NANOTECHNOLOGY

	• Nanotechnology is the **manipulation of matter** on an atomic, molecular, and supra-molecular scale. • It has the **potential to reduce costs** with its multiple applications and the inherent ability to **produce new materials** like non-corroding and flexible iron. **Nanotechnology has two different but important meanings.** • **One-** includes any technology dealing with something **less than 100 nanometres** in size. • The **other-** designing and building machines in which every atom and chemical bond is **specified precisely**. • One nanometre is **one billionth** of a metre. • The most important aspect of nanotechnology-enabled products is the **miniaturization of devices** and the diverse functionalities that can be integrated within a singular system.
India's Nano Mission	• The **Department of Science and Technology** is the nodal agency for implementing the Nano Mission. • **Capacity-building** will be of utmost importance for the Nano Mission so that India emerges as a global knowledge-hub in this field. • Equally importantly, the **development of products and processes, especially** in the areas of national relevance like safe drinking water, materials development, sensors development, drug delivery, etc. • The Nano Mission has been structured in a fashion so as to achieve **synergy between the national research efforts** of various agencies and **launch new programmes** in a concerted fashion. • **International collaborative research** efforts will also be made wherever required.

Applications

- **Nanotechnology in medications:** Nanotechnology provide **new options for drug delivery and drug therapies.** It enables drugs to be delivered to precisely the right location in the body and release drug doses on a predetermined schedule for optimal treatment.
- **Nano dentistry** will assist in the maintenance of complete oral health by employing nanomaterials, biotechnology, including tissue engineering, and dental nanorobotics.
- **Nanotechnology in Fabrics:** The properties of familiar materials can be changed by adding nano-sized components to conventional materials to **increase performance**.
- **Nanotechnology in Mobile technology**: **Morph**, a nanotechnology notion device is able to charge itself from available light sources using photovoltaic nanowire grass covering its surface.
- **Nanotechnology in Electronics field:** It enabled the further miniaturization of logic and memory devices. Organic molecules have been used to hasten the development of quantum computers and nanodevices that have extraordinary computational speed. Electrodes made from nanowires allow flat panel displays to be flexible as well as thinner than current flat panel displays.
- **Nanotechnology in computers**: Nano-computers would undertake the important task of activating, controlling, and deactivating nano mechanical devices. Such technology has massive medical and dental inferences.
- **Nanotechnology in food and agriculture safety:** to improve the quality of food.
- **Nanotech in defence sector:** Nanotechnology holds highly promising prospects for military applications, considering its wide applicability in defensive as well as offensive operations.
- **Electronics/Computers/Sensors:** The use of NT applications will drastically reduce the cost and increase the performance of memory, displays, processors, solar powered components, and embedded intelligence systems. In sensor manufacturing, NT has larger utility because it allows the production of smaller sensors down to the size of micrometres.
- **Bio-Defence:** Currently, NT is primarily being used in the development of bio-sensors. Some countries are working on extremely small machines and tools that can enter the human body. Drug and virus development costs can be reduced by using nanochips to test various medications or a combination of chemicals and vaccines.
- **Chemical defence:** NT offers solutions against the usage of chemical agents like VX, HD, GD, and GB. Some nanoparticle oxides like CaO, Al2O3, and MgO interact with such chemicals much faster than microparticles and are ideally suited for fast decomposition of such chemicals.
- **Conventional Weapons/Ammunition:** NT-based stronger and lighter materials

	would allow the building of conventional barrel-type weapons with reduced mass. The reduced mass could translate into a marked increase in speed, range, or payload and reduction in carrier size.
	• **Maritime applications:** Experts are of the view that nanoparticles can be used to mark ships, fishing boats, navigable channels, and delimiting safe havens.
	• **Aerospace and other defence applications:** Less vulnerable corrosive material is helpful in satellite manufacturing as well.
	• **Space applications of Nanotech-** Nanomaterials are potential candidates for
	  ○ enhancing **ignitors'** life and performance characteristics.
	  ○ alternative materials to conventional **solar panels/cells**.
	  ○ special lightweight suits, jackets etc.
	  ○ obtaining information on the ionosphere and other regions of space.

Nano tech in India's Space and Defence Sector	• Government of India initiated a Nanomaterials Science and Technology Mission (NSTM). • In the defence arena, **DRDO** is working on areas like sensors, high-energy applications, stealth and camouflage, Nuclear, Biological, and Chemical (NBC) attack protection devices, structural applications, nanoelectronics, and characterization. • **ISRO** also launched Nanosatellites, marking a milestone in space research and developments.
Concerns	• May harm human health or the environment • Change the regional/global 'military balance', thereby increasing threat and reduce stability. • Non-state actors could also develop or otherwise acquire military-related NTs. • May or may not come under existing export control regulations. • Violation of laws designed under Chemical Weapons Convention (CWC) likely to take place. • More nanotech designed satellite launches and may lead to further increase in space traffic and debris.
Way Forward	• To prevent or at least reduce such risks and instability, limitations can be agreed upon in advance before new weapons or technology are deployed, acting mainly at the stages of development and/or testing, and sometimes at the research stage.

BIOTECHNOLOGY

	• Biotechnology deals with techniques of using **live organisms or enzymes** from organisms to **produce products and processes** useful to humans. • However, it is used in a restricted sense today, to refer to such of those processes which use **genetically modified organisms** to achieve the same on a larger scale. • The **process of altering the chemistry of DNA** and construct recombinant DNA is called recombinant DNA technology or **genetic engineering**.
Genetic Engineering	• Genetic engineering involves techniques to **alter the chemistry of genetic material (**DNA and RNA) and thus change the phenotype of the host organism. • Asexual reproduction preserves the genetic information, while sexual reproduction permits variation. • There are **three basic steps** in genetically modifying an organism — ○ identification of DNA with desirable genes; ○ introduction of the identified DNA into the host; ○ maintenance of introduced DNA in the host and transfer of the DNA to its progeny.
Recombinant DNA (rDNA)	• Recombinant DNA (rDNA) molecules are DNA molecules formed by laboratory methods of genetic recombination to bring together genetic material from multiple sources, creating sequences that would not otherwise be found in the genome. • The cutting of DNA at specific locations became possible with the discovery of the so-called **'molecular scissors'**. • Recombinant DNA is used to produce ○ Recombinant human insulin, ○ Recombinant human growth hormone, ○ Recombinant blood clotting factor VIII, ○ Recombinant hepatitis B vaccine, ○ Insect-resistant crops etc.
Applications	1. **Agriculture**: Plants, bacteria, fungi and animals whose genes have been altered by manipulation are called Genetically Modified Organisms (GMO). Genetic modification has: • made **crops more tolerant** to abiotic stresses (cold, drought, salt, heat). • **reduced reliance** on chemical pesticides (pest-resistant crops).