Introduction to Nanobiotechnology:

Nano -Bio –Technology, Technology used at nanoscale to address the bio-applications

What is Nanotechnology?

Nanotechnology is the understanding and control of matter at dimensions of roughly 1 to 100 nanometers, where unique phenomena enable novel applications.

- Atoms
- Molecules
- Nanoparticles
- Microparticles
- Macroparticles/bulk

(Nano) From the Greek word (dwarf), and means 10^{-9}, or one-billionth of a meter.

1 nm = 1/1000 μm = 1/1000000 mm= 1/1000000000 m.

Nanotechnology is Field of science whose theme is the control and manipulation of matter on an atomic and molecular scale to create novel structures, devices and systems.

It's about creating and using these devices and systems that have novel and better properties and functions because of their small sizes.

What is a nanomaterial?

A nanomaterial is an object that has at least one dimension in the nanometre scale (approximately 1 to 100 nm).

Nanomaterials are categorised according to their dimensions.

Nanomaterials can be of two types:

non-intentionally-made nanomaterials', which refers to nano-sized particles or materials that belong naturally to the environment (e.g. proteins, viruses, nanoparticles produced during volcanic eruptions, etc.) or that are produced by human activity without intention (e.g. nano-particles produced from diesel combustion);

intentionally-made' nanomaterials, which refers to nanomaterials produced deliberately through a defined fabrication process.

Nanotechnology

The American physicist and Nobel Prize laureate Richard Feynman introduce the concept of nanotechnology in 1959. During the annual meeting of the American Physical Society, Feynman presented a lecture entitled "There's Plenty of Room at the Bottom" at the California Institute of Technology (Caltech). In this lecture, Feynman made the hypothesis "Why can't we write the entire 24 volumes of the Encyclopedia Britannica on the head of a pin?", and described a vision of using machines to construct smaller machines and down to the molecular level. This new idea demonstrated that Feynman's hypotheses have been proven correct, and for these reasons, he is considered the father of modern nanotechnology. After fifteen years, Norio Taniguchi, a Japanese scientist was the first to use and define the term "nanotechnology" in 1974 as: "nanotechnology mainly consists of the processing of separation, consolidation, and deformation of materials by one atom or one molecule".

K. Eric Drexler – 1981 Development of the ability to design protein molecules will open a path to the fabrication of devices to complex atomic specifications.

Biotechnology

At its simplest, biotechnology is technology based on biology - biotechnology harnesses cellular and biomolecular processes to develop technologies and products that help improve our lives and the health of our planet. We have used the biological processes of microorganisms for more than 6,000 years to make useful food products, such as bread and cheese, and to preserve dairy products.

Nanostructures

Objects with nanometer scale features—are not new and they were not first created by man. Individual nanostructures involve: clusters, nanoparticles, nanocrystals, quantum dots, nanowires, nanotubes The chemical and physical properties of nano materials can significantly differ from those of the atomic-molecular or the bulk materials of the same chemical composition.

In general, most agree that three things are important:

1. Small size, measured in 100s of nanometers or less
2. Unique properties because of the small size
3. Control the structure and composition on the nm scale in order to control the properties

Nanobiotechnology

Is defined as the applications of techniques of Nanotechnology for the development and improvement of biotechnological process and products. Nanobiotechnology is the interface of nanotechnology and biotechnology and it includes the application of nanotechnology in the life sciences. or

Nanotechnologies are defined thus:

‘Nanotechnologies are the design, characterisation, production and application of structures, devices and systems by controlling shape and size at the nanometre scale.

Natural Nanomaterials

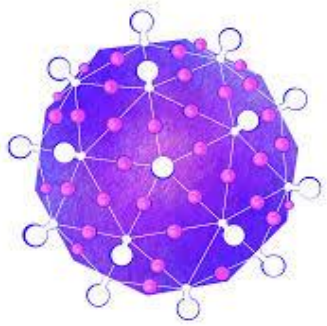
Nanoscale materials are found in nature. Naturally occurring nanomaterials exist all around us, such as in smoke from fire, volcanic ash, and sea spray, etc.

Hemoglobin, the oxygen-transporting protein found in red blood cells, is 5.5 nanometers in diameter.

The structure viruses (capsid), the wax crystals covering a lotus leaf, spider-mite silk, the "spatulae" on the bottom of gecko feet, some butterfly wing scales, and even our own bone matrix are all natural organic nanomaterials.

Gecko feet

Lotus leaf



Viral capsid

Studies of adhesive force under both hydrophobic and hydrophilic conditions indicate the gecko's ability to stick to and climb smooth surfaces is due to (relatively weak) van der Waals intermolecular interactions. (Van der Waals forces are weak intermolecular forces that are dependent on the distance between atoms or molecules. These forces arise from the interactions between uncharged atoms/molecules.)

Terms in Nanotechnology

Nanoparticle: particle with two or more dimensions at the nanoscale.

Nanoscale: having one or more dimensions of the order of 100 nm or less.

A bulk material: material should have constant physical properties regardless of its size.

Nanoscience - refers to the world as it works on the atomic or molecular scale, from one to several hundred nanometers, its pertain to the synthesis, characterization, and utilization of nanostructured materials in the nanometer range.

Nanobiotechnology-the branch of engineering that deals with things smaller than 100

Nanometers.

Green nanotechnology: It refers to the use of the products of nanotechnology to enhance sustainability.

Agglomerate: Collection of weakly bound particles or mixtures where the resulting external surface area is similar to the sum of the surface areas of the individual components. The forces are weak forces, for example van der Waals forces.

Aggregate: Particle comprising strongly bonded where the resulting external surface area may be significantly smaller than the sum of calculated surface areas of the individual components. The forces are strong forces, for example covalent bonds.