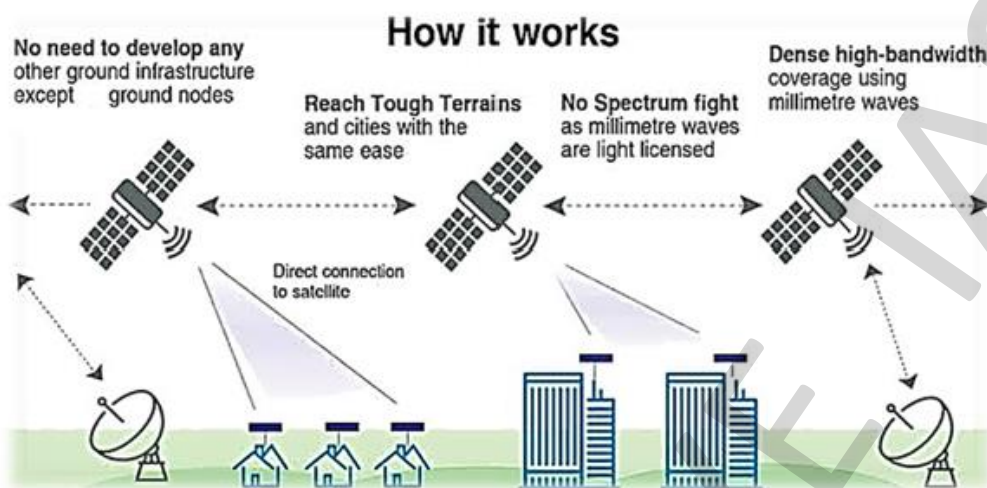


Satellite Based Internet



Satellite based internet:

- Use of satellites to relay broadband signals, instead of **cables** or **mobile towers**.
- Traditionally, it has been through **GEO** satellites, with very **limited user base** (e.g. military).
- Now, private companies are launching thousands of satellites in **LEO**, for use by **masses**.
 - e.g. Starlink of SpaceX
 - compared to GEO, LEO has less latency and stronger signals

Need:

- Half the world's population does not have access to reliable internet connection.
- Remote areas, difficult terrain, uneconomically small population

Benefits:

- **Access:** High speed broadband to remote areas.
- **Cost:** No need to invest in extensive ground infra (laying optical fibres)
- **Time:** Deployed in all areas simultaneously (not city -- town -- village)
- **Benefits:** (think of connectivity: tele-medicine, tele-education, defence, Disasters, etc.)

Issues:

- **Cost:** need to deploy thousands of satellites, and timely service/replacement.
- **Affordability:** currently, charges of such services are very high
- **Debris:** side-effects of overcrowded LEO and space debris
- **Weather:** thick cloud cover or rains may disrupt quality of service.
- **Latency:** It could have high latency (signal delay) compared to optical fibres.
- **Law enforcement:** blocking internet in limited areas will be difficult.
- **Spectrum fee:** possible revenue loss to govt as mobile spectrum demand could decrease
- **Monopoly of West:** such advanced networks will be controlled by private companies of western countries.

Way forward:

- Can't ban, so regulate. Frame national policy.
- International cooperation, as it will be provided by foreign private companies, globally.
- Encourage FDI, make maximum use for rural India.

Space Debris

Issues with crowded LEO:

- **SpaceX** to send **42,000 satellites** to LEO (only 6000 currently orbit)
- Will create difficulties for **new missions** to space.
- Will obstruct observations by ground spaced light and radio **telescopes** used for astronomical observations.
- Will increase space **debris**, risks satellites of all nations.
- Will need increased **monitoring** of space objects (money, manpower)

What is space debris?

- Space debris refers to human made objects in space that no longer serve any useful purpose. e.g. dead satellites, broken pieces of satellites, upper stages of rockets, tools lost during repair jobs, etc.
- **34,000 pieces** of space debris, of size more than 10 cm are orbiting the earth (European Space Agency, November 2020)

Why is it a problem?

