
Nuclear

Nuclear Fuel

Fission

- **Fertile material** - isotopes that are non-fissionable by neutrons, but can be converted into fissile isotopes.
- **Fissile material** - fissionable isotopes that are capable of undergoing nuclear fission.
- **NUCLEAR ENRICHMENT** - increasing the concentration of one isotope relative to another is called "enrichment."
- **Transmutation**: changing one element to other through nuclear reactions/decay;

Fusion

- Hydrogen
- Deuterium-Tritium:

3 Stage nuclear program of India

Nuclear Fusion

- combining of several small nuclei into one large nucleus - One atom of deuterium and one atom of tritium combine to form a helium-4 atom and a neutron; Plasma - state of matter where fusion reaction takes place;
- **Advantages**: Efficiency, Carbon, Safety, Radioactive waste, Proliferation;

Types

- Natural
- Artificial
 - Magnetic confinement
 - Inertial confinement

Experimental reactors

- **ITER** (INTERNATIONAL THERMONUCLEAR EXPERIMENTAL REACTOR)
 - ITER is a fusion reactor. It is located in Saint-Paul-les-Durance in southern France. It is joint collaboration of 35 countries.
- **EAST** - Experimental Advanced Superconducting Tokamak(CHINA);
- **NIF**: Lawrence Livermore National Laboratory, California:
- **ITER-India** is a special project under Institute for Plasma Research, Gandhinagar

Governance structure

Department Of Atomic Energy

- It is apex body under the direct charge of Prime Minister.

Atomic Energy Commission

- It is the governing body of the Department of Atomic Energy.

Atomic Energy Regulatory Board (AERB)

- Regulatory authority responsible for safe operations of nuclear reactors as well as regulation at all other nuclear facilities in India.

Public Sector Institutions

- **NPCIL:** Nuclear Power Corporation of India (NPCIL), Mumbai, Maharashtra (PSE for generation of electricity from nuclear power)
- **BHAVINI:** Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI), Kalpakkam, Tamil Nadu (Operating Stage II FBR at Kalpakkam)

International Atomic Energy Agency (Iaea)

- It is the international centre responsible for cooperation in the peaceful uses of nuclear energy under Nuclear Non-proliferation Treaty.

Miscellaneous topics

Xenotransplantation:

HLA factor, HLA genes;

- **Autogenic:** cells from same body
- **Allogenic:** Another body but same species
- **Xenogenic:** Cells from other species; Gene editing in pigs to reduce immune rejection

Synthetic biology

- **Xenobots:** synthetic lifeforms - combine different lifeforms;
- **Gelbots:** Gelatin, move without extra power source - gel swells or shrinks in response to temperature,

Cosmic microwave background radiation:

Nanotechnology

- Property of matter depends on size at which they are grouped; 1 nm = 10 hydrogen atoms together; 1 virus = 100 nm; Carbon nanotube;
- **Applications** - Biosensors, Optical tweezers, Textile - hydrophobic silicon nanofilaments, silver nano particles, drug delivery, tissue engineering,
- **Quantum dots** - box to trap electrons - QLED TV;

Superconductors

- Conductivity between conductors and insulators; E.g. Silicon, germanium,
- Band gap theory - Valence band, conduction band; diamagnetism; copper pair; Meissner effect;
- Doping - N type and P Type;

Immersive Technologies

- **Virtual reality** - simulator based, avatar image based, head mounted display,
- **Augmented reality:** Blend of real with virtual -
- **Mixed reality** - merging of real and virtual world;
- **Metaverse:** hypothetical iteration of the Internet as a single, universal, and immersive virtual world; facilitated by virtual reality (VR) and augmented reality (AR);