11.2.4 Early beginning and development (Not for examination)

2016
Jean-Pierre Sauvage, J. Fraser Stoddart, and Bernard Feringa won the Nobel Prize in Chemistry for their research in developing Nano-scale machines including a 'nanocar'

2004
2D material was isolated and characterized in 2004 by Andre Geim and Konstantin Novoselov at the University of Manchester. This work won the Nobel Prize in Physics in 2010.

1990's - 2000's
Research groups and commitees were formed to drive nano-related research. Consumer products making use of nanotechnology began appearing in the marketplace.

1981
Gerd Binning and Heinrich Rohrer developed the scanning tunnelling microscope (STM), that modern nanotechnology began. The STM allowed researchers to view atoms on the surface of materials for the first time ever, and since then nanotechnology began its gradual growth.

1989
Don Eigler and Erhard Schweizer at IBM's Almaden Research Center manipulated 35 individual xenon atoms to spell out the IBM logo. This demonstration of the ability to precisely manipulate atoms ushered in the applied use of nanotechnology.

1974
While working on the development of ultra-precision machines, Professor Norio Taniguchi coined the term nanotechnology.

1959
The ideas that define nanoscience and nanotechnology were mentioned long before the terms were coined, in a lecture by American physicist Richard Feynman "There's plenty of Room at the Bottom" in 1959. Feynman described processes that would allow scientists to manipulate and control individual atoms and molecules.

11. 2.5 Nano in laboratories

The nanostructures made in the laboratory mimic some of nature's amazing nanostructures. As the nanostructures are so small, specialized methods are needed to manufacture objects in this size range. There are two ways of preparing the nanomaterials, top down and bottom up approaches.

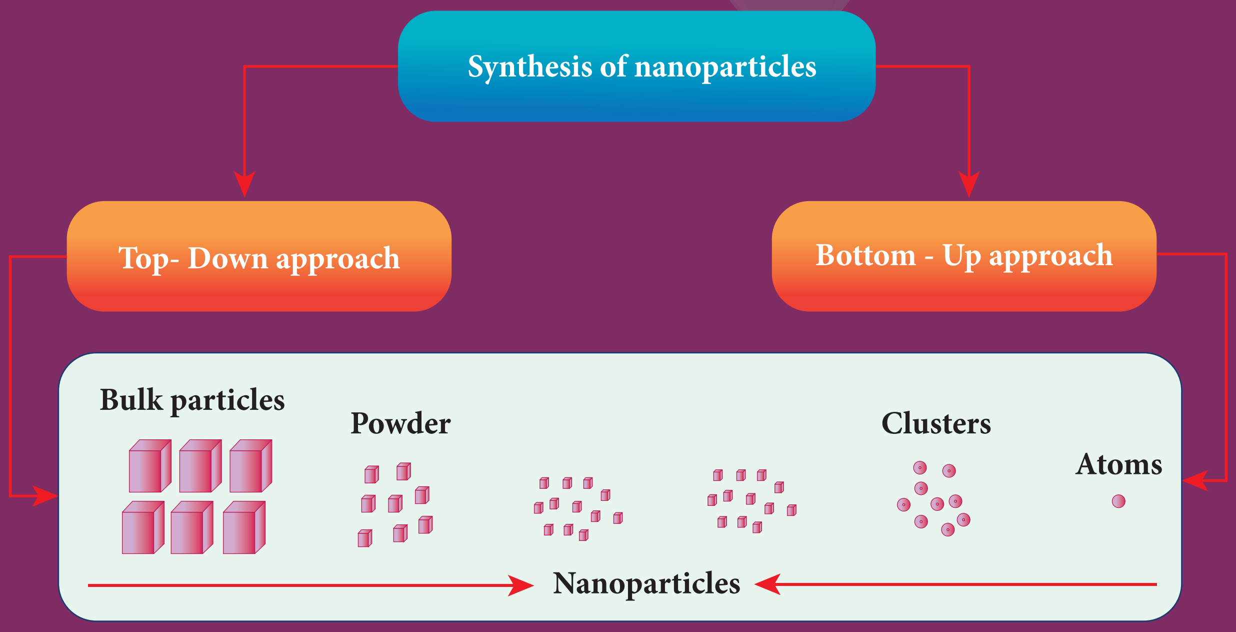
Synthesis of nanoparticles

Top Down Approach

Nanomaterials are synthesised by breaking down bulk solids into nano sizes. Example, Ball milling, sol-gel, lithography