- ❑ Space debris poses risk to:
 - ❑ **satellites** which serve important function like communication, GPS, etc.
 - ❑ **space station** which is inhabited by humans
 - ❑ **space telescope**, like Hubble and Astrosat
 - ❑ **humans**, as dead satellites may fall on earth, without complete burning
- ❑ Engages human and technological resources to track space debris.
- ❑ Increase cost of missions as satellites need to be navigated to avoid debris.
- ❑ Can lead to disaster, by way of Kessler Syndrome.

Kessler Syndrome: domino effect of few collisions destroying all space assets.

How to deal with space debris?

Prevent

- ❑ Reduce the **number** of satellites
- ❑ Mandatory **re-entry** of satellites after end-of-life

Manage

- ❑ **Track** the debris
- ❑ Avoid collision by **steering** satellites
- ❑ Use **graveyard orbits** for non-functional satellites
- ❑ **Ban** anti-satellite tests

Remove

- ❑ **Active** debris removal
- ❑ Net capture, Harpoon capture, etc.

Science Prelims pg-32

Space Debris

- ❑ **Kessler syndrome:** domino effect of satellite collisions in LEO
- ❑ **Law:** no explicit on space debris removal
- ❑ **ISRO's NETRA:** NETwork for space object TRacking and Analysis
- ❑ **Digantara:** Private company to track debris.
- ❑ Some other initiatives:
 - Europe's Clearspace-1;
 - China's Neo-01; Japan's Elsa-d

Space Law

Outer Space Treaty, 1967

- ❑ 110 members; **India ratified** it in 1982
- ❑ Launching country liable for damage
- ❑ **Bans WMDs**, not other weapons
- ❑ no nation can lay **claim** on any celestial body
- ❑ Administered by a **UN** committee
 - **COPUS:** Committee on Peaceful Uses of Outer Space (1959; HQ Austria)

Way forward:

- Increase spending on biotech R&D. This will also attract talent to this sector.
- Encourage industry-academia collaboration
- Create a Biotech Regulatory Authority
- Remove obstacles that prevent commercialisation of biotech products. e.g. all R&D on GM mustard goes waste if govt. does not allow its commercialisation.

Some government initiatives:

❑ National Biotech Development Strategy (2015-2020):

- ❑ It aims to make India a world class bio manufacturing hub by following:

- Focus on four areas: Food, Health, education, energy
- Establish Biotech Education Council
- Build global partnerships

❑ National Biopharma Mission:

- It is an industry-academia collaborative mission.
- Its focus is on new vaccines, medical devices, diagnostics, etc.

❑ NER-BPMC:

- To promote Biotech activities in NE, DBT had set up a North Eastern Region - Biotech Program Management Cell

▪ LOTUS-HR:

- Local Treatment of Urban Sewage for Healthy Reuse
- Launched in 2017 by DBT and Netherlands

▪ UMMID:

- Unique Methods of Management and treatment of Inherited Disorders
- Establish NIDAN kendras to diagnose genetic diseases
- Train doctors in Human genetics, so that they better screen pregnant women and new born babies for inherited genetic diseases.

▪ Biotech-KISAN:

- linking available science and technologies to farm

▪ Cattle Genomics Scheme:

- Genome sequencing of indigenous cattle breeds

IndiGau

IndiGau:

- by National Institute of Animal Biotechnology (NAIB), Hyderabad (DBT, MoS&T)
- India's first **Cattle Genomic Chip**; world's largest, has 11,496 markers
- It will help in **identifying pure** Indian cattle **breeds**
- Their milk is high in fat and SNF content (vitamins, minerals, casein, lactose)
- e.g. Gir, Kankrej, Sahiwal, Ongole etc.



