

**Springboard**  
**ACADEMY**

**AN INSTITUTE FOR IAS & RAS**

**RAS PRELIMS**

**2024 - 2025**

**SCIENCE  
&  
TECHNOLOGY**



**PRELIMS EXAM**

**SHIVENDRA  
SIR**

## SYLLABUS

- ☑ COMPUTERS, INFORMATION AND COMMUNICATION TECHNOLOGY.
- ☑ DEFENCE TECHNOLOGY.
- ☑ SPACE TECHNOLOGY AND SATELLITES.
- ☑ NANO TECHNOLOGY.
- ☑ BIO-TECHNOLOGY.
- ☑ ADVANCED TECHNOLOGY.

## INDEX

Sr.NO.	CHAPTER NAME	PAGE NO.
1.	NANO TECHNOLOGY	1-8
2.	SPACE TECHNOLOGY	9-39
3.	DEFENCE TECHNOLOGY	40-63
4.	TELE-COMMUNICATION TECHNOLOGY	64-70
5.	INFORMATION TECHNOLOGY	71-80
6.	BIO-TECHNOLOGY	81-91
7.	ADVANCED TECHNOLOGY	92-100

# NANO TECHNOLOGY

- Nano is a Greek term which means Dwarf
- Technically Nano refers to  $10^{-9}$
- Nano scale : 1-100 nm ( $10^{-9}$  m –  $10^{-7}$  m).

## ☑ Nano Technology -

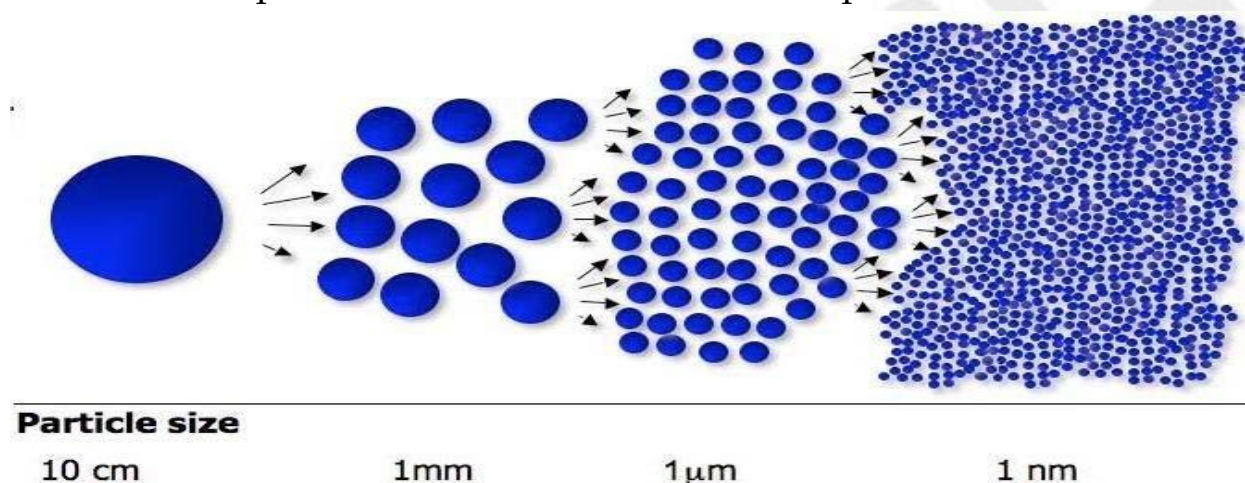
- That stream of technology in which matter is studied at Nano scale & various applications are developed by changing its structure at atomic/molecular level.
- Nano technology term was given by Japanese scientist Norio Taniguchi in 1974 AD.
- Father of Nano technology – Richard Feynman

## ☑ Types of approaches in Nano Technology

TOP TO BOTTOM	BOTTOM TO TOP
In this approach an ordinary material is broken down until the Nano scale is achieved.	In this approach free atoms are consolidated in specific configuration to achieve Nano scale structure.
This technique is relatively easy/simple	This technique is relatively complex
Less effective	More effective
Pioneer scientist – Norio Taniguchi	Pioneer scientist – Eric Drexler
Example – Nano practical, Nano powder	Example – Nano Robots, CNT

## Important facts

- At Nano scale whole new characteristics (Electrical/mechanical/ optical properties) of matter are encountered due to drastic increment in surface area to volume ratio.
- At nano scale laws of classical physics become insignificant and quantum laws come into effect.
- At nano scale structure defines the properties of matter. Thus by changing the structure, specific characteristics can be developed in the material.



☑ **Nano Assemblers** – Which can separate or Consolidate atoms at Nano Scale.

☑ **Nano Informatics** –

- Nano informatics is a branch of Computational Nano technology which generates, stores and disseminates large amount of data.

☑ In 1959 – American scientist Richard Feynman gave a lecture -

**“There is a plenty of room at the bottom”**

In this Feynman described that how science can be given a new dimension by the process of manipulating individual atoms/molecules.



☑ In 1981 AD-

- Scanning tunneling microscope (1981) & Atomic force microscope (1982) were developed, enabling to image matter at atomic/molecular level.
- IBM scientist bagged 1986 Nobel in physics for it.

☑ 1986 AD – Eric Drexler at MIT wrote a book “Engines of Creation”.

- It popularized Molecular Nano technology worldwide.

☑ **Nano Urea –**

- Developed by IFFCO
- World’s first Nano urea liquid
- High efficiency (80%) and minimal environmental effect



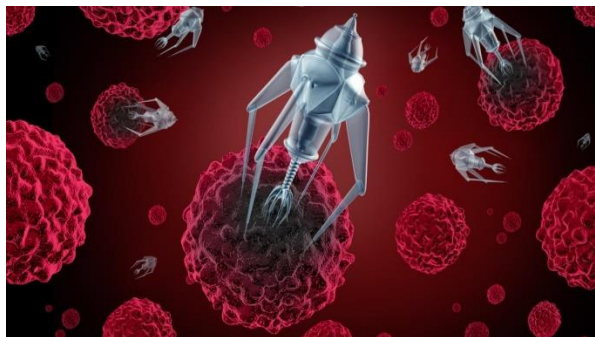
☑ **NanoSniffer** - Developed by NanoSniff Technologies. It can detect even nano gram quantities of all type of explosives in less than 10 seconds. (Based on Micro-Electromechanical System-MEMS)

☑ **Intelligent medicine (smart drugs) -**

- These will act only on malfunctioning tissues/cells. Therefore side effects of drugs will be minimized & Effectiveness will increase. (Targeted drug delivery)
- Cordy gold Nanopartical development by Indian Scientist.

☑ **Bio – NEMS (Nano electro mechanical Systems)** - These are special type Nano bots & robots which can be inserted in body without operation & they will treat the desired tissue/cell.

- ☑ **Cancer Therapy** - Quantum dots will identify the cancer cells & then Nano robots will destroy them precisely.



☑ **Cordy gold Nanoparticles**

- Developed by Indian scientists.
- These nanoparticles, are obtained from Cordyceps militaris (fungus) and gold salts.
- It could make drug delivery in the human body faster and surer.
- Got international patent from Germany.

- ☑ **Hemostat** - Developed by Institute of Nano Science & Technology, Mohali (Punjab). These are Nano particles which will help in forming blood clot in case of hemophilia disease or brain hemorrhage.

- ☑ **Graphene, CNT** are being used in development of Flexible, bendable, foldable electronics.

- ☑ **Nano Bulb** - Developed by CSIR scientists which is more efficient than LEDs

- ☑ **Paper/Nano towel** - nano fabric made up of nano wires of potassium manganese oxide, can absorb 20 times its weight in oil, used in oil spillage.

- ☑ **Gray goo** - Self-replicating ability of nano bots can be dangerous. (Xenobots - world's first living robots that can replicate itself)

- ☑ **Nano Litterbugs** - Those nano particles which are non-degradable. These will cause environment pollution.

## Nano Mission of India

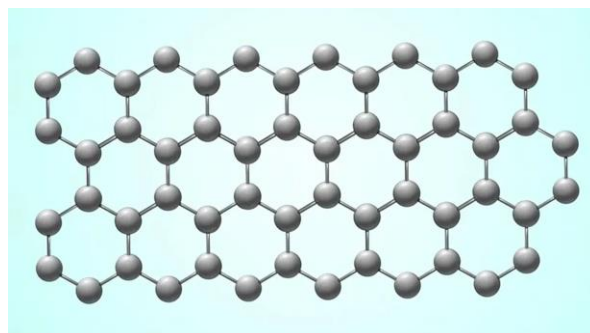
- In 2007 Nano science & technology mission (NSTM) was started by Department of science and technology.
- Nano mission council was constituted for Implementation of this mission.
- Chairperson of Nano Mission Council : Bharat Ratna Professor C.N.R. Rao (Father of nanotechnology in India)
- NSTM was started in two phases –
  - Phase I<sup>st</sup>                - 2007-12
  - Phase II<sup>nd</sup>             - 2012 afterwards
- A Budget of 1000 cr. & 650 cr. was allotted for NSTM.
- 64 mission mode projects were started.
- Under NSTM 19 Center of excellence are established across India. (For Nano science & Nano technology) Some of them are – IIT Bombay, Madras, Delhi, Kanpur, BHU, IISc, and TIFR.
- **Objectives of NSTM -**
  1. Development of infrastructure (Excellence centers, Labs, equipment's)
  2. Provide financial assistance to the institutions working in field of NST and promote private sector & PPP in NST field.
  3. Promote R&D in NST field.
  4. Skill development and training of human resource in NST field.
  5. Promote Academy Industry partnership for the development of applications in NST field.
  6. Establish international cooperation in NST field.



## Some important Nano materials

### 1. Graphene -

- Crystalline allotrope of carbon
- Structure : Hexagonal ring (2D)
- High strength & flexible
- Colour : almost transparent
- Use - In solar cells, In micro electronics, in foldable displays, In Kevlar
- UK Scientist won 2010 Nobel Prize in Physics for graphene.

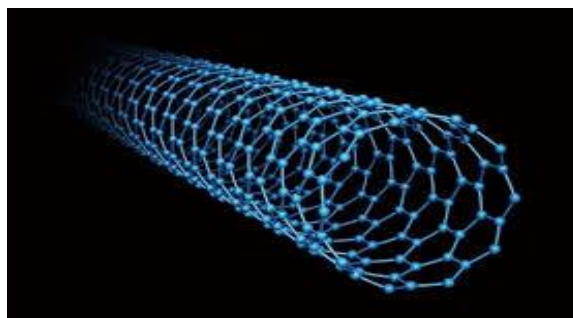
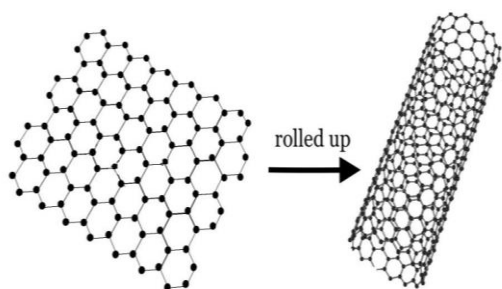


### 2. Carbon nanotube -

- It is a single walled cylindrical structure made of carbon's crystalline allotrope graphene with a diameter of nanometer scale.
- It has property of high strength with high resilience, Conductor.
- It has very high length to diameter ratio 132000000 : 1
- Uses -Tennis rackets, Foldable Screens, Nano electronics, Anti-seismic Buildings, Polymers.
- In 1991 AD Japanese Scientist Sumio Iijima developed Carbon Nanotube.

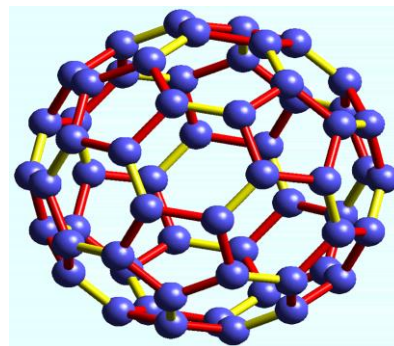
Graphene Sheet

Carbon Nanotube



### 3. Buckminster fullerene -

- Most common form of carbon's Crystalline allotrope fullerene (C<sub>60</sub>-70)
- Discovered by Scientist at Rice University in 1985 they bagged 1996 Nobel in Chemistry for it.
- Structure : Pentagonal or hexagon hollow spherical (football alike-bucky balls)
- Hard substance
- Use - In super conductivity, In purification of natural gases, In manufacturing light weight batteries .



### 4. Quantum Dots -

- When size of semiconductor material particles is reduced to nano scale then special optical & electronics properties appear.
- These nano sized particles are called quantum dots.
- 2023 Nobel Prize in Chemistry was awarded to Maung G. Bawendi, Louis E. Brus & Aleksey for quantum dots.
- The first artificial synthesis of quantum dots was done by scientists at MIT in 1993.
- Use - Solar cell, cancer therapy.

### 5. Carbon Quantum Dots -

- Carbon-based nanomaterials
- Remarkable optical properties, inexpensive, highly biocompatible, environment-friendly.
- Use - Drug delivery, detecting cancer cells, Aquatic pollutant detection.

## Generations of Nano technology

Nano tech product generation			Examples उदाहरण
1 <sup>st</sup>	2000	Passive Nano-structures निष्क्रिय नैनो संरचना	Nano particles, Nano composites, Nano coating, Nano polymers
2 <sup>nd</sup>	2005	Active Nano-structures सक्रिय नैनो संरचना	Nano sensors, Nano drugs/medicines, 3D transistors
3 <sup>rd</sup>	2010	Systems of Nano-systems सिस्टम्स ऑफ नैनो सिस्टम्स	Nano robots, 3D networking
4 <sup>th</sup>	2015	Molecular Nano-systems आण्विक नैनो-सिस्टम	Atomic designs, molecular devices

## SPACE TECHNOLOGY

### ☑ Brief History -

#### • At International Level -

1. October 1957 AD Sputnik 1 satellite was launched by USSR. It was the first manmade satellite launched in space.
2. November 1957 AD Sputnik 2 satellite was launched by USSR. A dog named Lyka was sent to space in it.
3. September, 1959 AD - Luna-2 was the first Lander to level on the Moon.(USSR)
4. April 1961 AD Yuri Gagarin of USSR was the first human to go into space. (By Vostok-1).
5. 1963 AD Valentina Tereshkova of USSR was the first woman to go into space. (By Vostok-6).
6. October 1958 AD NASA (National Aeronautics & Space Administration) was founded by USA.
7. 1961 AD Apollo programme was started by NASA. Under this in 1969 AD Apollo-11, Buzz Aldrin and Neil Armstrong were sent to moon. Neil Armstrong became the first ever human to step on moon.
8. 1970 AD Lunokhod-1 was the first robotics Lunas rover landed on the Moon by (USSR)  
(Under Lunokhod programme by Luna 17 Spacecraft.)

#### • At India Level -

1. 1962 AD INCOSPAR (Indian National Committee for Space Research) was constituted. It was headed by Dr. Vikram Sarabhai who is also known as the father of space research in India.
2. 1962 AD Thumba Equatorial Rocket Launching Station (TERLS) was established.

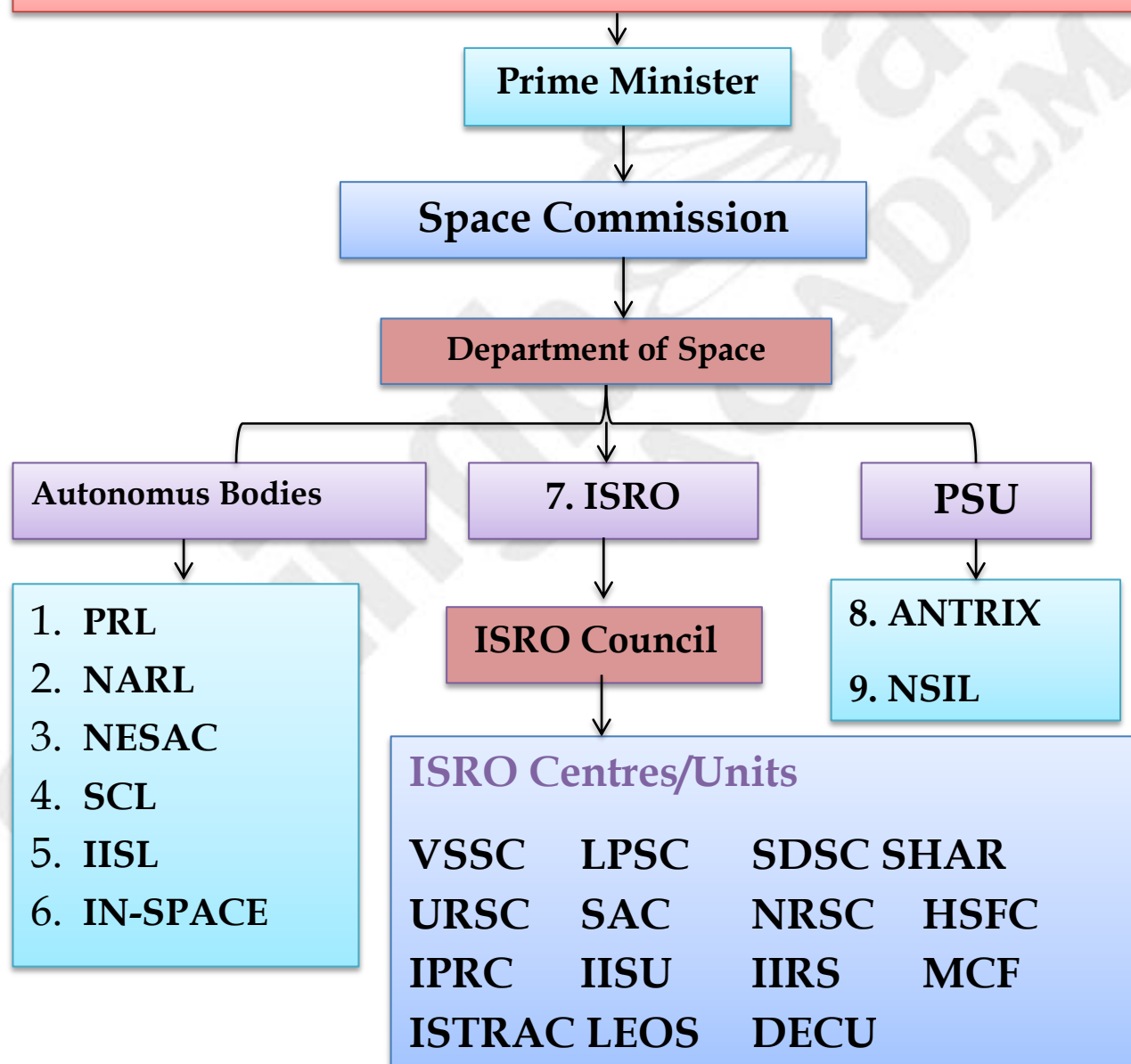


3. November 1963 AD India's first sounding rocket (testing rocket) named Nike-Apache was launched from TERLS.
4. 15 August 1969 AD Indian Space Research Organization (ISRO) established.
5. 1972 AD Space Commission was constituted & Department of Space was established.
6. 1975 AD India successfully launched its 1<sup>st</sup> **experimental satellite Aryabhata** with the help of USSR.
7. 1979 AD India Launched the first experimental remote sensing satellite Bhaskar-1 with the help of USSR.
8. 1980 AD Indigenously built satellite **Rohini series-1 (RS-1)** was successfully launched from Satish Dhawan Space Center Sriharikota by indigenously developed launch vehicle SLV-3.
9. 1981 AD Scanning Tunneling Microscope (1981) & Atomic Force Microscope (1982 AD) were developed, enabling to image matter at atomic/Molecular level. IBM scientist bagged 1986 Nobel in Physics for it.
10. 1982 AD communication satellite named **INSAT-1A** was launched with the help of NASA. This launch was unsuccessful.
11. 1983 AD INSAT-1B was successfully launched with the help of NASA.
12. 1984 AD Rakesh Sharma became the first Indian to go into space. (with the help of USSR)
13. 1987 AD ASLV was successful launched. (Augmented Satellite Launch Vehicle.)
14. 1988 AD India launched its first remote sensing satellite IRS-1A.
15. 1994 AD PSLV was successfully launched.
16. 2001 AD GSLV was successfully launched.
17. 2008 AD ISRO successfully conducted its first interplanetary mission Chandrayaan-1.
18. 2013 AD Successful launch of **IRNSS-1A**, the first satellite of the indigenous navigational system **NAVIC**.
19. 2013 AD Successful launch of Mangalyaan (Mars Orbiter Mission)
20. 2014 AD India successfully tested indigenously developed cryogenic engine.



