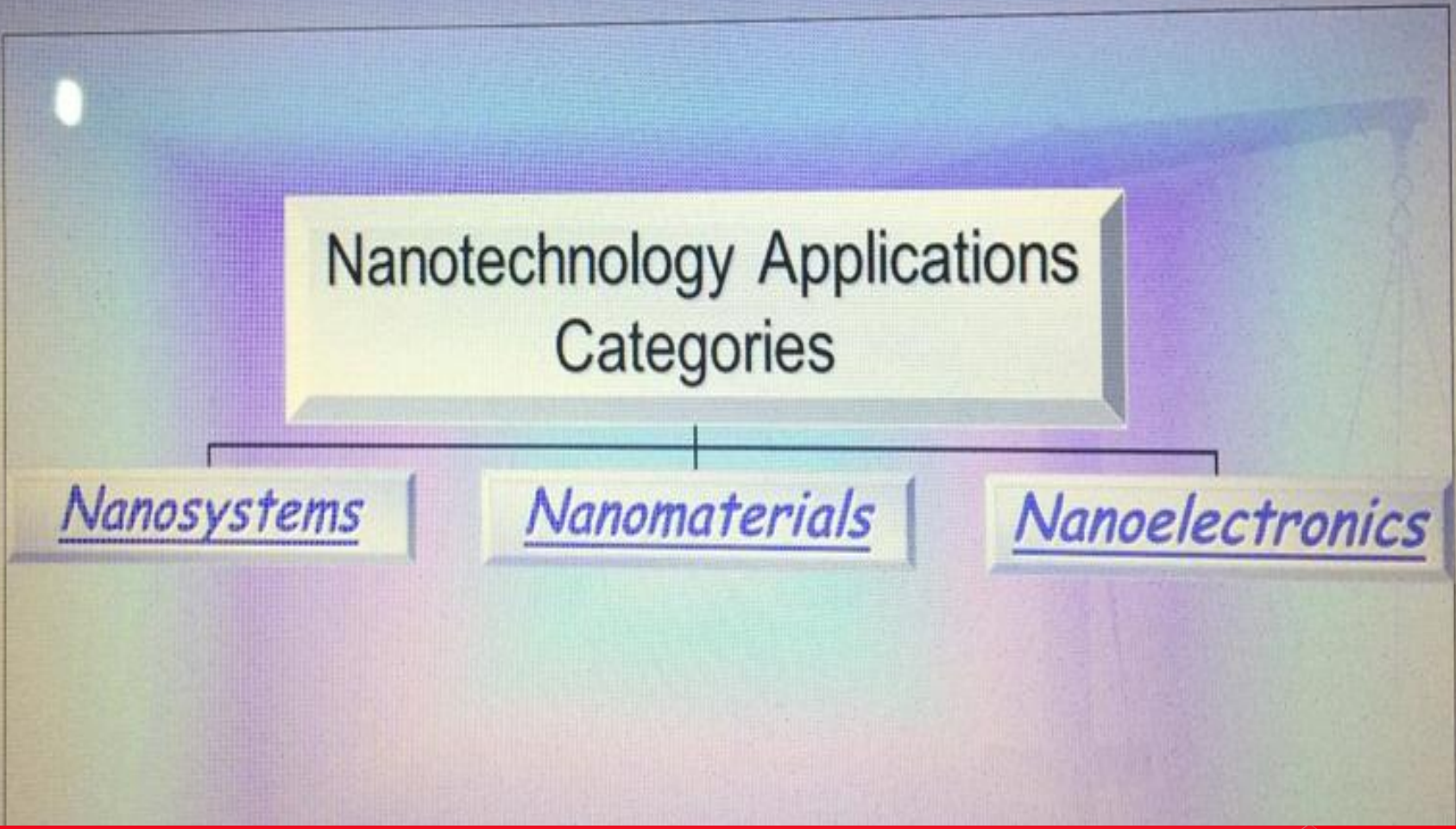
Bottom-up or top-down?



Types of Inspections of nanomaterials



Applications of Nanotechnology



Nanosystems

It is small systems can be seen as an extension of biotechnology. For example, to create a molecular motor about the size of a virus, scientists have combined genetically engineered proteins with other chemically structured components.

Nanomaterials

It is possible to create new kinds of materials by working at the nanolevel. One of the first nanomaterials was the "carbon nanotube", which conducts electricity better than copper yet is stronger and lighter than steel.

Nanoelectronics

Standard computer chips, which soon will have minimum feature sizes below 100 nanometers, will inevitably enter the realm of nanotechnology.

Applications of Nanotechnology: General Applications

Application	Examples
Medicine	Diagnostics, Drug delivery, Tissue engineering, Cryonics
Information and communication	Memory storage, Novel semiconductor devices, Novel optoelectronic devices, Displays, Quantum computers
Heavy Industry	Aerospace, Catalysis, Catalysis, Construction Vehicle manufacturers
Consumer goods	Foods, Household, Optics, Textiles, Cosmetics, Sports
Sensors	Pollutants sensors that able to detect lower limits with low cost

Future Applications

- 2011–15 -- nanobiomaterials, microprocessors, new catalysts, portable energy cells, solar cells, tissue/organ regeneration, smart implants
- 2016 and beyond – molecular circuitry, quantum computing, new materials, fast chemical analyses

THANK YOU