IndiGau SNP Chip



Conservation of cows

Biotech Kisan:

- launched in 2017, by DBT (MoS&T)
- **connect science** labs with **farmers** to find innovative solutions to their problems

Dairy sector:

- **1965:** National Dairy Development Board in Anand Gujarat
- **1970:** Operation Flood launched
- **1998:** India became largest producer of milk
- Today India has largest bovine population
- Only 36% milk goes to organized sector.

- **National Animal Disease Control Programme** to vaccinate 60 crore livestock against Foot & Mouth disease.
- **Dairy Processing and Infra Development Fund** to increase milk processing facilities.
- **Rashtriya Gokul Mission** for bovine breeding and dairy development
- **Pashu Sanjivani** to give health cards to milch animals
- **E-Pashu haat** portal to link farmers and breeders of indigenous breed

Biotech-PRIDE

- Promotion of Research and Innovation through Data Exchange
- guidelines released by DBT (MoS&T) to create Bio-grid (linking multiple bio data sets)
- will be implemented by IBDC
 - Indian Biologicla Data Centre
 - national repository of biotech related data



GM Crops

Genetically modified: genetic material (DNA) altered in a way that does not happen naturally.

- ❑ Conventional crop breeding is by crossing plants within same genus.
- ❑ GM crops: gene from other species can be used.
- ❑ e.g. animal or bacteria's genes can be put into plants.

Regulation of GM crops:

- ❑ Rules for GM crops were framed in 1989 under **EPA 1986**. [EPA 1986 classifies GM crops as "Hazardous Substances"]
- ❑ Genetic Engineering Appraisal Committee (**GEAC**), under MoEFCC, is responsible for approving commercial cultivation of GM crops.
- ❑ **Import** of GM food needs approval under EPA 1986 and Food Safety and Standards Act (FSSAI) Act 2006

Benefits of GM crops:

- **Less labour cost:** Ht-Bt cotton does not need manual weed removal.
- **Environment friendly:** Lowers use of pesticides due to inbuilt resistance to pests. e.g. Bt. cotton resistant to pink bollworm
- **Tolerance:** More tolerant to harsh conditions like cold, drought, salinity, etc.
- **High yield:** important for food security of growing population
- **More revenue:** farmer gets higher price due to better quality

Issues with GM crops:

- ❑ **Safety concerns:** unintended consequences on human consumption
- ❑ **Environmental damage:** Ht-Bt cotton encourages use of Glyphosate (e.g. recent cases of glyphosate poisoning in Maharashtra)
- ❑ **Monopoly:** GM seeds use terminator technology, i.e. they don't produce viable seeds. So, farmer becomes dependent on company to buy seeds every year.
- ❑ **Monoculture:** farmers will stop growing other natural varieties (95% cotton in India is Bt-cotton). During 2015 whitefly attack, 95% of damaged crop was Bt-cotton
- ❑ **Side-effects:** GM mustard decreased nectar formation by 40%
- ❑ **Gene flow:** alien genes may flow to neighboring wild plan

Way forward:

- GM crops should be introduced only after extensive '**confined field trials**'.
- The process and result of field **trials must be transparent** and publically available.
- Laws must be put in place to fix **liability** in case of adverse effects. e.g. USA imposes huge costs if GM tech affects regular varieties.

Status of GM crops in India:

Bt Cotton:

- 2002: commercial cultivation allowed
- Today: 95% of cotton is Bt. cotton

Bt Brinjal

- 2009: commercial cultivation allowed
- 2010: stiff opposition; moratorium

DMH-11 (2017-18):

- commercial cultivation allowed
- Allegations of 40% less nectar formation
- Approval put on hold.