21. 2016 AD RLV-TD was successfully tested
22. 2017 AD ISRO set a world record by successfully placing 104 satellites in a single launch.
23. 2019 AD Chandrayaan-2 was launched. (partially successful)
24. 2023 AD SSLV was successfully launched
25. 2023 AD Chandrayaan-3 was Successfully Launched.
26. 2023 AD Aditya L-1 Mission was successfully Launched.

## Organisational Structure



## Institutions functioning under Department of space

### 1. Physical research laboratory, Ahmedabad

1. Solar observatory, Lake Fateh sagar - Udaipur
2. Infrared observatory, Mount Abu

### 2. National atmospheric research laboratory, Gadanki (Tirupati) Andhra Pradesh

### 3. North Eastern space applications Centre, Umiam (Shillong) Meghalaya

### 4. Semiconductor laboratory, Chandigarh

### 5. Indian Institute Of Space Science & Technology, Thiruvananthapuram, Kerala

### 6. Indian Space Research Organization, Bengaluru Karnataka

### 7. Antrix, Bengaluru -

- Marketing & commercial arm of ISRO, deals with foreign customers.

### 8. New Space India Limited - Bengaluru -

- Commercial arm of ISRO established in 2019.
- Commercial engagement with domestic industries and ; their capacity building by technology transfer & large scale production of SSLV, PSLV.

### 9. IN-SPACe (Indian National Space Promotion and Authorisation Centre) -

- Autonomous agency under Department of Space (DOS) created in June 2020,
- Established to promote, authorize and supervise various space activities of private sector.

# Indian Space Research Organisation (ISRO)

- INCOSPAR was established as ISRO on 15 August 1969.
- Headquarter - Bengaluru



## Chairperson :-

- |                |                    |
|----------------|--------------------|
| 1. 1969-1972   | - Vikram Sarabhai  |
| 2. 1972        | - M. G. K. Menon   |
| 3. 1972-1984   | - Satish Dhawan    |
| 4. 1984-1994   | - U R Rao          |
| 5. 1994-2003   | - K. Kasturirangan |
| 6. 2003-2009   | - G. Madhavan Nair |
| 7. 2009-2014   | - K. Radhakrishnan |
| 8. 2014-2018   | - A.S. Kiran Kumar |
| 9. 2018-2022   | - K. Sivan         |
| 10. 2022 ..... | - S. Somanath      |

## Institutions functioning under ISRO

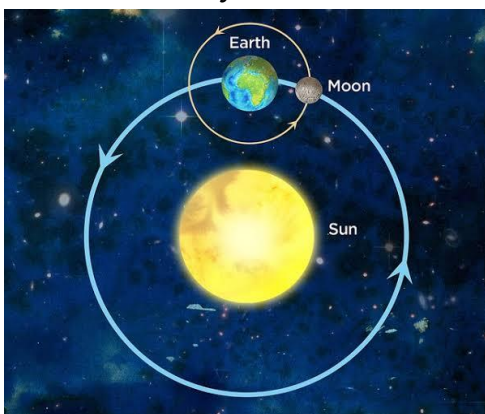
- Vikram Sarabhai Space Centre - Thiruvananthapuram**
  - Formerly known as "TERLS".
  - Satellite launch vehicles PSLV GSLV are developed here.
- U R Rao satellite Centre - Bengaluru**
  - Satellites & spacecrafts are developed here.
- Satish Dhawan Space Centre - Sriharikota (Andhra Pradesh)**
  - Sriharikota high altitude range (SHAR)
  - It is launching site for Indian satellites. (near equator at eastern coast of subcontinent)
  - 2nd : Kulasekarapattinam - Tuticorin (Tamilnadu)

4. **Liquid propulsion systems Centre - Thiruvananthapuram - Bengaluru**
  - It deals with design and development of solid and liquid propulsion systems.
5. **ISRO propulsion Complex - Mahendragiri Hills (Tamil Nadu)**
  - Formerly known as liquid propulsion systems Centre.
  - It deals with development of upper stage liquid propellant and cryogenic stage.
6. **Master control facility, (Hassan Karnataka) (Bhopal, Madhya Pradesh) :**
  - All geostationary/geosynchronous satellites of ISRO are monitored & controlled from this facility.
7. **National Remote Sensing centre - Hyderabad (Telangana)**
  - Data obtained from Remote Sensing satellites is stored & processed in this facility along with various techniques and applications.
  - NRSC has 6 Regional Centre - Dehradun, Jodhpur, Nagpur, Bengaluru, Kharagpur, Shillong.
8. **Human space flight Centre - Bengaluru (Karnataka)**
  - Recently established under "Indian human spaceflight programme" for implementation of Gaganyaan project.
9. **Indian deep space network - Byalalu (Karnataka)**
  - It supports and establishes connection with interplanetary missions with the help of "ISTRAC".
10. **ISRO telemetry tracking & command network (ISTRAC)**
  - Global network of ground stations to provide telemetry tracking & command support to satellite & launch vehicle missions.
  - Centers in India - Port Blair, Thiruvananthapuram/Trivandrum, Bengaluru, Sriharikota, Lucknow.
  - Global stations - Mauritius, Indonesia, Brunei, Vietnam, Russia, Norway, Panama.
11. **Space applications centre - Ahmedabad, Delhi**
12. **Indian Institute of Remote sensing - Dehradun (Uttarakhand)**

## ORBITS OF SATELLITE

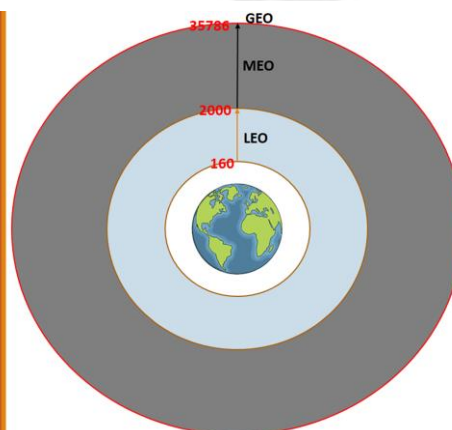
### ☑ Orbit

- Imaginary path of any Celestial body or satellite, revolving around another Celestial body is called orbit.



### Types of orbit

### कक्षा के प्रकार



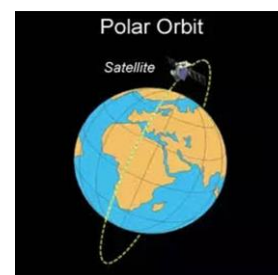
	Low Earth orbit निम्न भू कक्षा	Mid Earth orbit मध्य भू कक्षा	Geosynchronous orbit भूतुल्यकालिक कक्षा
Altitude of orbit कक्षा की ऊँचाई	160 – 2000 km	2000 – 35786 km	35786 km
Revolution period of satellite उपग्रह का परिक्रमण काल	90-128 min (1.5 - 2 hr)	2 – 24 hr	1 day (= 24 hr)
Use उपयोग	<ul style="list-style-type: none"> <li>Remote sensing satellites सुदूर संवेदी उपग्रह</li> <li>Experimental satellites</li> <li>Testing rockets</li> </ul>	Navigation satellites नौवहन उपग्रह	Communication satellite संचार उपग्रह
Special types विशेष प्रकार	<ul style="list-style-type: none"> <li>✓ Polar orbit ध्रुवीय कक्षा</li> <li>✓ Sun synchronous orbit सूर्यतुल्यकालिक कक्षा</li> </ul>		Geostationary orbit भूस्थिर कक्षा
			<ul style="list-style-type: none"> <li>➤ GTO – 200 km नीचे</li> <li>➤ Graveyard orbit – 300 km ऊपर</li> </ul>

### ☑ Polar orbit

- It is a special type of low Earth orbit.
- This orbit is parallel to the polar axis of Earth.

### ☑ Sun synchronous orbit

- It is a special type of Low Earth orbit.

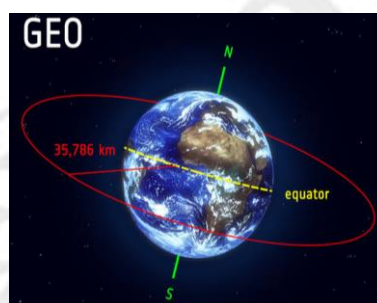
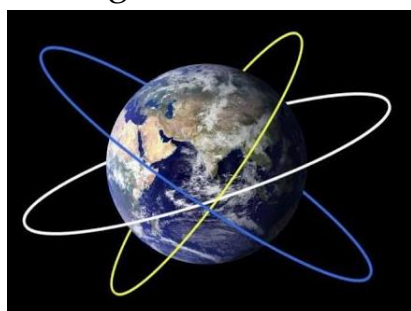




- The inclination of satellite's orbit remains constant wrt the Sun.
- Special use - Earth Imaging (cartography)

### ☑ Geostationary Orbit

- It is a special type of Geosynchronous orbit.
- This orbit is parallel to the equatorial plane of Earth.
- In this orbit the satellite always seems to be stationary W.R.T. the Earth.
- It is mainly used for communication satellites, but it can also be used for navigation or remote sensing.



### ☑ Geosynchronous/Geostationary transfer orbit

- It is situated approximately 200 km. below geosynchronous or geostationary orbit.
- Initially communication satellite is launched in this orbit, and then it is transferred to geostationary orbit.



### ☑ Graveyard orbit

- It is situated at altitude of 36,050 km. (Approximately 300 km. above GEO).
- It is also known as junk/disposal orbit.
- It is used to resolve the problem of space waste or Space debris.
- Inactive/ retired/ out of order satellites are transferred in this orbit.

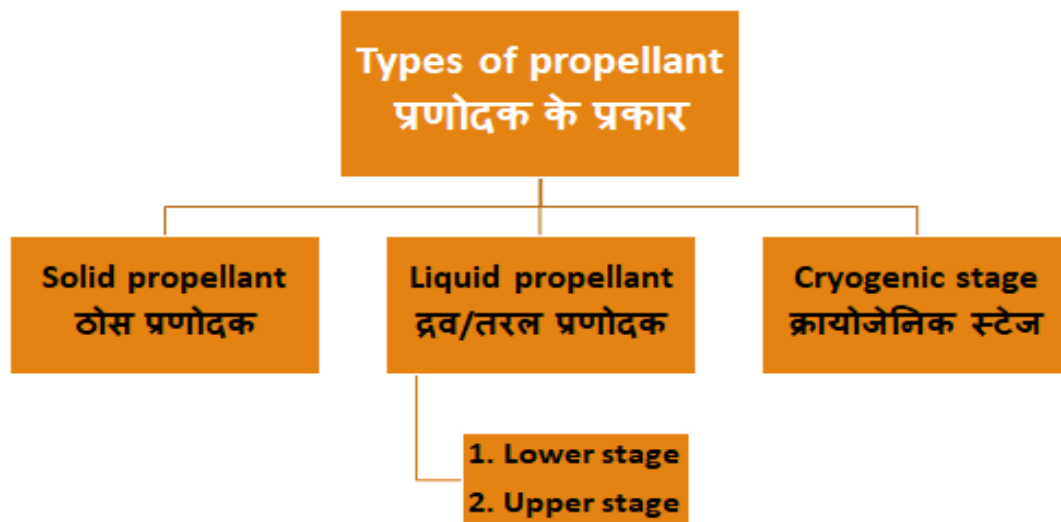
### ☑ Karman Line

- Altitude 100 km (62 miles).
- Boundary between Earth's atmosphere & space.
- Boundary between air travel & space travel.

## Propellant & Cryogenic Stage

### ☑ Propellant

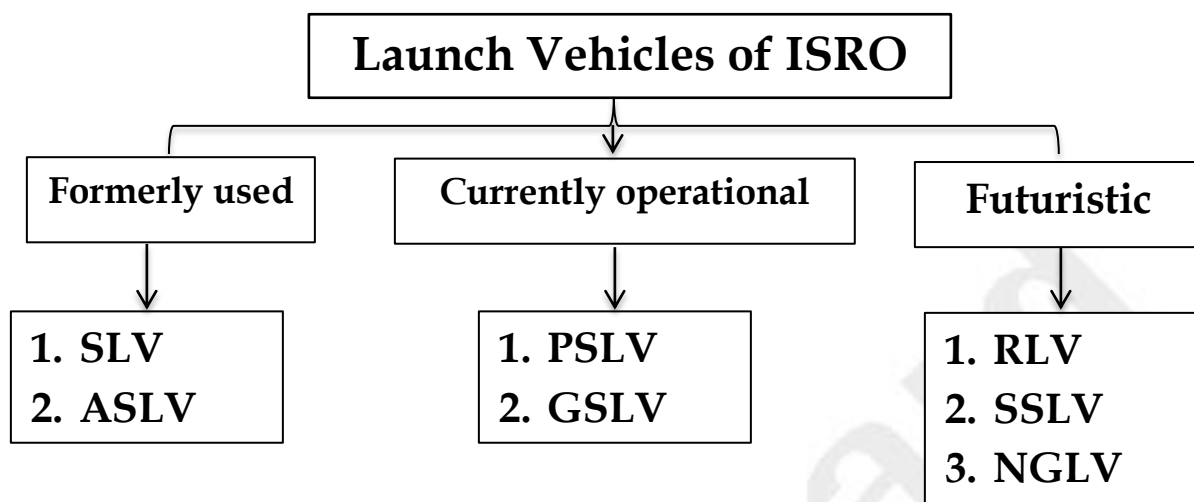
- Fuel and oxidizer are combinedly known as propellant
- Fuel + oxidizer = propellant
- The launch vehicle (rocket) works on the principle of momentum conservation & Newton's third law - the law of action and reaction.
- When fuel is burnt in presence of oxidizer, then a large amount of pressurized hot gases are emitted in downward direction thus launch vehicle gets thrust in upward direction.



Propellant प्रणोदक	Fuel ईंधन	Oxidizer ऑक्सीकारक
Cryogenic क्रायोजेनिक	Liquid hydrogen (-253°C) तरल हाइड्रोजन (-253°C)	Liquid oxygen (-183°C) तरल ऑक्सीजन (-183°C)
Liquid द्रव (Upper stage)	Mono Methyl Hydrazine (MMH) मोनो मेथिल हाइड्राजीन (MMH)	Oxides of Nitrogen नाइट्रोजन के ऑक्साइड
Liquid द्रव (Lower stage)	Unsymmetric Dimethyl Hydrazine (UDMH) अनसिमेट्रिक डाईमेथिल हाइड्राजीन (UDMH)	Nitrogen Peroxide नाइट्रोजन परऑक्साइड
Solid ठोस	Hydroxyl Terminated Poly Butadine (HTPB) हाइड्रोक्सिल टर्मिनेटेड पॉलीब्यूटाडाइन (HTPB)	Ammonium Perchlorate अमोनियम परक्लोरेट

## Brief history of cryogenic engine

- 1994 ISRO started "cryogenic upper stage project" in Mahendragiri Tamilnadu
- 2014 : India successfully tested indigenously developed cryogenic engine ( C.E.-7.5 & C.E.-20 )
- India is 6<sup>th</sup> country in the world to have indigenously developed cryogenic technology.
- ISRO's C.E. 20 is the most powerful cryogenic engine in the world so far. (C.E. 25 under testing)



## 1. Polar satellite launch vehicle

- Third generation launch vehicle.
- Main launch vehicle of a ISRO.
- It has been in use since 1994.
- 4 stage propellant is used in it (solid, liquid, solid, liquid).
- S-139 engine (solid stage) & Vikas engine (liquid stage) are used in it.
- 6 strap on boosters are used in it, In which solid propellant is used.



## Types of PSLV

## PSLV के प्रकार

Core alone कोर अलोन	Ground/Standard ग्राउंड/स्टैंडर्ड	XL/extra large एक्स्ट्रा लार्ज
4 stage propellant	4 stage propellant	4 stage propellant
No strap-on boosters	6 strap-on boosters with 9 tonne solid propellant	6 strap-on boosters with 12 tonne solid propellant
1100 kg satellite upto LEO	1680 kg satellite up to LEO	1800 kg satellite upto LEO

## 2. Geosynchronous satellite launch vehicle

- 4<sup>th</sup> generation launch vehicle
- Most powerful launch vehicle of ISRO.
- It has been in use since 2001.
- 3 stage propellant is used in it (solid, liquid, cryogenic)
- S-200 engine (solid stage), Vikas engine (liquid stage) & C.E. 7.5 / C.E. 20 (cryogenic stage) are used in it.
- 4 strap-on boosters can be used in it, in which liquid propellant is used.



## Types of GSLV

## GSLV के प्रकार

GSLV mk-1	GSLV mk-2	GSLV mk-3 (LVM-3)
3 stage propellant is used (S,L,C)	3 stage propellant is used (S,L,C)	3 stage propellant is used (S,L,C)
Russian KVD engine was used	C.E. 7.5 engine is used	C.E. 20 engine is used
1.5 tonne satellite upto GTO	2.5 tonne satellite upto GTO	4-5 tonne satellite upto GTO
	5 tonne satellite up to LEO	10 tonne satellite up to LEO



### 3. SSLV (Small satellite launch vehicle)

- "Baby rocket" of ISRO.
- 3 stage solid propellant will be used in it.
- No strap-on boosters are used.

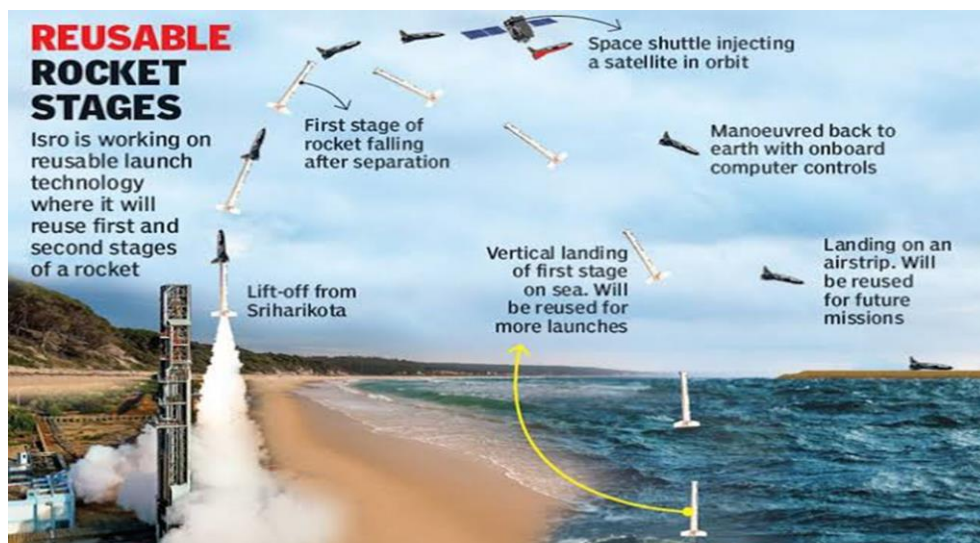
#### Characterstics :-

1. Can be assembled in 15 days.
  2. Capable of carrying small satellites (Micro, Nano) (500 kg upto LEO; 300 kg upto SSO)
  3. Capable of multiple orbital drop-offs
- Successfully launched in 2023
  - A New rocket launching site is being developed for SSLV in "Kulasekarapattinum".