Bottom Up Approach

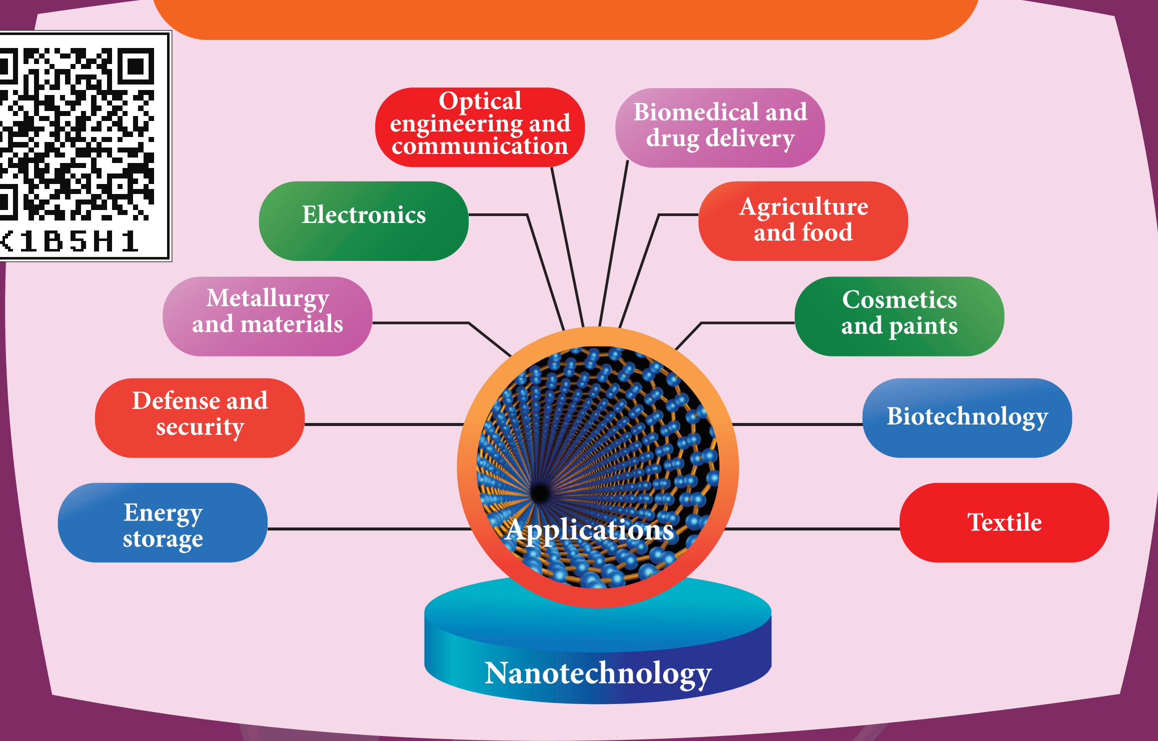
Nanomaterials are synthesised by assembling the atoms/molecules together. Selectively atoms are added to create structures. Example, plasma etching, and chemical vapour deposition



Due to the vast available methods the details are avoided at this level.

11.2.6 Applications of Nano technology

K1B5H1



Applications of nanomaterial based products in differernt areas

Automotive industry	Chemical industry	Engineering
• Lightweight construction • Painting (fillers, base coat, clear coat) • Catalysts • Tires (fillers) • Sensors • Coatings for wind-screen and car bodies	• Fillers for paint systems • Coating systems based on nanocomposites • Impregnation of papers • Switchable adhesives • Magnetic fluids	• Wear protection for tools and machines (anti blocking coatings, scratch resistant coatings on plastic parts, etc.) • Lubricant-free bearings
Electronic industry	**Construction**	**Medicine**
• Data memory • Displays • Laser diodes • Glass fibres • Optical switches • Filters (IR-blocking) • Conductive, antistatic coatings	• Construction materials • Thermal insulation • Flame retardants • Surface-functionalised building materials for wood, floors, stone, facades, tiles, roof tiles, etc. • Facade coatings • Groove mortar	• Drug delivery systems • Active agents • Contrast medium • Medical rapid tests • Prostheses and implants • Antimicrobial agents and coatings • Agents in cancer therapy

Textile/fabrics/ non-wovens	Energy	Cosmetics
• Surface-processed textiles • Smart clothes	• Fuel cells • Solar cells • Batteries • Capacitors	• Sun protection • Lipsticks • Skin creams • Tooth paste
Food and drinks	**Household**	**Sports/ outdoor**
• Package materials • Storage life sensors • Additives • Clarification of fruit juices	• Ceramic coatings for irons • Odors catalyst • Cleaner for glass, ceramic, floor, windows	• Ski wax • Antifogging of glasses/goggles • Antifouling coatings for ships/boats • Reinforced tennis rackets and balls

11.2.7 Possible harmful effects of nanoparticles

The research on the harmful impact of application of nanotechnology is also equally important and fast developing. The major concern here is that the nanoparticles have the dimensions same as that of the biological molecules such as proteins. They may easily get absorbed onto the surface of living organisms and they might enter the tissues and fluids of the body.

The adsorbing nature depends on the surface of the nanoparticle. Indeed, it is possible to deliver a drug directly to a specific cell in the body by designing the surface of a nanoparticle so that it adsorbs specifically onto the surface of the target cell.

The interaction with living systems is also affected by the dimensions of the nanoparticles. For instance, nanoparticles of a few nanometers size may reach well inside biomolecules, which is not possible for larger nanoparticles. Nanoparticles can also cross cell membranes. It is also possible for the inhaled nanoparticles to reach the blood, to reach other sites such as the liver, heart or blood cells.

Researchers are trying to understand the response of living organisms to the presence of nanoparticles of varying size, shape, chemical composition and surface characteristics.

DISEASES ASSOCIATED TO NANOPARTICLE EXPOSURE
(Not for examination)