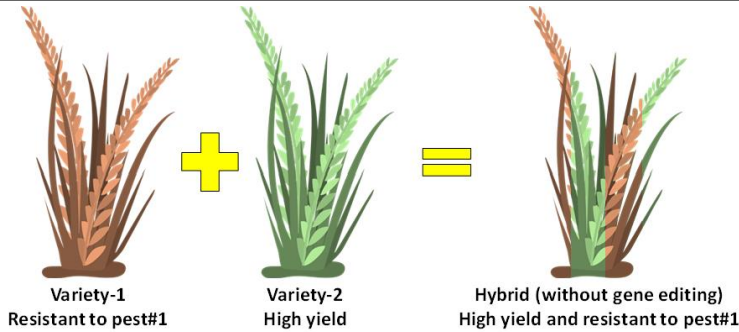
Ht-Bt cotton:

- Bt-cotton has two alien genes from Bacillus Thuringiensis: Cry1Ac & Cry2Ab
- These alien genes protect plant against many pests, like pink bollworm.
- Ht-Bt cotton = Bt. cotton + cp4-Epsps (brings glyphosate tolerance)

GM crops in other countries:

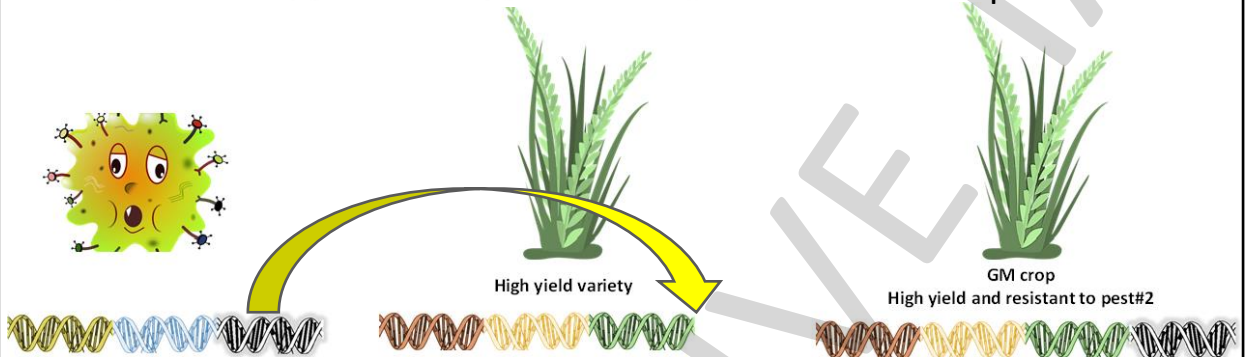
- Grown in 24 countries
- 19 developing; 5 developed
- World areas under GM crops:
 - 1996: 1.7 mha
 - 2017: 190 mha

GM crops



Problem: none of the varieties is resistant to pest#2, say pink bollworm

Solution: a soil bacteria has some gene that is resistant to pink bollworm



Regulation of GM crops:

- EPA 1986** classifies GM crops as "**Hazardous Substances**"
- Cultivation** needs approval from Genetic Engineering Appraisal Committee (MoEFCC, EPA 1986)
- Import** needs approval under EPA 1986 and FSSAI Act 2006 (1% adventitious presence allowed)

Benefits: Less labour; less pesticides; more tolerant; more yield

Issues: Consequences; monoculture; gene flow; monopoly (sterile plants i.e. seeds don't germinate)

Cartagena Protocol on Biosafety applies to GM crops?

Yes, if it can transfer genes

Bt Brinjal

- 2009 allowed
- 2010 stopped
- By Mahyco, TNAU, ICAR



Golden Rice:

- GM rice; German Sc. 1990s
- Genes from Maize/Bacteria
- Vitamin A**
- ✓ Philippines; X India

Flavr Savr

- GM Tomato;
- 1994; USA
- 1st GM food for consumption



Janak, BSS-793, Event-142

- Janak & BSS-793:** Bt Brinjal varieties
- Event 142:** Cry1Fa1 gene
- By Nat. Inst. for Plant Biotech (ICAR)
- GEAC has allowed field trials

Rht14 and Rht18:

- dwarfing genes in **wheat**
- better seedling vigour
- longer coleoptiles
- deeper sowing
- less paddy stubble burning

Bt Cotton:

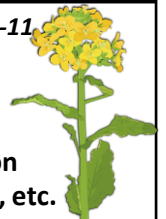
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- These alien genes protect plant against many pests, like pink bollworm.
- Ht-Bt cotton = Bt. cotton + **cp4-Epsps** (brings glyphosate tolerance)

DMH-11 (2017-18): Dhara Mustard Hybrid-11

- By **Delhi University**
- More yield; Herbicide tolerant
- Used **Bar, Barnase, Bastar** gene system
- Allows cross-pollination & hybridization
- Allegations: 40% less nectar formation, etc.