### 4. RLV (Reusable launch vehicle) (Pushpak)

- RLV is such launch vehicle, which re-enters the Earth's atmosphere after launching the payload (satellite, spacecraft) into space and then lands at the target location while withstanding excessive Heat & pressure.
- Thus RLV can be used for multiple launchings.
- In 2016 RLV-TD (Technology demonstrator) was successfully tested by ISRO.
- Scramjet engine is used in it.



## 5. NGLV (Next generation launch vehicle)

- Under development cutting edge launch vehicle of ISRO to replace PSLV.
- Expected development : 2030
- NGLV will use 'semi-cryogenic' technology which is both efficient and cost-effective.
- Capacity :-  
10 tonne – GTO  
20 tonne – LEO

	Cryogenic Technology	Semi Cryogenic Technology
Fuel ईंधन	Liquid hydrogen	Refined kerosene परिष्कृत केरोसीन
Oxidiser ऑक्सीकारक	Liquid oxygen	Liquid oxygen
Fuel temperature ईंधन का तापमान	Cryogenic temp (-253 C)	Normal
Advantage लाभ	The most powerful rocket engine	Engine is more powerful & Eco friendly than PSLV, cost effective than cryogenic
Engines इंजन	CE 7.5, CE 20, CE 25	SCE 200

- A semi-cryogenic engine uses refined kerosene instead of liquid hydrogen as fuel.
- The liquid oxygen is used as an oxidiser.
- Advantage - Refined kerosene, which is lighter than liquid fuel and can be stored at a normal temperature. It can enhance rocket's payload capacity from 4-6 tonnes.

## Satellite

### ☑ Types of satellite

1. Remote sensing satellite
2. Communication satellite
3. Navigation Satellite
4. Space exploration satellite

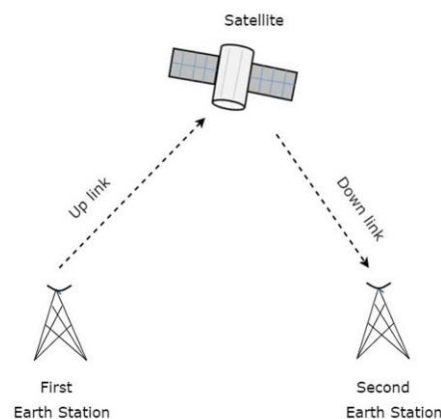
### 1. Remote sensing satellite

- These are generally launched in low earth orbit where its revolution period is 90-128 Minimum
- Various types of cameras scanners & sensors are placed on remote sensing satellite.
- **Uses of remote sensing satellite -**
  1. Resource assessment (forest, desert, agriculture, water, ocean, minerals)
  2. Weather research and forecasting
  3. Disaster management (warning, assessment, search, rescue)
  4. Urban planning
  5. Rural development.
  6. Surveillance & reconnaissance
- India launched its first remote sensing satellite, IRS-1A in 1988 with the help of USSR. (Indian remote sensing satellite)

- Remote sensing satellites of India -
  1. **ResourceSAT** - for resource & minerals assessment
  2. **OceanSAT** - for marine resource assesement
  3. **CartoSAT** - for cartography and Earth Imaging
  4. **RISAT** - For Earth observation
  5. **SARAL** - joint venture of ISRO and CNES France, Satellite with Argos and Altika, for oceanographic study.
  6. **EOS** - Earth observation satellite
  7. **Metsat/kalpana 1** - Remote sensing satellite launched in geostationary orbit (meteorological satellite), Weather forecasting, study of atmosphere
  8. **Megh Tropiques** - Study water cycle & energy exchange in Tropics.
  9. **Hysis** - Hyperspectral imaging satellite.

## 2. Communication satellite

- These are generally launched in geostationary orbit where its revolution period is 24 hours.
- There are transponders on communication satellite which ensure communication via Uplink & downlink.
- **Uses of communication satellite :-**
  1. Telecommunication
  2. Television broadcasting
  3. DTH Services
  4. Tele education
  5. Telemedicine
- India launched its first communication satellite INSAT-1B in 1983 with the help of NASA. Launch of INSAT-1A in 1982 was a failure.



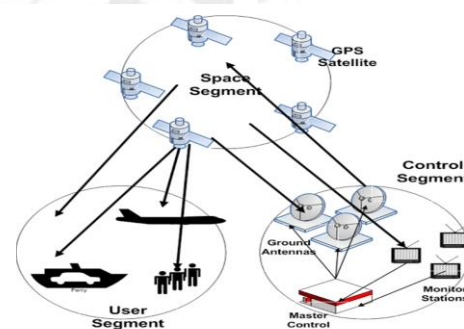


- INSAT and GSAT series satellites were launched under communication satellites. (Indian National Satellite, geostationary satellite )
- **Some of which are as below :-**
  1. Angry Bird - for Air Force
  2. Rukmani - for Navy
  3. Gramsat - for Rural Development, telecommunication & tele education.
  4. Edusat - for tele education

### 3. Navigation satellite

- Satellite navigation is a system that uses satellites to determine the Geo-spatial location of a subject.
- Latitude, longitude and altitude of subject can be detected through it.
- Minimum 4 satellites are required to detect 3-dimensional position of the subject.
- **Navigation system consists of three main components -**
  1. Space segment (navigation satellite)
  2. Control segment
  3. User segment
- Navigation system provides 2 types of services -
  1. standard position service - for general public
  2. Restricted service - for armed forces & important government offices.
- 24 satellites are required for navigation all across the Earth.
- Navigation systems in the world
 

1. GPS	- USA	}	<b>GNSS</b>
2. GLONASS	- Russia		
3. Galileo	- European Union		
4. Beidou	- China		
5. NAVIC/IRNSS	- India	}	<b>RNSS</b>
6. QZSS	- Japan		





### ☑ GPS (Global positioning system)

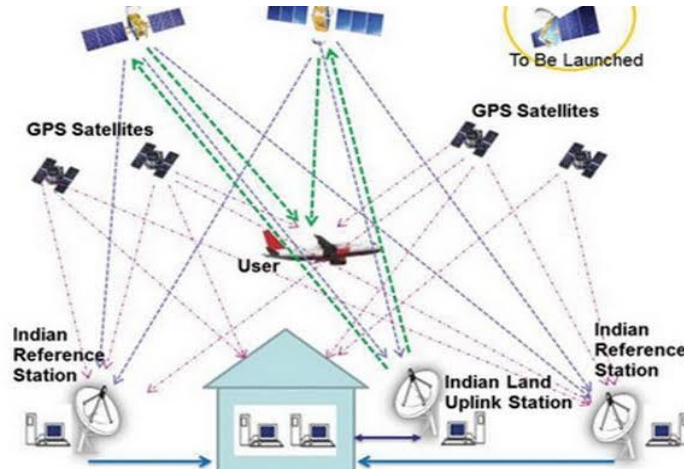
- Navigation system of USA.
- It is also known as "NAVSTAR" (navigation satellite and ranging)
- It is controlled by US Air Force.
- First satellite of GPS system was launched in 1978 & it became fully operational in 1995.
- There are total 32 satellites in this system.
- These satellites are launched in mid Earth orbit (20,200 km.)

### ☑ NAVIC (IRNSS)

- Navigation with Indian constellation
- It is also known as IRNSS (Indian Regional navigation satellite system).
- India's Regional navigation system.
- It provides navigation services within 1500 km range from Indian borders.
- 8 satellites are operational in this system
  - 3 in geostationary orbit
  - 4 in geosynchronous orbit
- **Accuracy -**  
Civilian (5-20 m), military (0.5 m)
- **Applications -**
  1. Terrestrial, aerial and Marine navigation
  2. Integration with mobile phones
  3. Mapping & Geodetic data gathering.
  4. Disaster Management.

### ☑ GAGAN

- GPS aided Geo augmented navigation system
- Joint project of ISRO and Airport Authority of India.
- GAGAN is a system consisting of satellites & ground stations, which augment GPS signals and thus enhancing their quality & precision.
- Thus better Air traffic navigation services can be provided over Indian flight information region.



- ☑ **GPS Spoofing** – GPS Spoofing is a technique of Manipulating GPS data or tricking a GPS receiver by broadcasting false GPS signals. Thereby misleading about its actual location.
- ☑ **GPS Jamming** – GPS Jamming means that one's aircraft is unable to receive standard GPS signals and the aircraft's navigation system must rely on other inputs to determine its position.

### Important Missions of India

#### ☑ Chandrayaan-1

- It was India's 1<sup>st</sup> interplanetary mission.
- It was launched on 22<sup>nd</sup> October 2008.
- On 29 August 2009 ISRO lost connection with it.
- It discovered water on Moon.
- It found the presence of lunar caves formed by lava flow.
- It studied effects of Apollo mission on surface of moon.

## ☑ Chandrayaan -2

- 2<sup>nd</sup> lunar mission of India.
- It was launched by GSLV - MK 3 M1 on 22<sup>nd</sup>, July 2019 from Satish Dhawan space centre Sriharikota.
- **This Mission consists of three parts**
  1. **Orbiter :-**
    - It will revolve around Moon
    - Contains 8 payloads
  2. **Vikram lander :-**
    - It will land on Southern pole of moon in controlled manner
    - contains 3 payloads
  3. **Pragyan Rover :-**
    - It will conduct experiments on surface of moon.
    - Contains 2 payloads
- In the last moments of the mission ISRO lost connection with Vikram lander. Although Orbiter will keep on functioning for 7.5 years.
- **Achievements of Chandrayaan 2 -**
  1. In August 2022 Chandrayaan-2 detected water and hydroxyl ions on the moon between 29 and 62 degrees north latitude.
  2. It accurately measured the presence of Iron, aluminium, and magnesium on the moon, and also detected titanium and calcium.
  3. The orbiter mapped the moon's topography.
  4. It studied the lunar exosphere.

## ☑ Chandrayaan-3

- 3<sup>rd</sup> lunar mission of India
- Follow up mission of Chandrayaan-2
- It was launched by LVM-3 M4 on 14<sup>th</sup> July 2023 from Satish Dhawan space centre Sriharikota.
- Landing on Moon - 23 August, 2023
- It contains Lander module (LM), Rover & Propulsion module (PM)
- budget - ₹ 615 (640) crore

- India will be 4<sup>th</sup> country in the world to achieve soft landing on surface of moon (USA, Russia, & China).
- India is 1<sup>st</sup> country in the world to achieve soft landing on south pole of moon. (World Space Award - 2024)
- **Objectives :-**
  1. Safe & Soft Landing on Lunar Surface
  2. Rover roving on the moon surface
  3. Conduct in-situ scientific experiments.
- Journey 42 days
- **Vikram lander :-**
  - It landed on Southern pole of moon in controlled manner.
  - Contains 3+1 payloads –
    - A. RAMBHA-LP
    - B. ChaSTE – Chandra's Surface.
    - C. ILSA – Instrument for lunar seismic activity.
- **Pragyan Rover :-**
  - It will conduct experiments on surface of moon while roving.
  - Contains 2 payloads
    - A. APXS – Alpha particle X-Ray. Spectrometer.
    - B. LIBS – LASER induced breakdown spectroscopy.
- **Propulsion Module –**
  - Contains 1 payload.
  - SHAPE – Spectro-polarimetry of habitable planet Earth.

☑ **Impact/Landing Point names on Moon -**

Chandrayaan 1 – Jawahar Point.

Chandrayaan 2 – Tiranga Point.

Chandrayaan 3 – Shivshakti Point.





The infographic is divided into three main sections: Lander Payloads, Rover Payloads, and Propulsion Module Payload. Each section contains images of the respective payloads and their descriptions.

**Lander Payloads**

- RAMBHA-LP Langmuir Probe**  
To measure the near surface plasma (ions and electrons) density and its changes with time.
- ChaSTE Chandra's Surface Thermo-physical Experiment**  
To carry out the measurements of thermal properties of lunar surface near polar region.
- ILSA Instrument for Lunar Seismic Activity**  
To measure seismicity around the landing site and delineating the structure of the lunar crust and mantle.

**Rover Payloads**

- APXS Alpha Particle X-Ray Spectrometer**  
To derive the chemical composition and infer mineralogical composition to further enhance our understanding of lunar surface.
- LIBS Laser Induced Breakdown Spectroscope**  
To determine the elemental composition (Mg, Al, Si, K, Ca, Ti, Fe) of lunar soil and rocks around the lunar landing site.

**Propulsion Module Payload**

- SHAPE Spectro-polarimetry of Habitable Planet Earth**  
An experimental payload to study the spectro-polarimetric signatures of the habitable planet Earth in the near-infrared (NIR) wavelength range (1-1.7  $\mu\text{m}$ ).

## ☑ Mangalyaan

- Mars orbiter mission (MOM)
- It was launched on 5<sup>th</sup> November 2013 by PSLV-XL C25 from Satish Dhawan space Centre sriharikota.
- It entered into Mars orbit on 24 Sept 2014.
- It was revolving around Mars in elliptical orbit with the revolution period of around 77 hours.
- India is 4<sup>th</sup> country in the world to achieve this success (USA, Russia, ESA)
- India got this success in 1<sup>st</sup> attempt and at very low cost.

## ☑ Astrosat

- It is an astronomical Observatory launched by ISRO in Low earth orbit (650 km) by PSLV-C30 in September 2015.
- World's first **Multi-wavelength Space Telescope** which can study more than one type of radiations at a time (cosmic rays, X-rays, ultraviolet rays)
- It is the world's first astronomical Observatory of such type. (multi-wavelength)
- India is 5<sup>th</sup> country in the world to launch astronomical Observatory (USA, ESA, Russia, Japan).



## ☑ Aditya L-1 mission

- A mission of ISRO for the study of the Sun.
- Launched by PSLV-XL in Halo orbit at Lagrangian point 1.
- Launched on 2<sup>nd</sup> September, 2023.
- **Objectives:-**
  1. Study of Sun's Corona, chromosphere, Photosphere
  2. Study of particles emitted from sun
  3. Study of variation in magnetic field
- **7 Payloads** are deployed on Aditya L-1 Mission some of which are as below
  1. Visible emission line coronagraph. (VELC)
  2. Solar ultraviolet Imaging telescope (SUIT)
  3. Aditya solar wind particle experiment. (ASPEX)
  4. Plasma analyzer package for aditya. (PAPA)
  5. Magnetometer.

## ☑ Gaganyaan

- It is a Manned Mission of ISRO under "Indian human space flight program" in which 3-4 persons will be sent in space (LEO 300-400 km) for 5-7 days.
- HLV-3 will be used for its launching.
- A budget of 10,000 crore Rupees is allocated for this Mission
- Expected launch year 2025
- India will be 4<sup>th</sup> country . (USA, Russia, China.)
- Astronauts of India will be called - "**Vyomnaut**"
- **Indian Air Force Astronauts selected for Ganganyan Mission are -**
  1. Prashanth Balakrishnan Nair
  2. Ajit Krishan
  3. Angad Pratap
  4. Shubhanshu Shukla

### Gaganyaan Mission



- Group Captain Shubhanshu Shukla will pilot the Axiom-4 (Ax-4) mission to the International Space Station (ISS) in early 2025. 1<sup>st</sup> Indian to be on ISS.

### ☑ **Indian / Indian origin astronauts**

1. **Rakesh sharma** - Soyuz T-11 rocket, Salyut 7 space station
2. **Kalpana Chawla** - Indian American astronaut, NASA Columbia space shuttle disaster 2003
3. **Sunitha Williams** - Indian American astronaut, technical issues with Boeing Starliner spacecraft
4. **Raja Jon Vurputoor Chari** - Indian American astronaut, NASA Artemis team astronaut
5. **Sirisha Bandla** - Indian American astronaut. 3<sup>rd</sup> Indian-origin woman to travel to space in the Virgin Galactic Unity 22 project.

### ☑ **NISAR**

- NASA ISRO synthetic aperture RADAR.
- Joint project of NASA and ISRO
- World's most expensive earth imaging satellite till date.
- It uses microwaves for scanning (L-band, S-band)
- It will be launched in sun-synchronous orbit.
- Expected launch year – 2025
- **Objectives :-**
  1. To study Earth & its evolution
  2. To study climate change
  3. Hazard management (Earthquake, Tsunami, Volcano, Landslides)

### ☑ **LASER Interferometer Gravitational-Wave Observatory (LIGO)**

- Built by : Department of Atomic Energy, Department of Science and Technology with the U.S. National Science Foundation.
- Aim : to detect gravitational waves from the universe.
- Structure : 2 perpendicularly placed, 4-km long vacuum chambers with mirrors at the end.
- Expected to begin scientific runs from 2030.
- Location: Hingoli (Maharashtra)
- Also at USA, Italy and Japan.
- The LIGO in the US first detected gravitational waves in 2015, which led to a Nobel Prize in Physics in 2017.

- ☑ **X-Ray Polarimeter Satellite (XPoSat)** : Launched by ISRO in 2024 to investigate the polarisation of cosmic X-rays and examine the 50 brightest known celestial objects in the universe. (PSLV-C58, LEO 650 km)
- ☑ **Lunar Polar Exploration Mission (LuPEx)** :- Joint lunar mission of ISRO & JAXA. (2026)
- ☑ **Indian space station**
  - It will be launched in low earth orbit, 400 km.
  - Weight - 20 tonnes
  - Use - space exploration & research
  - Expected launch – 2030/2035
- ☑ **Shukrayaan Mission** - Expected launch - 2024. It will study Venus for 4 years.
- ☑ **Disha** - It is a twin-satellite system that will study Earth's aeronomy, the uppermost layer of Earth's atmosphere.
- ☑ **Trishna** -  
(Thermal Infrared Imaging Satellite for High-resolution Natural resource Assessment) :- It is a joint mission of ISRO and CNES, the French space agency. It is meant for accurate mapping of land surface temperature. It is scheduled for a 2024 launch.

### International space missions

MISSION	AGENCY	OBJECTIVE
Luna	ROSCOSMOS	Moon
Apollo	NASA	Moon
Viking	NASA	Mars
Voyager	NASA	Jupiter Saturn Uranus Neptune
Magellan	NASA	Venus

<b>Cassini huygens</b>	NASA	Saturn Titan
<b>Hayabusa</b>	NASA, JAXA	Asteroid
<b>Messenger</b>	NASA	Mercury
<b>Deep Impact</b>	NASA	Comet
<b>New horizon</b>	NASA	Pluto
<b>Juno</b>	NASA	Jupiter
<b>Curiosity rover</b>	NASA	Mars
<b>Maven</b>	NASA	Mars
<b>Insight lander</b>	NASA	Mars
<b>Parker soler probe</b>	NASA	Sun
<b>Chang'e</b>	CHINA	Moon
<b>Al Amal / Hope (Orbiter)</b>	UAE	Mars
<b>Artemis program</b>	NASA	Manned mission for moon
<b>Asteroid Impact Deflection Assessment</b>	NASA	Asteroid
<b>Atmospheric waves experiment</b>	NASA	Atmospheric layers
<b>Perseverance (Rover)</b>	NASA	Mars
<b>Tianwen</b>	China	Mars
<b>DART</b>	NASA	Double Asteroid Redirection Test
<b>OSIRIS - REx</b>	NASA	Astroid (Dust sample)
<b>Kepler space telescope</b>	NASA	Find Exoplanets
<b>Falcon</b>	SpaceX	Reusable satellite launch vehicle
<b>Shukrayan (2024)</b>	ISRO	Venus
<b>Polaris Program</b>	NASA	Mars
<b>Luna 25</b>	Roscosmos	Moon Lander
<b>Smart Lander of Investigation Moon</b>	JAXA	Moon Lander
<b>Juice</b>	ESA	Jupiter

## ☑ International Space Station

- It is an international project in which 5 space agencies have collaborated :-
  1. NASA USA
  2. ROSCOSMOS Russia
  3. Jaxa Japan
  4. European Space Agency
  5. Canadian space agency.
- It provides residential facility for humans in space for the purpose of laboratory Observatory & support station.
- It was launched in 1998.
- It is placed in Earth's orbit at an altitude of 400 km (Revolution period 92 minutes, 15-16 revolutions/day)
- Human is residing there since year 2000.
- It can be seen from Earth.



## ☑ Tianguang 1,2

- Chinese space station
- Tianguang means "Heavenly Palace".
- It was launched on Sept 2016

## ☑ Mission Artemis

- NASA
- Series of manned missions to the moon
- Expected launch : 2024
- Female astronaut & person of colour will be sent to the moon
- Orion spacecraft will be used
- 11 member countries - USA, UK, Canada, Australia, New Zealand, Japan, South Korea, Ukraine, Luxembourg, Italy, UAE

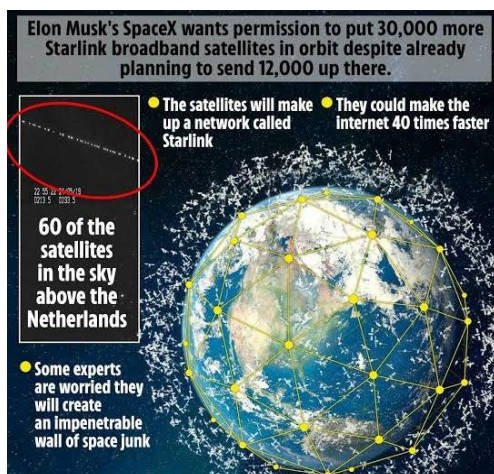
## ☑ Starlink project

- Starlink is SpaceX's ambitious project to provide low-cost and reliable space-based internet.



- Under this project a total number of 42,000 satellites will be launched in low earth orbit (550 km).
  1. First phase - 12,000
  2. second phase - 30,000

**Benefits :-** Reduced latency (time lag between user and server), Internet to remote areas.



#### ☑ James Webb Telescope

- Successor of “Hubble Space Telescope”
- Launched in Dec 2021 at L-2 point.
- Largest space telescope in space.

#### ☑ Transiting Exoplanet Survey Satellite (TESS)

- Launched by NASA in 2018
- Objective :- discovering exoplanets.

#### ☑ Event Horizon telescope

- Event horizon :- Surrounding portion of black hole, which is so powerful that nothing can escape through its gravitational pull.
- EHT - It is the Space Telescope Established by NASA in 2006 to study and observe black holes and Event Horizon
- Recently EHT has captured an image of blackhole for the first time in history.

☑ **Blackhole** - A black hole is a region of space-time with such immense gravity that nothing, not even light, can escape from it.

### ☑ Event horizon –

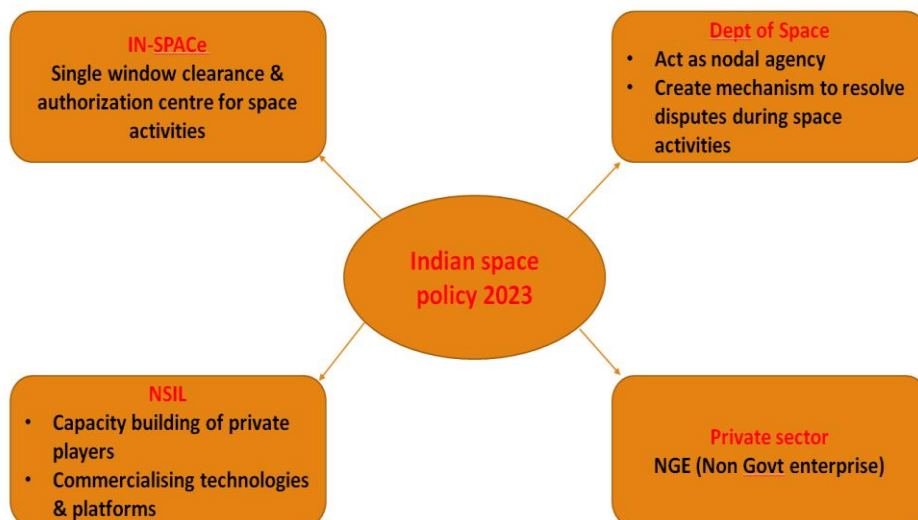
- A notional boundary around a black hole beyond which no light or other object can escape.
- It is also known as point of no return.

### ☑ World's Largest Telescopes –

World's Largest Telescopes	Place	Diameter	07:27
500-meter Aperture Spherical Telescope (FAST)	Guizhou, China	1,640 feet (500 meters)	2020
Extremely Large Telescope (ELT)	Atacama desert, Chile	128 feet (39.3 meters)	2027
Square Kilometre Array (SKA)	Australia and South Africa	512 x 49.2 feet (15 meters)	2028
Thirty Meter Telescope (TMT)	Hawaii (USA, Canada, Japan, China, India)	98 feet (30 meters)	Under construction
Giant Magellan Telescope (GMT)	Atacama desert, Chile	80 feet (24.5 meters)	2029
Atacama Large Millimeter Array (ALMA)	Atacama desert, Chile	66 x 39.4 feet (12 meters)	operational

### Indian Space Policy - 2023

- To promote Indian private players in space sector
- To boost India's participation in space economy –
  - World space eco - \$ 360 B
  - Indian space eco - \$ 1.6 B
  - Targeted Indian space eco by 2030 - \$60 B, 2 lakh jobs



## ☑ Indian Private Companies working in the Field of Space

1. Skyroot - Vikram
  2. Agnikul Cosmos - Agniban
  3. Bellatrix
  4. Dhruv Space
- **Vikram** : Launch vehicle of Skyroot aerospace
  - **Vikram-1** : Solid propulsion engine based rocket, India's 1<sup>st</sup> rocket launched by private company.
  - **Vikram-2** : Cryogenic engine based rocket.
  - **Dhawan-1** -
    - India's 1<sup>st</sup> privately developed, fully cryogenic rocket engine.
    - Propellant – liquid natural gas (LNG) and liquid oxygen.
    - This engine was developed using 3D printing with a super alloy.
  - **Mission Prarambh** :
    - Successful launch of India's first private rocket 'Vikram-S' built by private company Skyroot Aerospace.
    - Single stage, solid propellant engine used in 'Vikram-S' is 'Kalam-80'

- **RHUMI-1**

- India's 1<sup>st</sup> reusable hybrid rocket developed by 'Space Zone India'. It combines the advantages of both liquid and solid propellant systems. (Hybrid = solid propellant and liquid oxidizer)
- It was launched by hydraulic mobile launch system from Thiruvudandhai in Chennai.
- It uses eco-friendly and cost-effective mechanism of "parachute system", for safe recovery of rocket components.

☑ **Private Companies working in the Field of Space in the world**

1. SPACE X : Elon Musk
2. Blue Origin : Jeff Bezos
3. Virgin Galactic : Richard Branson
4. Axiom Space
5. Space Adventures

✓ **Dennis Tito :-**

- world's 1<sup>st</sup> space tourist, space adventures company, 2001, USA

✓ **Anousheh Ansari :-**

- world's 1<sup>st</sup> woman space tourist, space adventures company, 2006, USA

✓ **Alyssa Carson :-** USA, one way trip to mars, NASA 2033

## DEFENCE TECHNOLOGY

### ☑ Types of missile on the basis of Launch mode

1. Surface to Surface
2. Surface to Air
3. Air to Air
4. Air to Surface
5. Water to Water
6. Water to Surface/Air

### ☑ Types of missile on the basis of Range

1. Short range
2. Medium range
3. Intermediate range
4. Intercontinental (5,000 km.)

### ☑ Types of missile on the basis of Speed

1. Subsonic (speed less than 1 mach)
2. Supersonic (1-5 mach)
3. Hypersonic (speed more than 5 mach)

### ☑ Types of Missile on the basis of Path

1. Cruise Missile
2. Ballistic Missile

Cruise missile कूज मिसाइल	Ballistic missile बैलिस्टिक मिसाइल
Its path is not pre determined. इनका पथ पूर्व निर्धारित नहीं होता है	Its path is pre determined. इनका पथ पूर्व निर्धारित होता है
It can be controlled during the flight. इन्हें उड़ान के दौरान नियंत्रित किया जा सकता है	It can't be controlled after launch. इन्हें प्रक्षेपण के पश्चात नियंत्रित नहीं किया जा सकता है
These are very difficult to detect. इनका पता लगाना मुश्किल होता है।	These are easy to detect. इनका पता लगाना आसान होता है।
Generally Classified on the basis of speed. वर्गीकरण सामान्यतः गति के आधार पर	Generally Classified on the basis of range. वर्गीकरण सामान्यतः परास के आधार पर
Example – BrahMos उदाहरण - ब्रह्मोस	Example – Agni उदाहरण - अग्नि



## Integrated guided missile development programme (IGMDP)

- IGMDP was started in 1983 under leadership of Dr APJ Abdul Kalam. (2008)
- The responsibility of this program was given to DRDO.
- 5 missiles were built under this – Prithvi, Agni, Trishul, Akash, Nag

### ☑ Prithvi

- DRDO (IGMDP)
- Surface to Surface,
- Short range, Ballistic missile.

Prithvi 1	Prithvi 2	Prithvi 3
Army version	Airforce version	Navy version
Range : 150-250 km	Range : 250-350 km	Range : 350-600 km
Advanced version - Prahar, Pranash	Transferred to army in 2004	Also known as - Dhanush
	Now it is capable of carrying nuclear warhead	

### ☑ Agni

	Agni 1	Agni 2	Agni 3	Agni 4	Agni 5
Range (km)	700-1200	2000-2500	3200-3500	3000-4000	5000-5500
	MRBM	MRBM	IRBM	IRBM	ICBM Intercontinental ballistic missile

- DRDO (IGMDP)
- Surface to surface,
- Intercontinental, ballistic missile
- it is capable of carrying nuclear weapons/warheads.

### ☑ **Trishul**

- DRDO (IGMDP)
- Surface to Air,
- Supersonic, Cruise missile  
Range : 9 km
- Guidance system – Radio Altemeter

### ☑ **Akash**

- DRDO (IGMDP)
- Surface to air
- Supersonic, Cruise missile
- Range : 30 km
- It is equipped with Command guidance **system and Rajendra radar.**

### ☑ **Nag**

- DRDO (IGMDP)
- Anti tank guided missile
- Range : 4-9 km.
- Equipped with Infrared imaging guidance system, which is capable of functioning at night.
- It is based on fire and forget technique.
- **NaMiCa** (Nag missile carrier ) is used for its ground transportation & launching.
- **Its Air version is called –**
  1. **HeliNa** (Helicopter Nag) (Indian Army) (Advanced version – SANT stand off anti tank missile).
  2. **Dhruvastra** (Indian Airforce).

## Other Important Missiles

### ☑ BrahMos -

- Joint Venture of India & Russia
- BrahMos name is derived from Brahmaputra & Moskva rivers.
- Supersonic cruise Missile
- Speed : 2.8-3 Mach
- Range : 290 Km
- Can be launched from anywhere surface, air, water
- Capable of carrying Nuclear warhead
- World's fastest Anti-ship Cruise missile in operation.
- Exported to : Philippines

### ☑ BrahMos-II

- Advanced version of BrahMos
- Long range Hypersonic Cruise Missile
- Range : 600-800 km
- Speed : 7-8 Mach
- Scramjet engine is used in it
- It is based on Fire & Forget technique

### ☑ K-15 / Sagarika

- Developed by DRDO
- Submarine launched Ballistic missile. It is deployed on Arihant Submarine
- Range : 750 - 1500 KM
- Conventional + Nuclear warhead
- India is 5<sup>th</sup> Country in the world to develop under water missile technology
- It's advanced versions are under development -
  1. K-4 → Range : 2000 - 3500 KM (In production, deployed on Arihant)
  2. K-5 → Range : 5000 KM
  3. K-6 → Range : 8000 KM

### **K series missiles –**

- SLBM
- K – Kalam
- Faster, lighter, stealthier than Agni missile counterparts.

### **☑ Astra**

- Developed by DRDO.
- Air to Air
- Supersonic cruise Missile
- Range :  
    Short Range – 20 KM  
    Long Range – 80 KM (BVR)
- Deployed on Sukhoi, Mig-29, Tejas & Rudra
- Recently Exported to Armenia.

### **☑ Nirbhay**

- Developed by DRDO.
- Long range Subsonic Cruise missile.
- Range – 1000 KM
- Speed 0.7-0.8 Mach
- Conventional + Nuclear warhead.

### **☑ Shaurya**

- Developed by DRDO.
- Long range Hypersonic Cruise missile
- Range : 1200 KM
- Speed : 7-8 Mach
- Capable of carrying Nuclear Warhead
- Land version of K-15

## ☑ Surya

- ICBM under development by DRDO.
- Range
  - Surya 1 : 5000-8000 KM
  - Surya 2 : 12000 KM
- Indigenous cryogenic engine is used
- Capable of cNuclear Warhead)



## ☑ Pinaka

- Multi barrel rocket launcher developed by DRDO.
- It can Launch 12 rockets in 44 Sec
- Range
  - Mark 1 : 40 KM
  - Mark 2 : 60-75 KM
- Recently exported to Armenia.



## ☑ RudraM-I

- Developed by DRDO.
- First indigenous Anti-radiation missile.
- It can detect, track & target any radiation emitting sources like enemy radars, communication sites & other Radio Frequency (RF) emitting equipment.
- Destroy jamming platforms, radar stations of the enemy, thereby clearing path for own fighter jets & prevent own systems from being jammed.
- Range : upto 200 km & speeds : 0.6-2 mach

## ☑ RudraM - 2 : Renge - 350 KM.



## ☑ ASAT / Mission Shakti

- Joint program of DRDO & ISRO.
- Anti satellite system (ASAT) is missile based system to attack moving satellites.
- India's ASAT missile successfully destroyed moving satellite in low earth orbit (300km).
- India is 4th country in the world to acquire such capability (USA, Russia, China 2007)



## ☑ Barak 8

- Indo-Israeli, Long range, surface to air, cruise missile
- Capable of destroying aircrafts, helicopter, UAVs, ballistic missile, cruise missile
- Range : 100 km
- Advanced version - Barak-8ER, range : 150 km

## ☑ QRSAM

- Quick reaction surface to air missile
- Developed by DRDO
- Air defence system for Indian Army (replaced Akash air defence system)
- Range : 25-30 km
- 360 degree coverage
- Capable of hitting several targets at once

### ☑ **Varunastra**

- Ship/submarine launched, Electrically propelled, Heavy weight torpedo
- Developed by DRDO
- Range : 40 km
- It can hit stealth submarines

### ☑ **Amogha-III**

- Developed by Bharat Dynamics Limited (BDL) under IGMDP
- Third generation man-portable anti-tank guided missile (ATGM)
- fire & forget technology Fire & Forget, Infrared Imaging Guidance System
- Other anti-tank guided missiles – Nag (Helina Dhruvastra) (DRDO), Spike (Israel), Milan (France)

### ☑ **Agni prime**

- Developed by DRDO
- Next generation advanced variant of Agni missile
- MRBM (Range : 1000-2000 km)
- Developed to replace Agni-1 & Agni-2
- Equipped with advanced guidance system & propulsion system
- Can be fired from mobile launchers

### ☑ **Mission Divyastra**

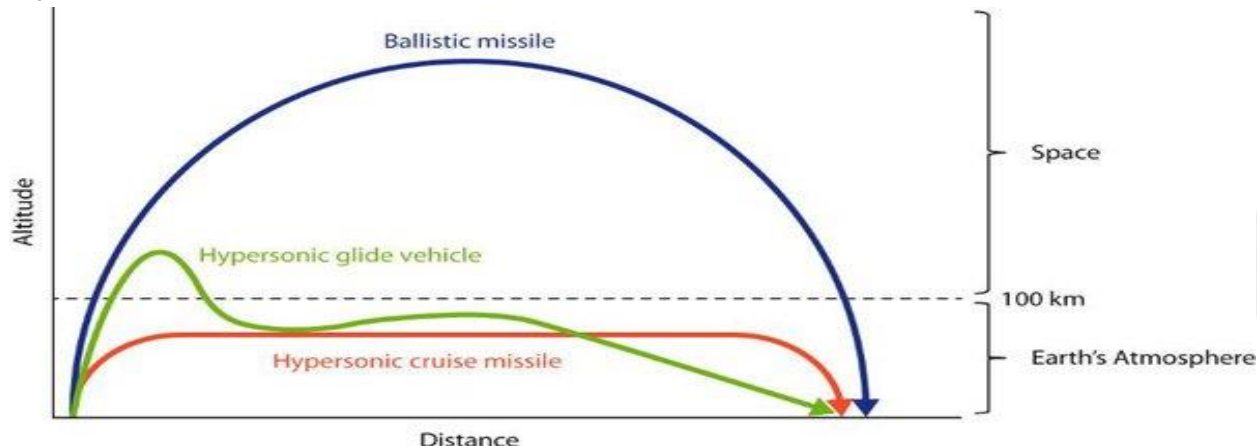
- MIRV technology based highly advanced Agni-5 missile.
- MIRV (Multiple Independently targetable re-entry vehicle.) – Single missile carrying multiple warheads which are capable of destroying multiple targets independently. (Agni-5, Agni Prime.)

### ☑ **Pralay**

- Developed by DRDO
- Surface to surface, Short range, Ballistic missile
- Range : 150-500 km
- India's 1<sup>st</sup> Quasi-ballistic missile

- State of the art guidance system is used
- It can be launched from a mobile launcher.

### ☑ Hypersonic Glide vehicle

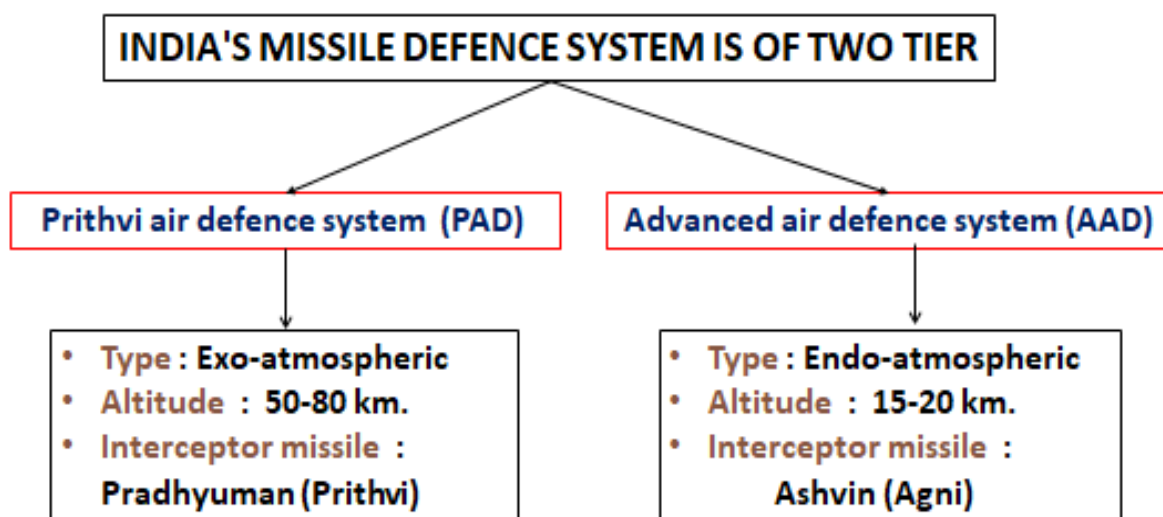


## Missile Defence System

- Under the missile defense system, enemy missiles are detected & destroyed before reaching their target.
- India's missile defense system has been developed only to thwart ballistic missile attack.