Codex Alimentarius: (food code)

- Standards to ensure food is **safe** and can be traded
- Also used as reference in WTO trade disputes.
- C.A. Commission est. by **FAO & WHO** in **1963**
- India member? Yes, since 1964

I read I forget, I see I remember

See explanation of this PDF on **YouTube** www.youtube.com/c/allinclusiveias


Quantum Technology

In March 2021, for the first time in India, ISRO successfully demonstrated free-space Quantum Communication over a distance of 300 m.

Quantum Technology:

- It is based on the principles of **quantum theory** which explains nature of energy and matter at atomic and subatomic level.
- It aims to achieve **information processing** beyond the limits of classical world.
- It will be used for solutions to **complex problems** in computing, communications, sensing, chemistry, cryptography, imaging and mechanics.
- It has not yet matured for commercialization, due to the **extreme scientific challenges** involved.
- It can bring to India multifold economic **growth** and dominant **leadership** role.

Ministry of Electronics & IT



75
Azadi Ka
Amrit Mahotsav

QSim is the gateway for Indian scientists to take us in direction of future demands of computing power, MoS IT Shri Rajeev Chandrasekhar

QSim – Quantum Computer Simulator Toolkit launched today

Toolkit to enable Researchers and Students to carryout research in Quantum Computing in a cost effective manner

Posted On: 27 AUG 2021 7:19PM by PIB Delhi

Applications:

- **Cryptography / Secure communications:** e.g. China's Micius satellite that uses Quantum Key Distribution.
- **Faster computers:** e.g. Google's Sycamore is millions of times faster than fastest supercomputer.
- **Industry 4.0:** QT will help faster development of AI and ML based technologies.
- **Cosmology:** it can solve fundamental questions of physics related to black hole, gravity, etc.
- **Medicine:** faster development of vaccines and medicines for untreatable diseases.
- **Disaster management:** Tsunami, cyclone, drought, etc. can be made more predictable.
- **Weather forecast:** more accurate forecast of weather, monsoon, etc.



NEWS SERVICES DIVISION
ALL INDIA RADIO

ALL INDIA RADIO NEWS

Feb 01, 2020, 10:15PM

Budget 2020-21 announces largest ever science mission: A 8000 cr National Mission on Quantum Technologies & Applications

The government in its budget 2020 has announced a National Mission on Quantum Technologies & Applications (NM-QTA) with a total budget outlay of Rs 8000 Crore for a period of five years to be implemented by the Department of Science & Technology (DST).

Finance Minister Smt. Nirmala Sitharaman in Union Budget 2020 speech said that the new economy is based on innovations that disrupt established business models. Artificial intelligence, Internet-of-Things (IoT), 3D printing, drones, DNA data storage, quantum computing, etc., are re-writing the world economic order."

National Mission on Quantum Technologies & Applications:

- **Implemented by:** Dept. of Science & Technology
- **Budget:** 8,000 crore for five years
- **Need:** Global economic order is being re-written by disruptive technologies like AI, IoT, 3D printing, DNA storage, quantum computing, etc.
- **Focus areas:** fundamental science, technology development, human resource, infra development, start-ups.
- **Applications:** aero-space engineering, weather prediction, secure communication, secure financial transaction, cyber security, health, education, agriculture.