### Missile defence systems in the world

- USA - THAAD - Terminal High Altitude Area Defense
- RUSSIA - S-400, S-500
- ISRAEL - Iron Dome
- INDIA - Indian Ballistic Missile Defence Program ( PAD, AAD )



### ☑ S-400 / Triumf

- Imported from Russia.
- Most advanced, long-range surface-to-air missile defence system.
- Range – 400 Km.

Missile	Country	Type
David's sling डेविड्स स्लिंग	Israel	Air defence system
Arrow-3 एरो-3	Israel	Air defence system
Patriot पेट्रियट	USA	SAM (Air defence system)
Javelin जेवेलिन	USA	Man portable anti tank guided missile
Stinger स्टिंगर	USA	A2A
Hellfire हेलफायर	USA	A2S
Minuteman मिनटमैन	USA	ICBM
Jericho जेरिको	Israel	ICBM
Bulave बुलावे	Russia	SL-ICBM
Zircon जिरकॉन	Russia	Hypersonic missile
Fateh फ़तेह	Iran	Hypersonic missile
Spike स्पाइक	Israel	Anti tank guided missile



## Indian Army

	Country	Year	Type
<b>Ajeys</b> अजेय T-72	Russia	1980s	Main battle tank मुख्य युद्धक टैंक
<b>Bhishma</b> भीष्म T-90	Russia	2001	Main battle tank मुख्य युद्धक टैंक
<b>Arjun</b> अर्जुन	India (DRDO)	2004	Main battle tank 'कंचन कवच' युक्त
<b>Abhay</b> अभय	India (DRDO)		Infantry fighting/combat vehicle 'kanchan armour' protected
<b>Sarath</b> सारथ (BMP-2)	Russia		Infantry fighting/combat vehicle इन्फैंट्री फाइटिंग/कॉम्बैट व्हीकल
<b>NaMiCa</b>	India		Tank destroyer

### ☑ Zorawar -

- Developed by DRDO & L&T
- Light weight main battle tank (<25 tonne)
- High power to weight ratio, AI based, Amphibious

### ☑ Vajra/K-9

- Made in India artillery gun.

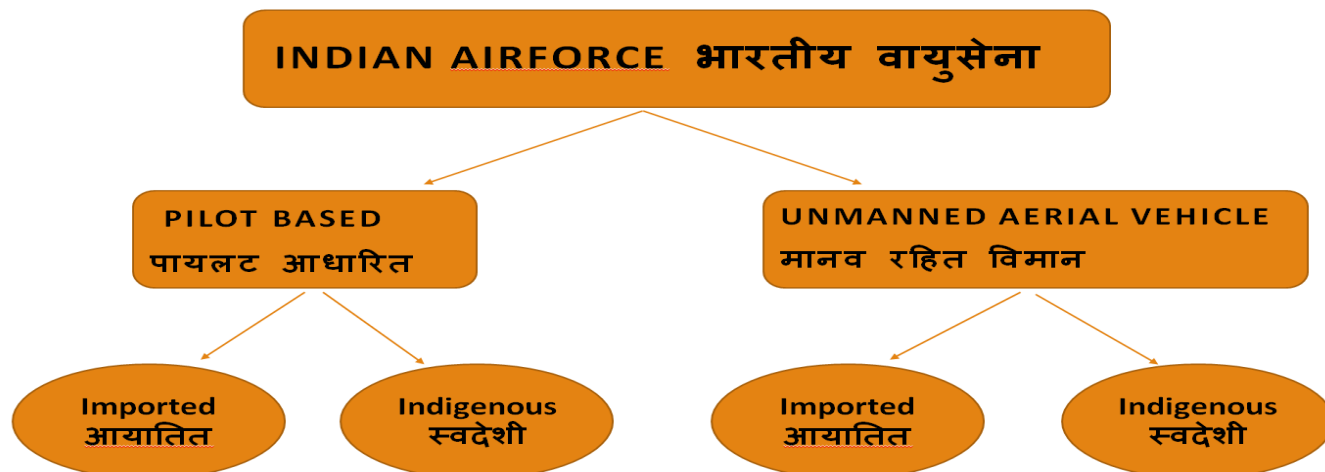
### ☑ Kali 5000

- Kali (Kilo Ampere Linear Injector)
- Developed by BARC & DRDO.
- It is a Directed energy weapon Which will emit powerful pulses of electron beam or LASER & destroy electronic system of enemy missiles & fighter jets.

### ☑ Durga-2

- DURGA- II - Directionally Unrestricted Ray-Gun Array.
- Developed by DRDO
- 100-kilowatt lightweight, Directed Energy weapon

# Indian Airforce



## ☑ IMPORTED AIRCRAFTS & FIGHTER JETS

- MiG 21 - Russia (fighter jet)
- MiG 27 - Russia (fighter jet)
- MiG 29 - Russia (fighter jet)
- Sukhoi 30 - Russia, supersonic (fighter jet)
- Mirage 2000 - France (Dassault) (Supersonic fighter jet)
- Rafale - France (Dassault) (Supersonic fighter jet, 36 jets)
- Jaguar - France & United Kingdom (Attack aircraft)
- Hawk - United Kingdom (trainer plane)
- C 130 J Hercules - USA (Lockheed Martin) ( military transport)
- C 17 Globemaster - USA (Boeing) (military transport)
- C 295 - Spain (Airbus), Transport aircraft, 16+40 Aircrafts.
- Apache - USA (Boeing) (multi-mission attack helicopter, 22 helicopters)
- Chinook - USA (Boeing) (multi-mission airlift helicopter, 15 helicopters)
- Mh-60r (Romeo) Helicopter - USA (Lockheed Martin), Multirole All Weather Helicopter, 24 Helicopter

## ☑ INDIGENOUS AIRCRAFTS

### ★ LCA Tejas -

- Light combat aircraft
- Development started in 1983 AD
- Developed by Hal (Hindustan Aeronautics Limited)
- Single engine, multirole, supersonic fighter jet
- Introduced in IAF in 2016
- It replaced MiG 21
- World's lightest one engine one seat fighter jet
- Production of Tejas mk2 is expected by 2025-26 (GEN 4.5)



### ★ AMCA- Advanced Medium Combat Aircraft

- 5<sup>th</sup> /6<sup>th</sup> Generation stealth, multirole fighter jet for Airforce & Navy.
- Developed by - HAL & DRDO
- Single seat, Twin engine.
- Expected development - 2025

## ☑ INDIGENOUS HELICOPTERS

### ★ Dhruv :-

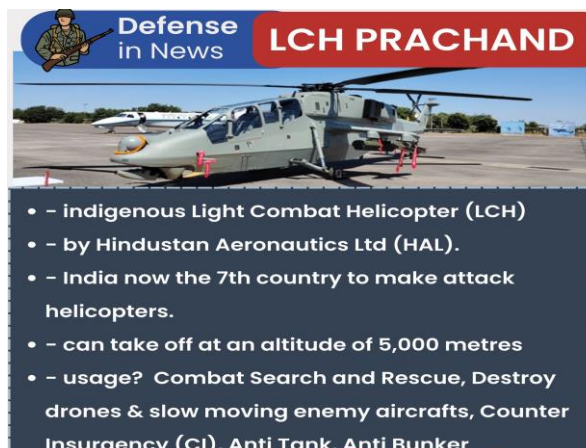
- Advanced light helicopter
- Developed by HAL
- Use - transportation & utility

### ★ Rudra :-

- Advanced light helicopter
- developed by HAL
- combat version of Dhruv
- Nag (Dhruvastra) and Astra are deployed on it

### ★ LCH Prachand

- Light combat helicopter
- Developed by HAL
- Multirole, long range
- High altitude warfare (5000m)
- Shakti engine (HAL) is used
- A2A, A2S missiles are deployed



### ☑ IMPORTED UNMANNED AERIAL VEHICLE

UAV (Drone)	Country	Purpose	
Searcher, Heron	Israel	Reconnaissance & Surveillance.	
Hermes 900 Starliner	Israel	Reconnaissance & Surveillance.	Altitude – 30,000 Feet Endurance – 36 Hours.
MQ – 9B Predator Gaurdian	USA	Land & Marine Surveillance, Warfare.	Altitude – 40,000 Feet Endurance – 40 Hours Sea Guardian – Navy (15) SkyGuardian – Army (8) Airforce - (8)



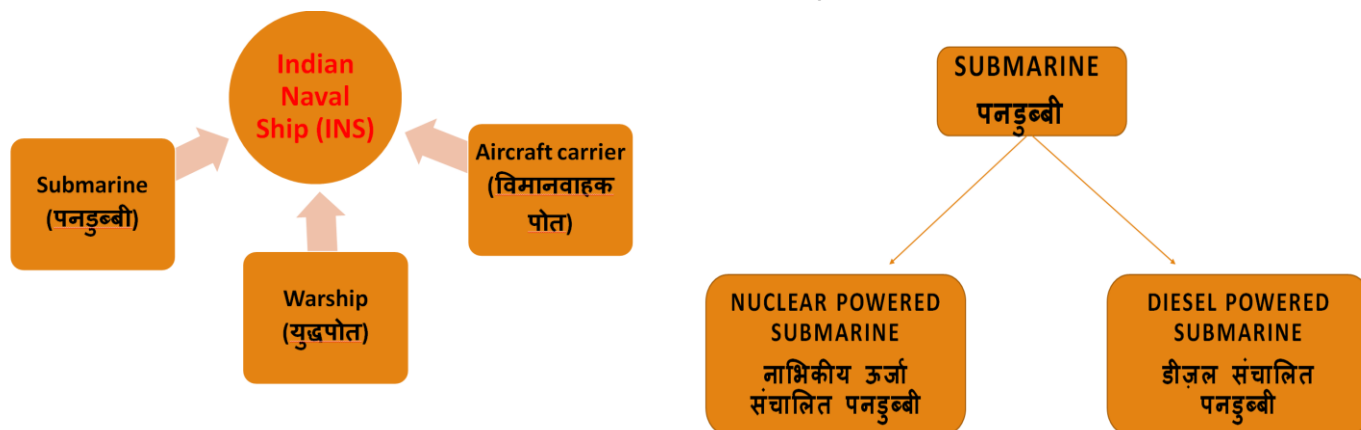
☑ INDIGENOUS UNMANNED AERIAL VEHICLE

UAV (Drone)	Country	Purpose	
Lakshya Abhyas	DRDO	Training & Target Practicing	
Nishant Rustom	DRDO (ADE)	Reconnaissance & Surveillance.	
TAPAS	DRDO (ADE)	Surveillance, Tracking, Target Acquisition.	Altitude – 28,000 feet. Endurance – 36 Hours. Payload – 350 Kg.
Ghatak	DRDO (ADE)	Stealth Combat Drone	Penetration, tactical reconnaissance, electronic warfare.





# Indian navy



## ☑ Nuclear powered Submarin

### 1. Arihant class :-

#### ✪ INS Arihant -

- India's Indigenously developed 1<sup>st</sup> nuclear submarine.
- Built by "Ship building centre, Visakhapatnam" under "Advanced technology vessel project".
- Commissioned in August 2016
- 83 MW pressurized water reactor engine
- k-15 (Sagarika), k-4 missiles are deployed on it.



#### ✪ INS Arighat -

- Built by "Ship building centre, Visakhapatnam" under "Advanced technology vessel project"
- Commissioned in August 2024
- 83 MW pressurized water reactor engine
- k-15 (Sagarika), k-4 missiles are deployed on it.
- Maximum speed of 22-28 km/hr on surface and up to 44 km/hr when submerged.
- Stealth submarine.

## 2. Chakra class :-

### ✧ INS Chakra -

- Leased from Russia for 10 years in 2012
- Also known as Nerpa/ Akula class
- Returned to Russia in 2021

## ☑ Diesel powered Submarine

### 1. Kalvari Class -

- Project-75
- Based on Scorpene Submarine of France.
- Total 6 Submarine developed under this project.
  1. Kalvari
  2. Karanj
  3. Khanderi
  4. Vela
  5. Vagir
  6. Vagsheer

### 2. Sindhugosh Class -

- Imported from Russia.
- 9 Submarines

### 3. Shishumar -

- Imported from Germany.
- 4 Submarines
- INS Shalki - 1<sup>st</sup> Made in India submarin



## 1. Corvette Warship -

**A. Arnala Class** - Anti Submarine Warfare.

**B. Kamorta Class** - Kamorta, Kadmatt,  
Kiltan, Kavartti.

**C. Kora Class** - Guided Missile Corvette  
Karmuk, Kirch, Kora, Kulish.

**D. Khukri Class** - Khanjar, Khukri, Kirpan,  
Kuthar.



### ☑ INS Arnala -

- 8 Arnala class warships are being built to replace the Abhay class ships of the Indian Navy.
- INS Arnala is its first warship.
- Built by Garden Reach Shipbuilders and Engineers Limited (GRSE)
- The warship is named after Arnala Island (Maharashtra)

## 2. Frigate Warship -

**A. Talwar Class** -  
Talwar, Teg, Tarkash, Tabar, Trikand.

**B. Shivalik Class - (Project 17)**  
Shivalik, Satpura, Sahyadri.

**C. Brahmaputra Class** -  
Brahmaputra, Betwa, Beas.

**D. Godavari Class** -  
Godavari, Ganga, Gomati.

**E. Nilgiri Class - (Project 17 A)**  
Nilgiri, Taragiri, Udaygiri, Dunagiri, Himgiri, Vindhyagiri, Mahendragiri.



### 3. Destroyer Warship –

#### A. Visakhapatnam Class - (Project- 15 B)

Visakhapatnam, Mormugao, Imphal, Surat.

#### B. Kolkata Class – (Project – 15 A)

Kolkata, Chennai, Kochi.

#### C. Delhi Class (Project - 15)

Delhi, Mysore, Mumbai.

#### D. Rajput Class –

Rajput, Rana, Ranveer, Ranvijay.



### ☑ Aircraft Carrier

#### ✧ INS Vikramaditya :-

- Aircraft carrier imported from Russia
- It's Russian name was Admiral Gorshkov
- commissioned in Indian Navy in 2013
- It can carry 34 aircraft
- It can accommodate 1750 soldiers.



#### ✧ INS Vikrant :-

- Indigenous aircraft carrier
- Build by Cochin shipyard ltd
- 30 aircrafts & helicopters
- 1600 navy personnel

#### ✧ INS Vishal :-

- Under construction
- Indigenous aircraft carriers

#### ✧ INS Virat :-

- Imported from Britain
- Commissioned in Indian Navy in 1987
- Decommissioned in 2017

☑ Joint Military Exercise (Army, Air Force & Navy)

S. No.	Country	Army Exercise
1.	Australia	AUSTRA HIND
2.	Bangladesh	SAMPRITI
3.	China	HAND IN HAND
4.	France	SHAKTI
5.	Indonesia	GARUDA SHAKTI
6.	Kazakhstan	PRABAL DOSTYK
7.	Kyrgyzstan	KHANJAR
8.	Maldives	EKUVERIN
9.	Mongolia	NOMADIC ELEPHANT
10.	Myanmar	IMBEX
11.	Nepal	SURYA KIRAN
12.	Oman	AL NAGAH
13.	Russia	INDRA
14.	Sri Lanka	MITRA SHAKTI
15.	Thailand	MAITREE
16.	UK	AJEYA WARRIOR
17.	USA	YUDHABHAYAS
		VAJRA PRAHAR
18.	Vietnam	VINBAX



S. No.	Country	Navy Exercise
1.	Australia	AUSINDEX
2.	Bangladesh	IN-BN CORPAT
3.	Brazil & South Africa	IBSAMAR
4.	France	VARUNA
5.	Oman	Naseem-al-Bahr
6.	Russia	INDRA NAVY
7.	Sri Lanka	SLINEX
8.	Singapore	SIMBEX
9.	Thailand	INDO-THAI CORPAT
10.	UAE	In-UAE BILAT
11.	UK	KONKAN
12.	USA	MALABAR
		RIMPAC (Multilateral)
S. No.	Country	Airforce Exercise
1.	Bangladesh	Table Top
2.	Israel	Ex Blue Flag
3.	Oman	EASTERN BRIDGE
4.	Russia	INDRA
5.	Thailand	SIAM BHARAT
6.	UAE	DESERT EAGLE
7.	UK	INDRADHANUSH
8.	USA	RED FLAG

### ✧ Kamikaze drone -

- Small unmanned aircraft carrying explosives, which can be flown directly at a tank or a group of troops that are destroyed when it hits the target and explodes.
- Unlike normal drones that return to base once missiles are launched, “kamikaze” or “suicide” drones are destroyed in an attack.
- Also called Switchblade.
- Difficult to detect on RADAR.
- Russia, China, Israel, Iran and Turkey have such drones.

### ✧ High altitude pseudo satellite

- Developed by CSIR
- 5m long drone
- Flying altitude - 3 km
- Endurance- 8 hrs

### ✧ Shardul Class -

- Tank landing ship
- Amphibious
- Shardul, Kesari, Airavat
- Preceded by - Magar class

### ✧ Project Kusha -

- Long range air defence system
- Developed by DRDO
- 3 long range interceptor missiles - 150, 250, 350 km

### ✧ Igla- S

- Hand held anti aircraft missile.
- Russia to export India.

### ★ Drishti 10 'Starliner' -

- UAV for Indian navy
- Developed by Adani defence & aerospace
- Purpose- surveillance & reconnaissance
- All weather drone

### ★ INS-Tarini -

- Completed 17000 nautical miles trans ocean inter-continental voyage in 7 months
- 6 crew members including 2 women officers.

### ★ INS-Jatayu

- 2<sup>nd</sup> naval base in Lakshadweep island.
- Dweepprakash - kavaratti island
- Jatayu - Minicoy island.

### ★ Nuclear Triad -

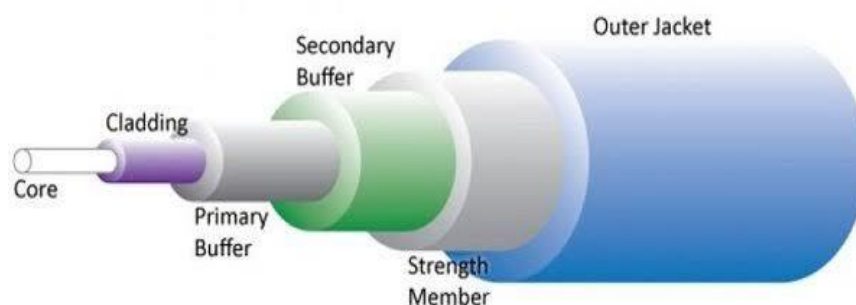
- Ability to launch a Nuclear attack by air, land or sea.

## TELE-COMMUNICATION TECHNOLOGY

### ☑ Optical fiber

- It is made of silica (Si) or glass or plastic.
- Digital signals are transmitted in it in form of light.
- It functions on principle of total internal reflection of light.
- Quality of transmission is good in optical fiber.
- It can be used for long distance communication because energy loss is negligible.