Q-Sim: (by MeitY)

- Quantum Computer Simulator Toolkit
- It will help cost-effective R&D in quantum computing

Quantum Frontier Mission:
one of the nine missions of PM-STIAC (S&T & Innovation Advisory Council)

Quantum Information Science and Technology (QuST):
By DST; a mission mode scheme under ICPS program (Interdisciplinary Cyber Physical Systems)

Global developments:

- In 2018, USA allotted \$ 1.2 billion for quantum research.
- **Google's Sycamore** achieved **quantum supremacy**. It did a calculation in 200 seconds that fastest supercomputer would do in 10,000 years.
- Quantum **patents** filed in 2018: 492 by China, 248 by USA.
- China's **QUESS project** that made Micius- world's first quantum enabled satellite

Three primary parts of a Quantum Computer:

- 1) A device that houses qubits
- 2) A method for performing quantum operations
- 3) A classical computer to send instructions

The process of quantum computing:

- 1) Access the qubits
- 2) Initialize the qubits to the desired state
- 3) Perform operations to transform the states of the qubits
- 4) Measure the new states of the qubits

Superposition:

- Qubit can have multiple quantum states at the same time.
- This makes quantum computers exponentially faster than classical computers.

Entanglement:

- It enables particles to affect each other instantaneously across any distance.
- Quite useful to secure communication systems.

Decoherence:

- Due to interference from environment, certain quantum behaviour is lost,
- Just as energy appears to be lost by friction in classical mechanics

Challenges: (Lab → people → technology):

- Weak **infra** for R&D in basic sciences in India.
- **Young talent** in India is more attracted to high paying **MNC jobs** instead of research in basic sciences.
- Controlling qubits is **technically** challenging.
- Creating **algorithms** for quantum computers.
- **Integration** with classical computers will need modifications to existing computers.

Way forward:

- Strengthening institutes for basic sciences like **IISERs**.
- Improving the number and quality of **PhDs** (better stipend).
- More **international** collaboration with friendly countries.

With China and many other countries investing heavily in quantum technologies, India has no choice but to double-down its efforts in this area.

Dark Web

Surface web:

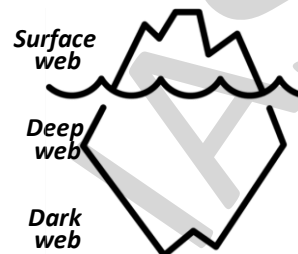
- Everything that can be found by a search engine like Google.
- e.g. info on websites freely accessible by all

Deep web:

- Everything that can't be found by search engine like google.
- One needs authentication (login) to access this info.
- e.g. email; bank statements

Dark web:

- One needs specific software to access this info, e.g. TOR, Freenet
- Uses public internet infra, but its hidden and totally anonymous.
- Used for: trading stolen data; organizing anti-govt. protests



Issues with Dark Net:

Anonymity:

- Due to use of end to end encryption and use of overlay networks, it is almost impossible to identify the actual users.

Illegal activities:

- Anonymity helps users in illegal activities like selling confidential data; drugs, etc.

Payment:

- It uses cryptocurrencies for payment, makes tracking transactions difficult.

Global distribution:

- Users are spread over different countries, making it difficult to crack the network.

Technical competence:

- Law enforcement agencies are not well equipped to deal in such hi-tech areas

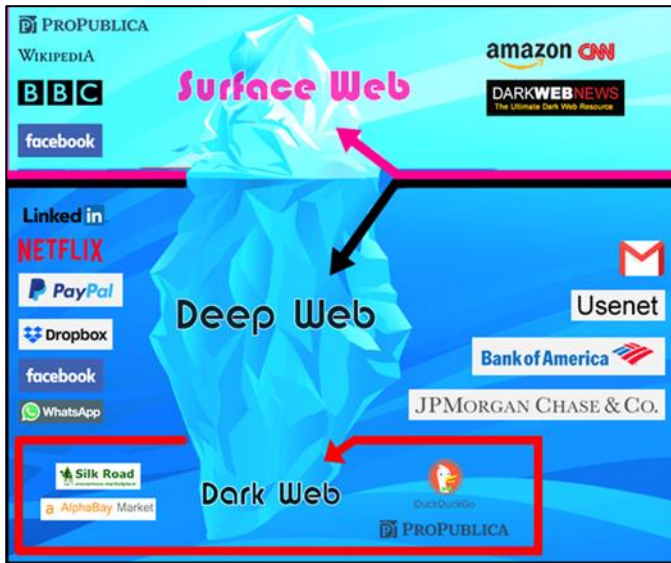
Steps taken:

- Centre has directed immunity for ethical hackers who help police counter dark web crimes.
- CDAC is working with CSIR to develop a darknet telescope to monitor dark web activities.
- Kerala has established a darknet lab in its cyberdome project.

Way forward:

- Amend IT Act and Evidence Act to make prosecution simpler to deal with cyber-crime.
- Greater international cooperation with Interpol, other countries.
- Capacity building of police for covert presence and tracking activities on dark net.

Dark Web



Surface web:

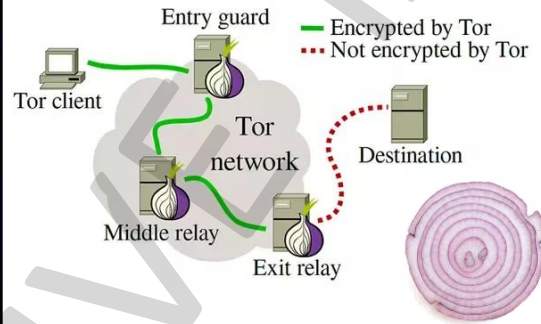
- Open for all, only 5%

Deep web:

- Needs login
- Email, net banking

Dark web:

- Totally anonymous
- By special software like DuckDuckGo, TOR, Freenet



Supercomputer

- 1987: India requested Cray X-MP; USA denied; India started our own mission; CDAC formed
- 1991: **PARAM 8000** (**PAR**Allel **M**achine; also Supreme); 28 times faster than Cray; Exported
- What are Pratyush, Mihir and Param (8000... Shivay, Shakti, Brahma...)? **Supercomputers**
- Fastest: PARAM Siddhi-AI** (210 AI PetaFlops / 5.3 Pflops / 4.5 Pflops) (completely indigenous? No)
FLOPS = Floating Operations Per Second (K:1000; M:million; G:billion; T:trillion; P: 1000T)

National Supercomputing Mission:

- 2015; MoS&T / Meity; implemented by CDAC
- Create a network of 70 high performance computing facilities (Supercomputing grid)
- Link to National Knowledge Network

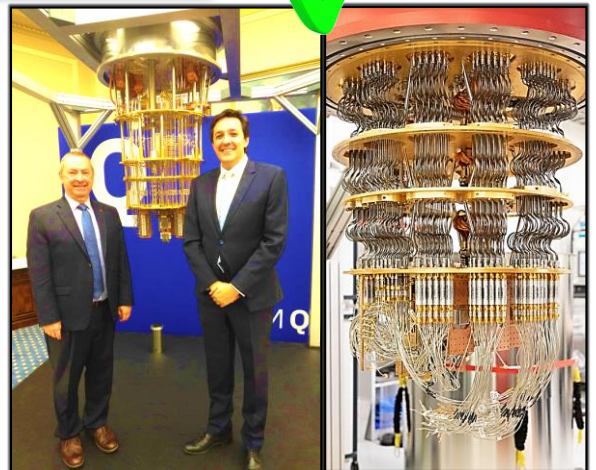
C-DAC:

- 1987 / MEITY
- Centre for Development of Advanced Computing



NKN: (2010)


inter-connect all research institutions in India through a high bandwidth network