### Structure of optical fiber



#### ✧ Core -

- Core is the most inward part of optical fiber in which signal is propagated.
- The refractive index of core is higher than cladding.

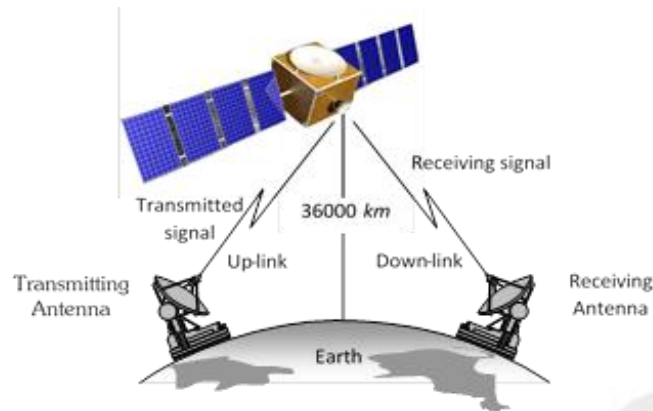
#### ✧ Cladding -

- Cladding is outer layer of core whose refractive index is less than core (Less density).
- It reflects light back towards core.

#### ✧ Buffer - Buffer separates case and cladding from parts.

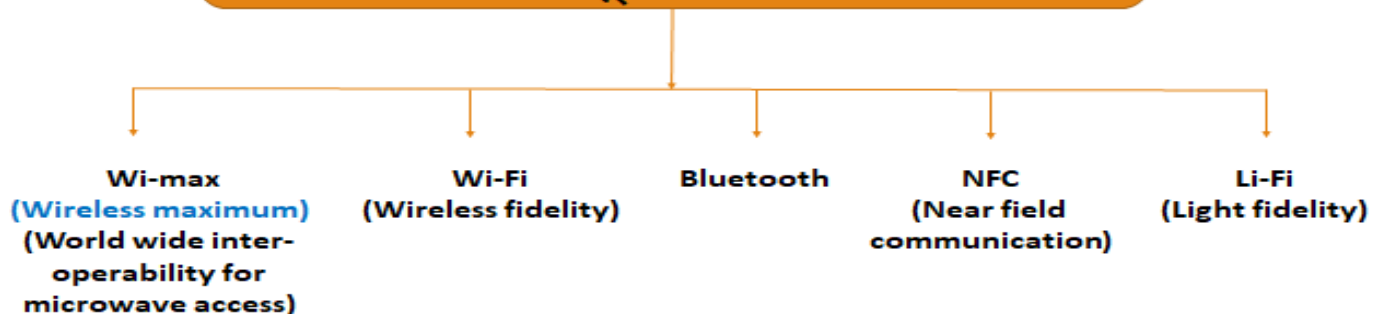
#### ✧ Jacket - Jacket is the outer most layer of optical fiber which protects it from outer dangers.

## ☑ Satellite Communication



- In this communication waves are transmitted towards Geo-Stationary satellite.
- Transmitted waves are received by satellite through Up-Link.
- Transponders on satellite amplify these waves.
- These amplified waves are then transmitted towards receiver station on earth through down link.
- Microwave frequency is used in it-
  - S band = 2-4 GHz
  - C band = 4-8 GHz
  - X band = 8-12 GHz
  - Ku Band = 12-18 GHz - DTH
  - Ka Band = 27-40 GHz

### Short range wireless communication कम/सीमित दूरी का बेतार संचार

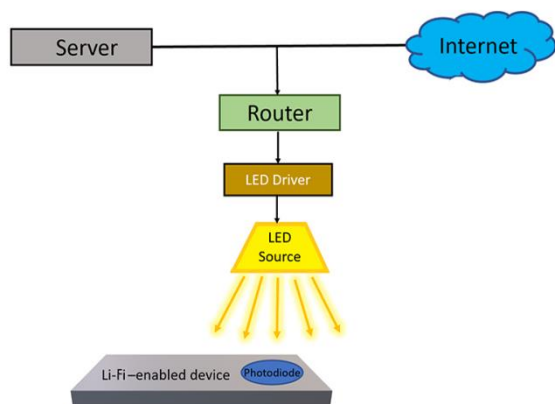




	Wi-Max	Wi-Fi	Bluetooth	NFC
<b>Network</b>	A Network Connecting ICT devices of a city.	A Network Connecting ICT equipment of an Institution/Building.	A Network Connecting ICT devices in a room.	A Network Connecting two closely placed ICT devices.
<b>Use</b>	Internet	Internet File Transfer.	File Transfer Internet.	Commercial Payment.
<b>Range</b>	50-60 KM.	30-50 M.	10 M.	2 CM.
<b>Speed</b>	100 Mbps	Around 1 Gbps	24 Mbps	424 Kbps
<b>Frequency</b>	2.3, 2.5, 3.5, 3.8 GHz.	2.4, 5 GHz.	2.4 GHz.	13.56 MHz.
<b>IEEE Standard</b>	802.16	802.11	802.15	-

### ☑ Li-fi (Light fidelity)

- Visible Light Communication (VLC) based system to provide high quality Internet.
- Frequency : 380 – 780 THz
- Wavelength – 380 – 780 nm
- Speed : About >1 Gbps
- Range : 10 m
- Required equipment : LED bulb, photo detector, lamp/LED driver
- Better privacy, more secure, High speed



## ☑ Types of communication system on the basis of Range

### 1. PAN (Personal Area Network) :-

- Network which connects ICT devices present in a room

### 2. LAN (Local Area Network) :-

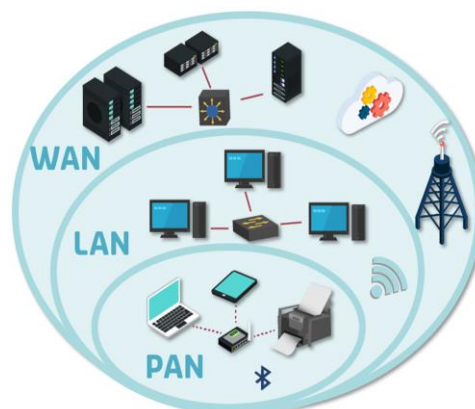
- Network which connects ICT devices present in an Institution/Building

### 3. MAN (Metropolitan Area Network) :-

- Network which connects ICT devices present in a city.

### 4. WAN (Wide Area Network) :-

- Network which connects ICT devices present in a very large area (state, country, Intercontinental)



## ☑ Generations of mobile communication

1. 1G
2. 2G
3. 3G
4. 4G
5. 5G

## 1G

- Mobile communication was started by Japanese Company 'NTT'. In decade of 80's its commercial use was begun in USA.
- In this generation FDMA technique was used.
- In this generation analog signals were used.

## 2G

- It started in 1991 with launch of GSM services.
- In this generation TDMA technique was used.
- In this generation digital signals were used.
- Text & voice call services were provided in it.

## 2.5G

- In this generation GPRS (General radio packet service) technique was used which made use of internet possible.
- It had speed of 56-115 kbps.
- It enabled the use of Normal value added services. Such as - downloading wallpapers, ringtones.

## 2.75 G

- In this generation EDGE (Enhanced data rates for GSM evolution) technology was used &
- Speed was increased upto 384 Kbps.

## 3G

- In this generation for data services, packet switching was used instead of circuit switching. Still voice call services were kept on circuit switching
- In this generation HSPA (High speed packet access) technique was used.
- Which increased speed upto 100 Mbps

## 4G

- In this generation packet switching is used for both data services as well as voice call services.
- It is called long term evolution (LTE).
- In this generation OFDM technique was used
- which increased speed upto 1Gbps

	<b>LTE</b>	<b>VOLTE</b>
1.	Stands for Long Term Evolution	Stands for Voice over LTE
2.	Primarily designed to be a data-only technology	Designed to carry both voice and data
3.	Does not natively support voice transmission.	Supports voice as well as data transmission.
4.	Quality of voice reduces if data connection is left on.	Voice quality remains excellent even if the data connection is on

## 5G

- Fifth generation of wireless mobile communication.
- It is based on IEEE Std 802.11ac
- Its final parameters will be determined by ITU.
- Speed : 1-10 Gbps
- Use : HD Video, HD games, Artificial intelligence, Internet of things.

### 5G in India –

#### Low band

- Large coverage
- Less speed
- 600 MHz, 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz

#### Mid band

- Avg coverage
- Avg speed
- 3300 MHz

#### High band

- Less coverage
- High speed
- 26 GHz



- In 2019, South Korea became the first nation to implement a network of 5G.
- Verizon, a US firm, introduced their 5G connectivity in the USA on the same day.
- China has the largest network of 5G in the world.
- 5G trials began in India in Feb 2022.
- Its commercial use was started by Airtel & Jio respectively in Oct 2022.

### ☑ National Digital Communication Policies

1<sup>st</sup> - 1994

2<sup>nd</sup> - 1999

3<sup>rd</sup> - 2012

4<sup>th</sup> - 2018



# INFORMATION TECHNOLOGY

## ☑ Basics of Computers

### ★ Computer

- Computer is an electronic machine which generates required information/output by processing of input data according to series of given commands/instructions (programme).



### ★ Main components of Computer

1. Hardware
2. Software

### ★ Hardware

- The components of computer which are visible & which can be touched.
- It can be divided in following categories -
  1. Input devices
  2. Processing Unit
  3. Memory
  4. Output Devices



### ★ Software

- Software is a series of instructions which activates hardware to perform a specific task in a particular order.
- Mainly it is of 3 types -
  1. Operating System / System software
  2. Application Software



### 3. Programming Software

#### ✧ Input Devices

- Those devices by which instructions are provided to computer that how and what task to do.
- Example - key board, mouse, joystick, touch screen, scanner, webcam, microphone.

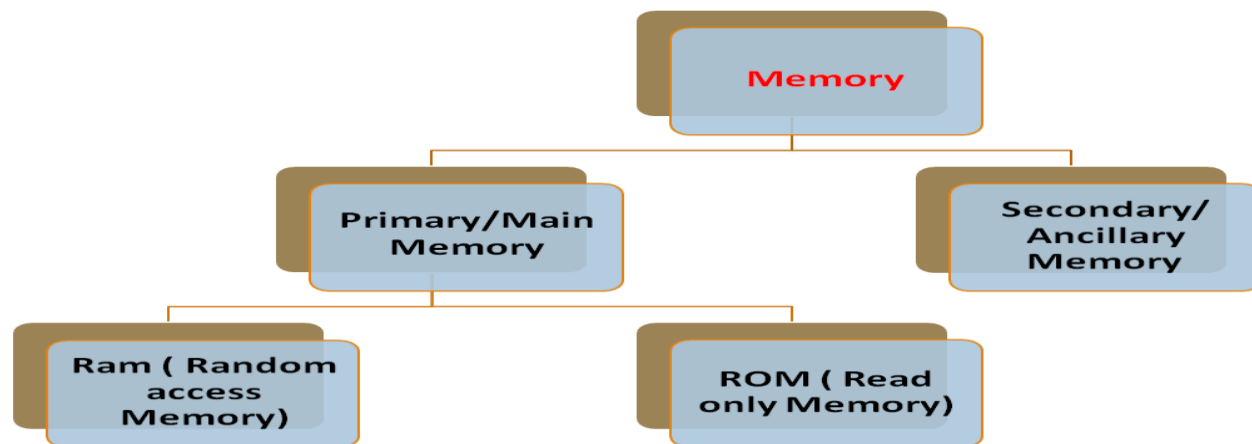


#### ✧ Processing Unit

- Central Processing Unit (CPU) consist of Arithmetic logic unit (ALU) and Control Unit (CU).
- It processes the instructions given by user and generate the output result.
- It is also called brain or heart of computer.

#### ✧ Memory

- It is information storage area of computer. Some instructions are also stored in it which are helpful in processing of CPU.



### ☑ Primary / Main memory

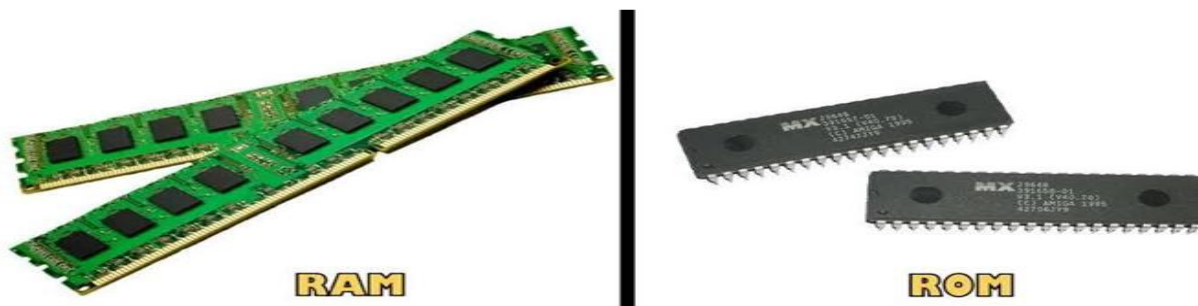
- It is electronic memory placed in computer system unit.
- Data, instructions & instantaneous results are stored in it.
- It has low memory capacity but high processing speed.

#### A. Random access Memory (RAM)

- When computer is started (switched on) some operating system files, basic programs and data are loaded in RAM.
- The instructions/commands & data given by user to the computer are stored in RAM and are sent accordingly to other parts.
- Data stored in RAM is temporary, which is lost after turning off computer. Therefore for future use that data has to be saved.
- High Capacity RAM can smoothly run various programs simultaneously.

#### B. Read Only Memory (ROM)

- Permanent data, information & instructions are stored in ROM. It means it is a permanent memory.
- This data is not lost after turning off computer.
- The data stored in it can be read only, it can't be destroyed or altered.



RAM	Differences	ROM
❖ stores during and after processing	<b>Data and Program</b>	❖ stored by manufacturer
❖ stores information temporarily	<b>Content</b>	❖ stores information permanently
❖ very fast but uses a lot of power	<b>Processing Time</b>	❖ fast but uses very little power
❖ volatility	<b>Volatile</b>	❖ non-volatile

### ☑ Operating System

- A set of programs which is indispensable for functioning of computer.
- It activates the computer and it manages & controls all resources of computer.
- Example : Android, iOS, Linux, Ubuntu windows.



### ☑ Open Source Software

- Open source software is copyright/patent free. All open source software are available free to users & developers.
- Example – Android, Linux, Arogya setu, VLC media player

### ☑ Malware

- Malware is any malicious software, that harms our computer.
- Malware includes viruses, Trojan horses, spyware, scareware, ransomware etc.

## ☑ VIRUS

- Viruses are auto execute programs. Viruses can fail or hack a computer system or steal personal information.
- A computer virus accesses applications and files without the user's consent.
- Ex- Stuxnet (2010)

## ☑ Ransomware

- It prevents users from accessing their device or the data stored on it, usually by encrypting files.
- The attacker then demands a ransom, usually in the form of cryptocurrency, in exchange for decryption.
- Ex- CovidLock (2020), LockerGoga (2019), WannaCry (2017)

## ☑ Spyware

- It is a software that steals personal information. Example – Pegasus.

## ☑ Trojan horse

- A Trojan horse can be used to remotely control a phone or computer. Ex- Emotet 2018.

## ☑ Phishing

- A cyber crime in which internet users are cheated through fake emails or websites.

## ☑ Antivirus

- Antivirus is a software that prevents any malware from entering the computer. If there is a virus already present in the computer then anti virus detects and removes it from the system.
- Kaspersky, McAfee, Norton



## ☑ Super Computer -

- A computer with a high level of performance.
- The performance of a supercomputer is measured in floating point operations per second (FLOPS).
- Seymour Cray is known as the father of the supercomputer.
- World's 1<sup>st</sup> supercomputer : Crey-1 (1975-76)
- Frontier(hp), Fujitsu Fugaku (Japan), LUMI (Finland), Leonardo (Italy), IBM Summit (USA)
- The name of India's first super computer is Param 8000. Center for Development of Advanced Computing (C-DAC), 1991.
- **Airawat (75<sup>th</sup> rank), PARAM Siddhi-AI, Pratyush, Mihir**



- **CERT-IN (Computer Emergency Response Team India)**
  - Ministry of Electronics and Information Technology
  - Nodal agency to deal with cyber security incidents.

## National e-Governance plan

- The national e-governance plan was formulated by the Department of Electronics & info-technology and Department of Administrative reform & public grievances.
- Started in May 2006.
- currently there are 44 mission mode projects operating under it.

National e-Governance plan राष्ट्रीय e-गविसें योजना		
Central Government mission mode projects [15]	State Government mission mode projects [17]	Integrated mission mode projects [12]

## Digital India Programme

- Digital India is a flagship programme of the Government of India with a vision to transform India into a digitally empowered society and knowledge economy.
- Launched in 2015

Vision areas –

1. Development of digital Infrastructure
2. Provide Governance & Services on Demand
3. Digital Empowerment of Citizens

- Management structure for Digital India consists of
- A Monitoring Committee headed by the Prime Minister, and
- A Advisory Group headed by the Minister of Electronics & IT

## BharOS

- Indigenous mobile operating system developed by IIT Madras incubated firm JandK Operations Private Limited
- **Features -**
  1. Native Over the Air (NOTA) Updates – automatically installs security updates and bug fixes.
  2. No Default Apps (NDA) setting – No pre-downloaded applications.
  3. Private App Store Services (PASS) system – will check apps to see if they are safe for users.

## Imprtant Facts

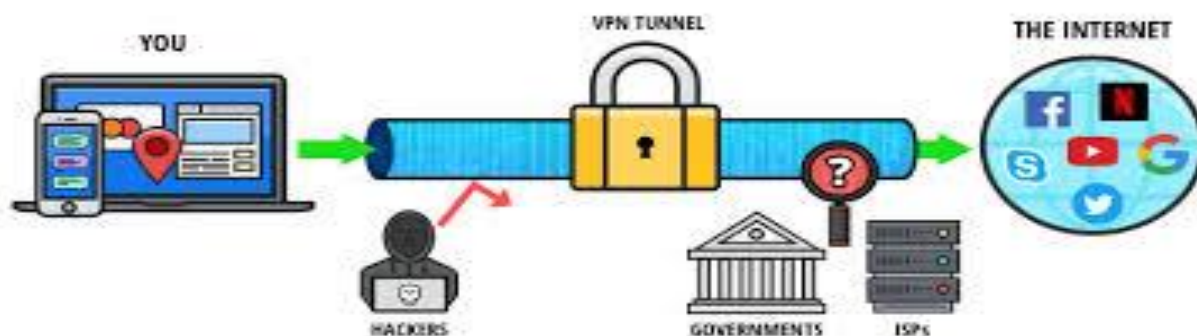
CAD	Computer Aided Design
CAM	Computer-Aided Manufacturing
DVD	Digital Versatile Disc
GIF	Graphic Interchange Format
HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol

ISP	Internet Service Provider
JPEG	Joint Photographic Experts Group
LCD	Liquid Crystal Display
MP3	Motion Pictures Experts Group Layer 3
MPEG	Motion Pictures Experts Group
OMR	Optical Mark Reader
PDF	Portable Document Format
PNG	Portable Network Graphics
PPT	PowerPoint presentation
SIM	Subscriber Identification Module
URL	Universal Resource Locator
USB	Universal Serial Bus
VAN	Virtual Area Network
VPN	Virtual Private Network
WWW	World Wide Web
ZIP	Zip compressed file

- First calculating device - Abacus
- World's first successful electronic computer - ENIAC (Electronic Numerical Integrator and computer)
- Father of modern computer science - Alan Turing
- Father of artificial intelligence - John McCarthy

### ☑ VPN (Virtual Private Network) -

- ✓ A technology by which a user can connect his computer to a remote server of a VPN provider while using the Internet.
- ✓ This encrypts the user's data and hides his IP address. (more privacy and autonomy)



### ☑ Ethernet -

- ✓ It is a way of connecting computers and other network devices with Ethernet cable.
- ✓ Ethernet delivers stable, speedy, secure wired connections to the internet and between devices.
- ✓ It connects devices in a local area network (LAN) or wide area network (WAN).





## BIO-TECHNOLOGY

- Bio Technology is the branch of technology in which the use of the organisms (Animals, plants & microbes) & technique takes place to produce substance & services.
- Those are beneficial to human.

⇒ Basic concept related to bio technology

### ☑ Cell :

- Cell is the basic structural, Functional & biological unit of all organisms.
- This is smallest unit of life that can divide. It means new cell can form from one cell.
- The cell contains the genetic material (DNA) in Nucleus.
- The genetic material (DNA) is found in the form of 'Chomosomes'.
- Chromosomes are made up of DNA & protien.
- The protien found in chromosomes is of 2 type :
  - (i) 'Histone Protien'
  - (ii) Non-Histone 'Protien'
- One chromosome contains one DNA molecule.

⇒ DNA : Deoxy Ribo Nuclic Acid :

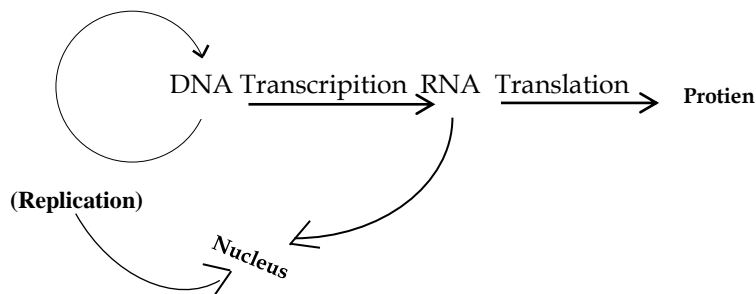
☑ **Discovery** : 'Frienrich Meischer'

☑ **DNA Model by** : Watson & Crick (1953)

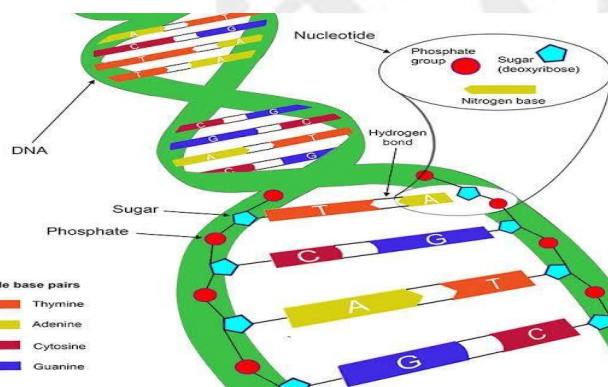
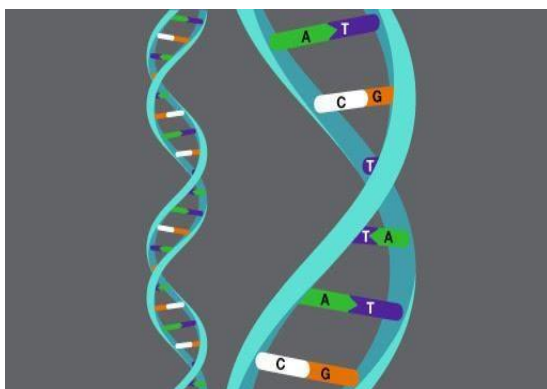
### ☑ Functions :

- DNA can forms new DNA molecule by the process known as 'Replication'.
- DNA forms RNA by the process of 'Transcription'.
- A part of DNA that formed a particular RNA by the process of Transcription is known as 'Gene'.
- That RNA translate into protien, it means a particular gene is responsible for formation of a particular protine.

- One DNA molecule contains many Genes.
- The process of formation of protein from RNA is known as 'Translation'.

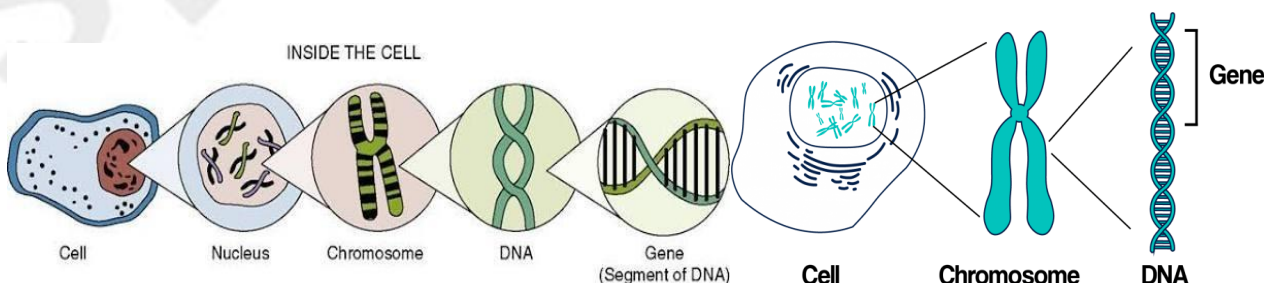


### ☑ DNA Structure - Double helix.



- ☑ Replication, Transcription, Translation collectively known as central dogma".
- ☑ When RNA formed DNA, this process is known as "**reverse transcription**" that generally occurs in viruses.
- ☑ **GENE** -

Gene is a sequence of nucleotides in DNA which contains genetic information and transfers it from one generation to another, it is also responsible for protein synthesis in body.

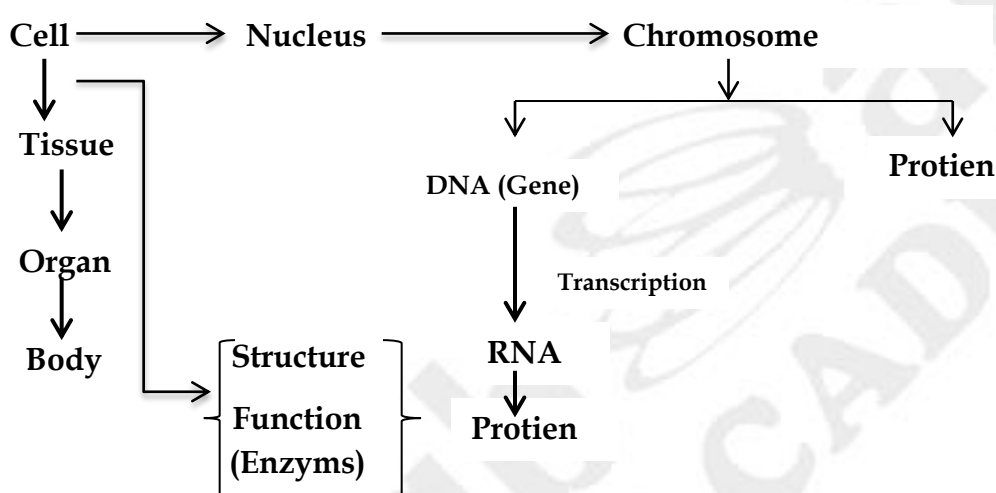


⇒ **Genome :**

- ☑ The complete genetic material of any organism is known as genome.

⇒ **Virus :**

- ☑ They are connecting link between living & non-living.
- ☑ Viruses are acellular.
- ☑ Viruses are made up protien & DNA/RNA.
- ☑ Viruses are host specific, a particular virus can infect a particular organism.



⇒ **Enzymes used in Genetic Engineering :**

**1. Nuclease :**

- ☑ This is a family of enzymes which cut the nuclic acid (DNA,RNA).
- ☑ Therefore these enzymes are known as 'Molecular Scissor' & 'Chemical Knife'.
- ☑ Nuclease those cut RNA are known as 'RNAase'.
- ☑ nuclease those cut DNA are known as 'DNAase'.
- ☑ **DNAase are of 2 types :**
  - ✳ **Exonuclease**
  - ✳ **Endonuclease**
- (i) **Exonuclease :** These enzymes cuts DNA from there ends.
- (ii) **Endonuclease :**
  - These enzymes cuts DNA from the middle or center.

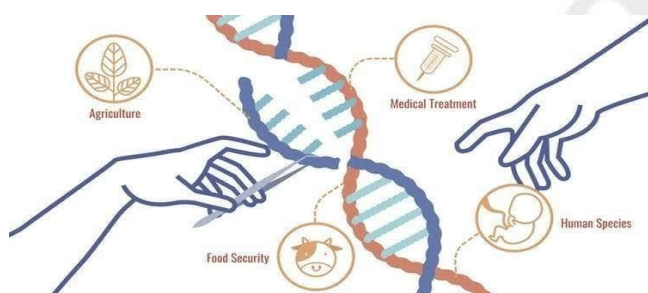
- There are special class of endonuclease enzyme which are 'Restriction endonuclease. These enzyme cuts DNA from a particular side.

## 2. Ligas Enzyme :

- ☑ These enzymes joint 2 DNA molecule (Nuclic Acid) together.

## 3. Genetic Engineering :

- ☑ It is a combination of techniques in which scientists can modify or manipulate the genetic material of any organism.
- ☑ By such change scientists are able to add one or more character those are naturally not found in them.

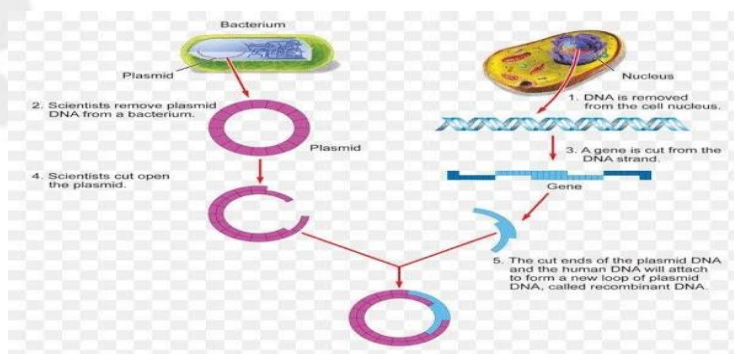


### ☑ Examples :

- ✧ DNA Recombinant Technique.
- ✧ Gene Therapy
- ✧ Gene/Genome Editing

### 1. DNA Recombinant Technique :

- ☑ It is a type of genetic engineering in which scientist recombine the genetic material of any organism of they can transfer genes from one organism to another.
- ☑ As a result new type of protien can form in that organism.



**Process :-**

**Step 1 :-** Identification & Isolation of gene of interest.

**Step 2 :-** Amplification of gene of interest by PCR technique.

**Step 3 :-** Insert gene of interest in vector (Plasmid)

**Step 4 :-** Enter the vector with gene of interest into host cell.

**Step 5 :-** Adjust the gene of interest into host cell DNA.

**Step 6 :-** By cell division scientist can obtain so many cells with desired genes.

- With the help of these cells scientists can develop a GMO, LMO or Transgenic Organism.

- **LMO : Living modified organism**

- **GMO : Genetically Modified organism.**

☑ **Transgenic Organism :** Those organisms which contain a gene that is transferred from another organism.

- Example of LMO, GMO & Transgenic organism.

- **GMO :**

<input type="checkbox"/> Flavr savr tamato	-	<b>Fouling resistant</b>
<input type="checkbox"/> Golden Rice	-	<b>Vit- A beta carotene</b>
<input type="checkbox"/> Super potato	-	<b>Protein Rich</b>
<input type="checkbox"/> Super Banana	-	<b>Vit A Rich</b>
<input type="checkbox"/> BT cotton	-	<b>Insect resistant (Bacillus thuringiensis)</b>
<input type="checkbox"/> BT Brinjal	-	<b>Insect resistant (Bacillus thuringiensis)</b>

**Genetically modified animals Eg. 'GM Mice'**

**DMH-11 : Dhara mustard hybrid-11**

- Weed resistant

- Prepared by : 'D.U. (Delhi University)'

☑ **GEAC : Genetic Engineering Approval Committee**

- That works under "Ministry of environment, forest & climate change", is an institute that gives approval of GMO, LMO & Transgenic organism in India.



- B-T cotton is only GMO that is used in India & currently DMH-11 is under trial.

## 2. Gene Therapy:

- ☑ Gene therapy is a technique of genetic engineering in which scientists can treat disease by changing in the genetic material of any organism.

### ☐ Methods of Gene Therapy :

#### 1. Gene Replacement :

- ☑ In this method any unhealthy gene is replaced by healthy gene with same function.

#### 2. Gene Augmentation :

- ☑ In this method unhealthy gene stays in DNA but a gene with normal function also adjusted in the DNA.
- ☑ Therefore 2 copies of same gene occurs in same DNA.

#### 3. Gene Correction :

- ☑ In this method faulty gene is repaired by different techniques.  
Eg.: Alzheimer, Parkision & sicklecell animea.
- ☑ With the help of gene therapy scientists get initial success in the treatment of Alzheimer, parkisions & sicklecell animea.
- ☑ Sickle cell animea is the disease that get approval for gene therapy treatment.
- ☑ Recently, the cancer treatment get the next step in India because Indian scientists develops indigenously a new cancer treatment therapy that is based on gene therapy, known as 'CART-Cell Therapy'
- ☑ The scientist of 'TATA memorial Hospital' & 'IIT Bombay' develop this therapy & commercial name of this therapy is 'NEXCAR-19.
- ☑ Initially only blood cancer (Lukemiya) will be treated by this therapy.

### 3. Gene/Genome Editing :

- ☑ It is most advanced technique of genetic engineering in which scientists change or alter DNA of any organism on a pricised location.
- ☑ A special type of enzyme used in this process that is known as CAS-9.

#### **Crispr - Cas - 9 CRISPR Asociated Protien - 9'**

'Clustered regularly intre spaced short palindromic repeats'.

**CRISPR & CAS - 9 Together make immune system of Bacteria against the bacteriophage (virus).**

- ☑ For the discovery of a method of Genome editing (CRISPR-CAS-9) 'Emmanulle Charpentier' & 'Jennifer A Doudna' were awarded by 'Nobel Prize of Chemistry' in 2020.
- ☑ With the help of gene/genome editing technique scintists can cure many disease & they can introduced new characters in organisms.



#### ☑ **Stem Cell :**

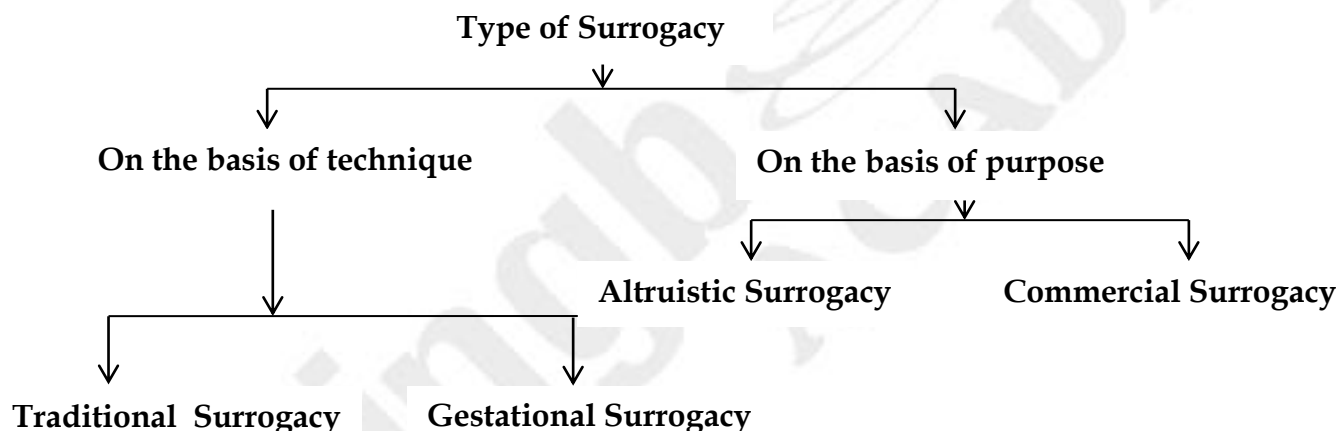
- Stem cell are those 'undifferented primitive cells' which have ability to convert in cell of any specific organ.
- It is also called Master cell'.

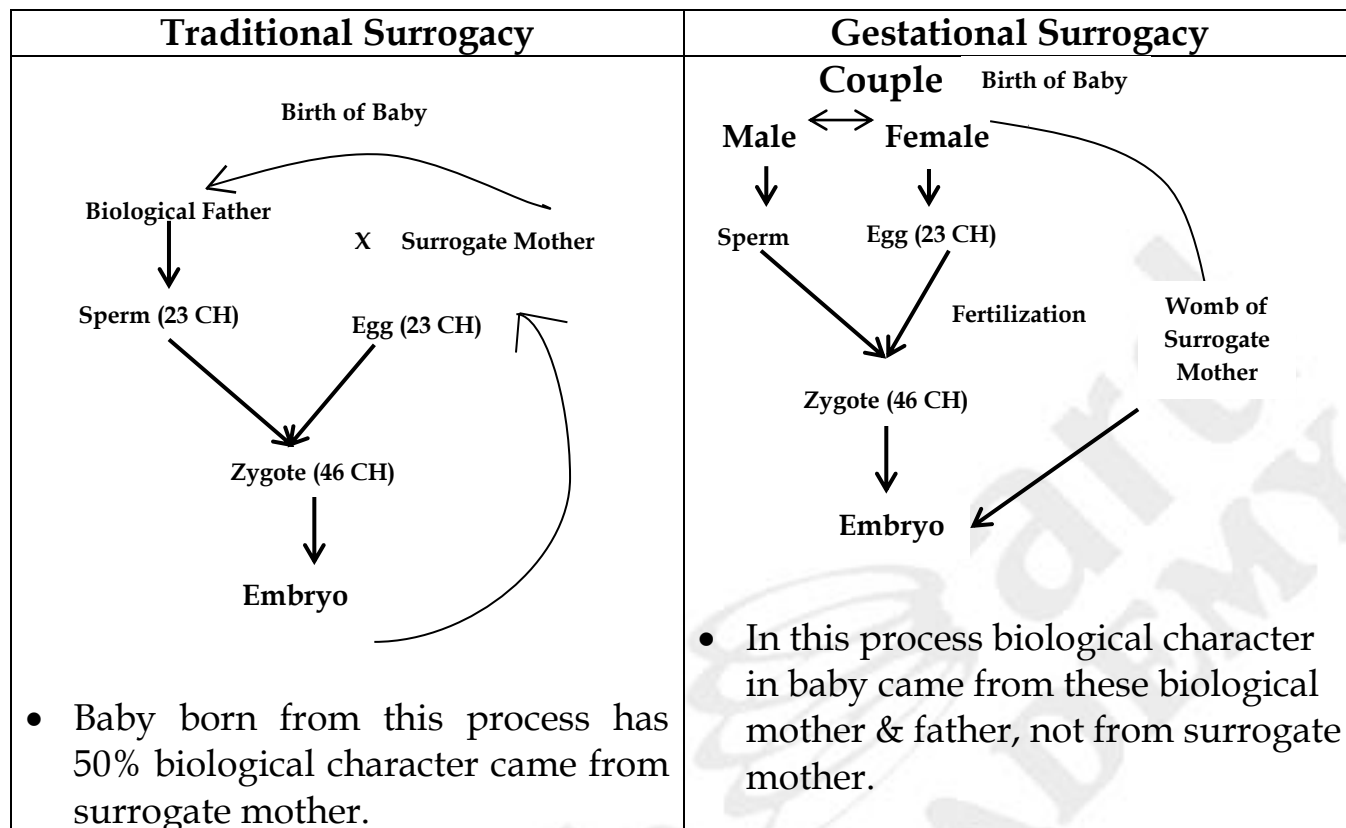
☑ **Stem Cell Therapy :**

- When stem cells are used for treatment of dysfunctional, injured & unhealthy tissue or organ this method is known as stem cell therapy.
- Stem cell therapy is also known as 'Regenerative Medicine'.
- recently, India allows blood cancer treatment with the help of bone marrow stem cells.
- '**Central Drugs Standard Control Organisation**' is the agency that allows the use of new drugs & therapy use in India.

## Surrogacy

- **Surrogacy means :** 'Rental Womb
- Surrogacy is an agreement Between a woman (Surrogate Mother) & a couple or a person regarding conception, pregnancy & giving birth to a child.





- ☑ Parliament of India pass the 'surrogacy regulation act 2021', for regulation of surrogacy in India .
- ☑ It allows only 'altruistic surrogacy' that is based on gestational surrogacy technique.

## Important Terminology

### ☑ Cloning

- A clone is a biological structure which is produced by asexual method from sole parent.
- The clone produced is physically and genetically identical to its parent.
- The process of creating replica of an organism is called cloning.

### ☑ Bio-Informatics

- That branch of Biology in which computer science and information technology are used for compilation, storage & analysis of biological data; is known as Bioinformatics.

### Uses :-

- DNA mapping & analysis (HGP, GIP)
- Protein sequence analysis
- Finding the gene responsible for deadly diseases
- Drug designing

### ☑ Bio-sensor

- Bio-sensors :- These are used to detect various biochemical changes occurring in the body and to identify diseases.
- Examples: detection of glucose level in blood, pregnancy detection.

### ☑ Bio-signature

- Any material or molecule or phenomenon that provides scientific evidence of any past or present life; is called Biosignature.

#### Example -

- Biosignature of early life on earth – microfossils
- Biosignature of early life on exoplanets – water molecule, methane, phosphine

### ☑ Bio-remediation

- Using microorganisms to reduce the effects of pollutants present in the environment (soil, water, air); is called bio- remediation.
- Bio-remediation is mainly used at leakage/spillage of Petroleum.
- Bacterias like pseudomonas putida breaks down complex petroleum compounds into simple compounds which are easily degradable.
- **Example :-**
  - Oil zapper
  - Oilivorous-S (developed by TERI)



## ☑ Bio-fuel

### ✧ Bioethanol

- These are produced by fermentation process of biological/organic matter.
- sources - sugarcane, beet, sorghum, potato

### ✧ Biodiesel

- These are produced by a esterification of plant & animal fat/lipid.
- Sources - soyabean, Ratanjot, Jatropa, animal fat

## ADVANCED TECHNOLOGY

### ☑ Robot

- Robot is a programmable, automatically operated machine that replaces human effort or capable of carrying out a complex series of actions.
- Term Robot is derived from the Czech word Robota which means forced labour or serf.

### ☑ Robotics

- Robotics is a branch of engineering that deals with the conception, design, construction & operation of robots.
- The term robotics was firstly used by Science-fiction author Isaac Asimov in 1942.

### ☑ ASIMO

- Advanced step in Innovative Mobility
- 1st humanoid robot.
- Manufactured by Japanese company Honda in 2000.
- It could walk at a speed of 6km/hr.



### ☑ Vyommitra

- Creator: ISRO
- Female humanoid robot
- Capable of doing multiple tasks, It can speak two languages & can also mimic human crew.



### ☑ Sophia

- Sophia is a AI based social humanoid robot, developed by the Hong-Kong based company Hanson Robotics.

## ☑ Artificial Intelligence

- It is a branch of computer science which deals with development of computers or machines as intelligent as human beings.
- A.I. term was coined by John McCarthy in 1956 at MIT.

### Real life examples of "A.I."

- Virtual assistants – Siri, Alexa
- Facial recognition
- Spam detectors
- Chatbot
- Autopilot mode in airplanes
- Self driving cars
- Accurate translating softwares
- Gaming

## ☑ Machine learning

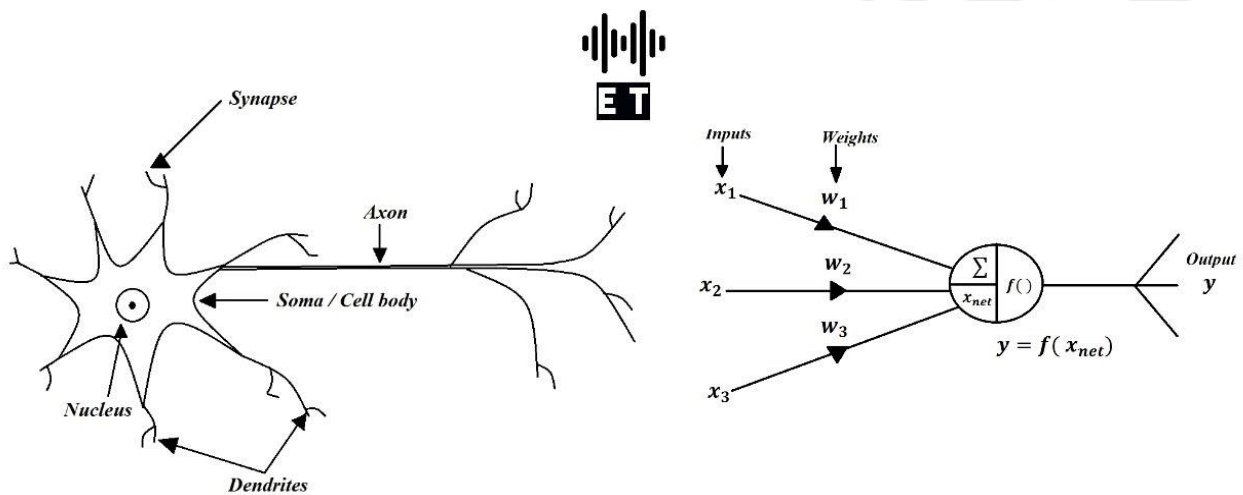
- Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.

## ☑ ChatGPT

- AI (machine learning) based chatbot
- Developed by : OpenAI
- GPT stands for Generative Pre-trained Transformer.
- Applications :- digital marketing, online content creation, answering customer service queries, to write code or help debug code, writing the basic emails, CVs, college essays and homework.

## ☑ Artificial Neural Network (ANN)

- An artificial neural network (ANN) is a machine learning technique that uses a network of interconnected nodes, or artificial neurons, to process data in a way that mimics the human brain.
- ANN are used to solve complex problems, such as recognizing faces and summarizing documents, with greater accuracy.
- It is a key component of deep learning.
- The 2024 Nobel Prize in Physics was awarded to John J. Hopfield and Geoffrey E. Hinton for their work in machine learning using artificial neural networks.

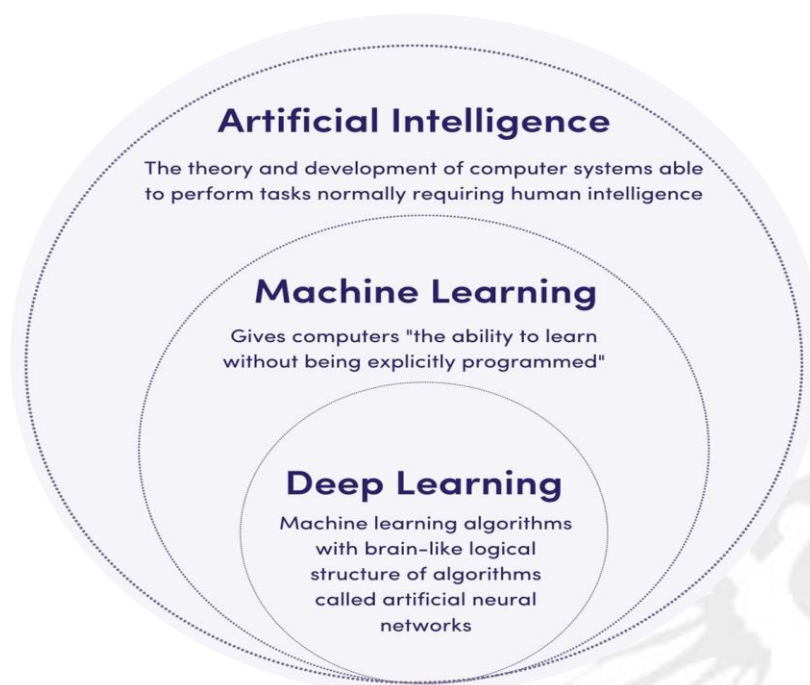


## Biological and Artificial Neural Networks

## Neural Networks

## ☑ Deep Learning -

- Deep learning is a type of machine learning that uses artificial neural networks to teach computers to process data in a way that mimics the human brain.
- The term "deep" refers to the multiple layers of neural networks that are used in deep learning.



### ☑ Generative Artificial Intelligence -

- It is a branch of artificial intelligence that focuses on generating new content (text, image, audio, video etc) by learning & analyzing data.
- It is associated with Machine learning & Deep learning.

### ☑ Deepfakes

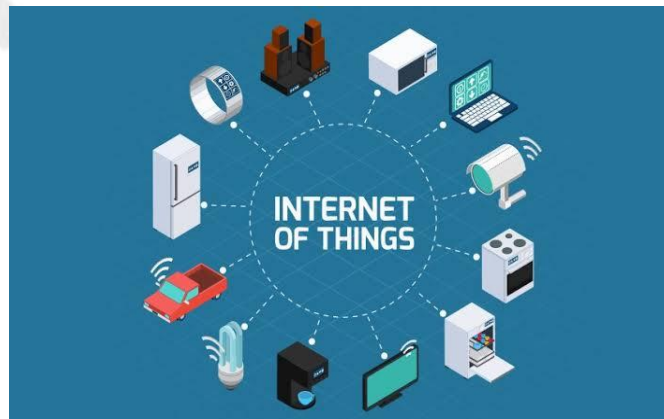
- Deepfake refers to fabricated video/audio/pictures created using powerful Artificial Intelligence tools and face-swapping technology.
- It is called deep-fake because it uses deep learning technology, (a branch of machine learning) to create fake content, which appears real/original .
- The origin of the word "deepfake" can be traced back to 2017 when a Reddit user, with the username "deepfakes", posted explicit videos of celebrities.



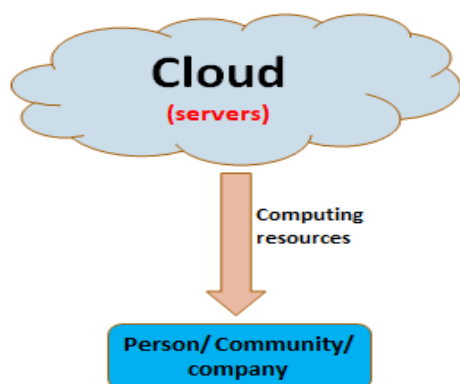


### ☑ Internet of things (IoT)

- It is a network of interlinked machines, digital devices, home appliances, vehicles or other objects through internet where they are provided unique identity and can transfer data (interact) over the network.



## ☑ Cloud Computing



- Cloud computing is a technology that provides virtual/online resources & services over the Internet.
- These resources include storage, applications, software and other services.
- Internet is the basic requirement of this technology.
- Ex :- Facebook, Google drive, i-cloud, Gmail, Netflix, Flipkart, WhatsApp, YouTube, Springboard app, online image/pdf converter, Digilocker.

## ☑ Quantum Computing

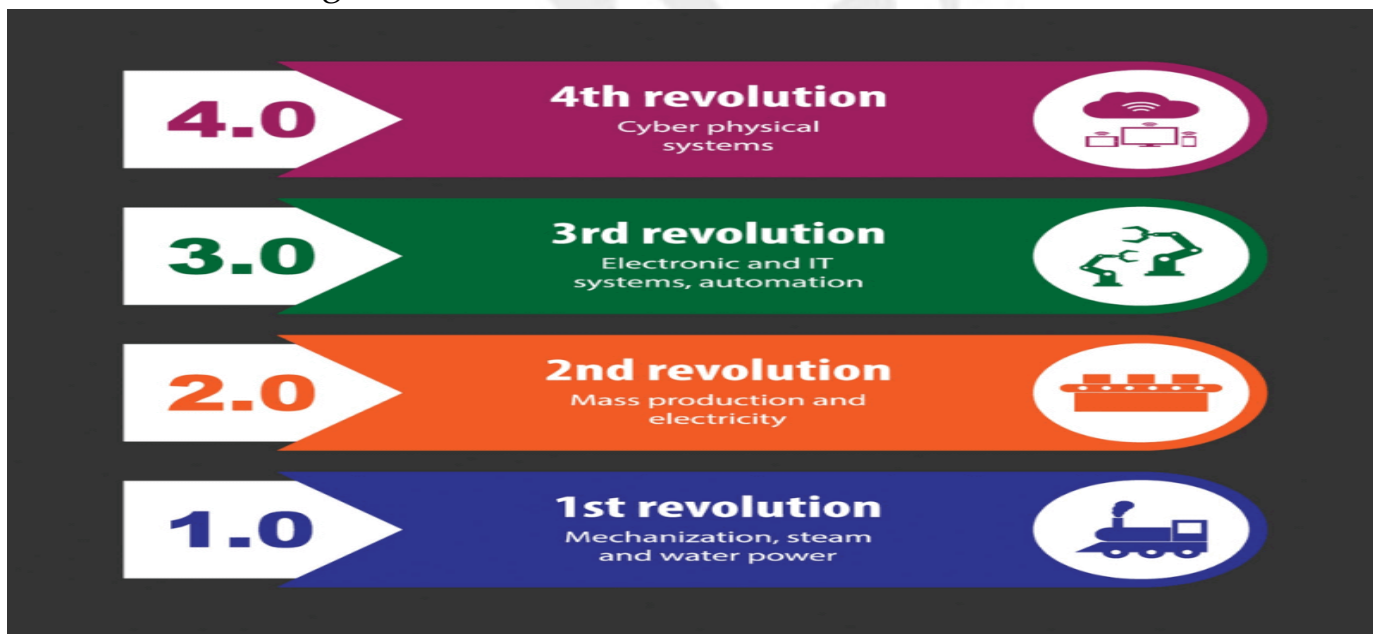
- **Quantum Superposition** - When qubit represents both 0 & 1 at the same time.
- **Entanglement** - When Qubits in a superposition are correlated/ entangled with each other.
- **Quantum supremacy** - The ability of a quantum computer to perform a task that a conventional computer cannot perform in its normal lifetime.

## ☑ CRYPTO CURRENCY

- Crypto currencies run on a distributed public ledger called blockchain.
- Crypto currency is generated through a process called mining.
- The first crypto currency was Bitcoin, which was introduced in 2009 by Satoshi Nakamoto.
- Example :- Bitcoin, Ethereum, Litecoin, Dogecoin
- The Digital rupee, also known as Central Bank Digital Currency (CBDC), was introduced on 01/12/2022.

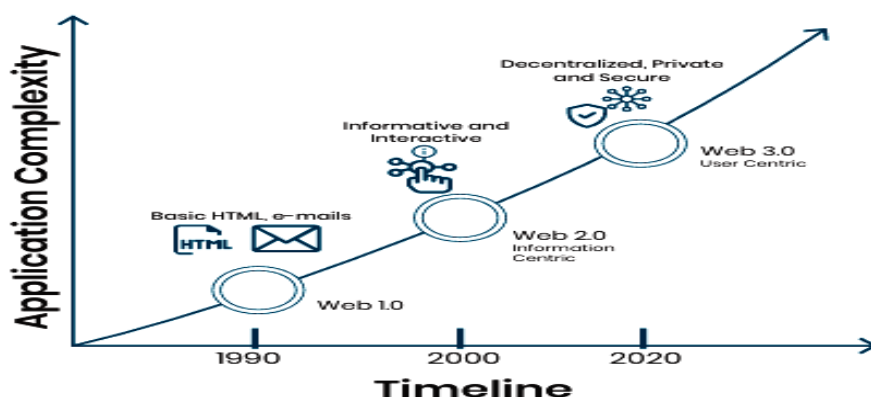
## ☑ Industrial Revolution 4.0

- Industrial Revolution 4.0 refers to the 4<sup>th</sup> industrial revolution related to manufacturing and chain production.
- Industry 4.0 is complex cyber physical systems which is a fusion of technologies like artificial intelligence (AI) robotics the internet to things (IoT), 3D printing, genetic engineering, quantum computing, blockchain and other technologies.



## ☑ Web 3.0

- Web 3.0 Web 3.0 refers to the next generation of the internet, in which apps and websites will be able to manage data effectively using technologies such as machine learning (Artificial intelligence), Big Data, and Blockchain technology.

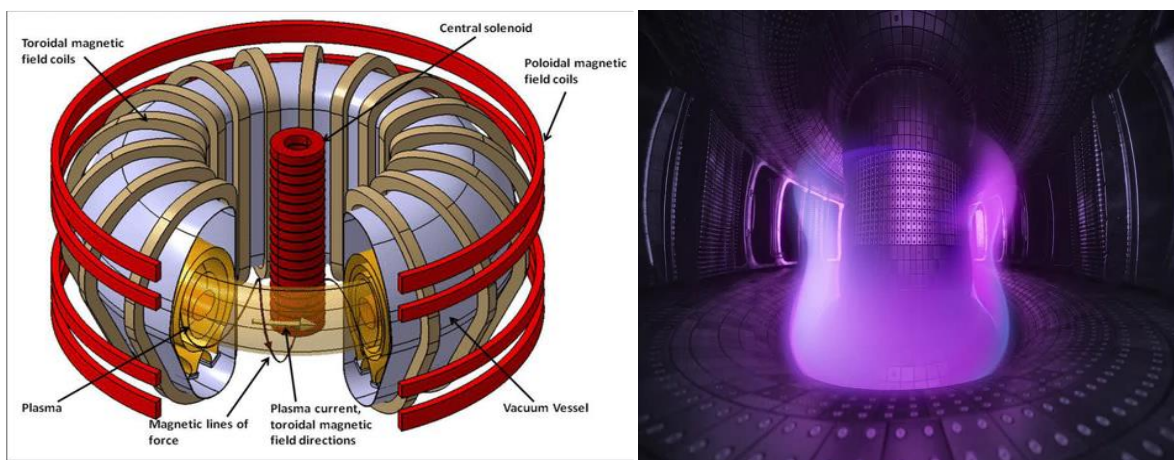


- Inventor of the Web 3.0 - Tim Berners-Lee
- Gavin Wood, founder of Ethereum (crypto currency), coined the term Web 3.0 in 2014.

## ☑ International Thermonuclear Experimental Reactor (ITER)

- ☼ **Aim** : To build the world's largest tokamak to prove the feasibility of nuclear fusion
- ITER agreement was signed in 2006.
- It is located in France.
- ☼ **Members** : The project is funded and run by 7 members :- the European Union (45.6%), India, china, Japan, South Korea, Russia and the United States (9.1% each) [Total 35 nations]**India** will share 9.1% of the cost of project construction, operation and decommissioning. India will also share the experimental results and any intellectual property generated by the project.
- ITER cryostat is manufactured by India (Larsen and Tourbo).
- Cryostat is a chamber that can maintain very low temperatures.
- ☼ **Tokamak** :- It is a machine designed to harness the energy of fusion.
- The energy produced through the fusion of atoms is absorbed as heat in the walls of the tokamak.





### ☑ Artificial sun -

- China's Experimental Advanced Superconducting Tokamak (EAST) fusion energy reactor produced an artificial sun that was five times hotter than the sun for 1,056 seconds while operating at temperatures of 70 million degrees Celsius.
- (sun's core reaches temperatures of about 15 million degrees)