Quantum Computer



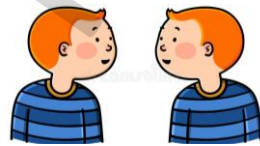


I read I forget, I see I remember | See explanation of this PDF on [YouTube](https://www.youtube.com/c/allinclusiveias) www.youtube.com/c/allinclusiveias

	Classical Computers	Quantum Computers
Based on	Classical physics	Quantum physics (physics at atomic/subatomic level)
Uses	Transistors	Photons and electrons
Basic unit of info	Bit State of transistor at any instant	Qubit State of photon/electron at any instant
Basic principle	At a time, Bit can take single value from either of the two values: either 0 or 1 (like a tube light). 	At a time, Qubit can take multiple values , i.e. at a time a qubit can be both 0 and 1 (like a fan with regulator) (Superposition) 



3 billion transistors

Moore's law: observation that every two years transistors on chip doubles but cost becomes half

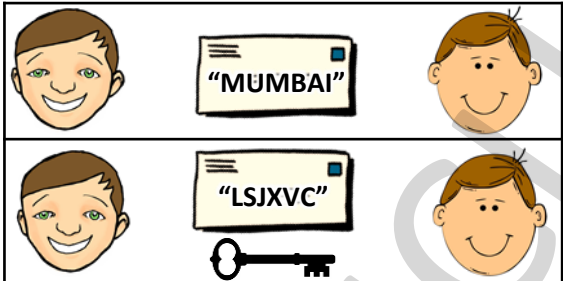
Classical (Binary)	Quantum (Superposition)	 <p>Entanglement <i>Einstein: spooky action at a distance</i></p>
		

Quantum Metrology: Using Quantum theory to take highly sensitive **measurements**.

Quantum Cryptography: Using Quantum theory for secure **communication**.

Quantum supremacy:

- QC solving a problem that Classical Computer cannot in feasible amount of time.
- Google's **Sycamore** solved a problem in 200 seconds that fastest SC will take 10,000 years.



Top row: Sender (face) → Message "MUMBAI" → Receiver (face)

Bottom row: Sender (face) → Message "LSJXVC" + Key → Receiver (face)

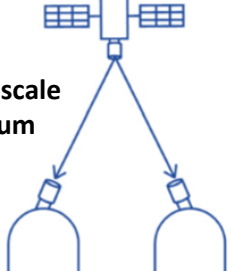
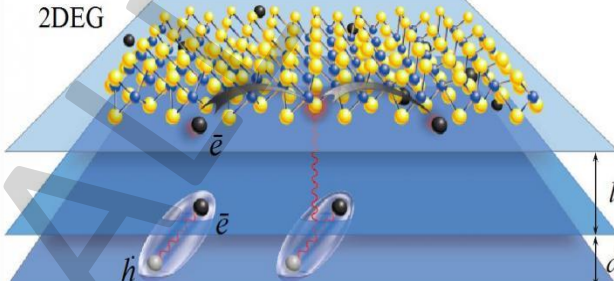
	Traditional Cryptography	Quantum Cryptography
Based on	Mathematics	Quantum physics
Secured by	Code	Quantum state of particle
Safety	Code can be deciphered by powerful computers	if one attempts to read the encoded data, the quantum state will be changed

National Mission on Quantum Technologies and Applications:

- Launched in 2020
- Budget: ₹ 8,000 crore for five years
- Dept. of Science & Technology

QUESS (China)

- Quantum Experiments at Space scale
- Made '**Micius**' world's 1st quantum comm. satellite.
- Uses Quantum Key Distribution

2DEG

2DEG: Two-Dimensional Electron Gas

- Ultra-**high mobility** 2-D electron gas
- Produced at **INST**, Mohali, Punjab (D.o.S&T)
INST = Institute of Nano Science & Technology
- Use in **Quantum devices** (speed, storage, etc.)

Spintronics: (spin-electronics)

- Application in modern electronic devices
- Manipulating **spin degree of freedom** of electron
- Uses **Rashba effect** (splitting of spin-bands)

Blockchain

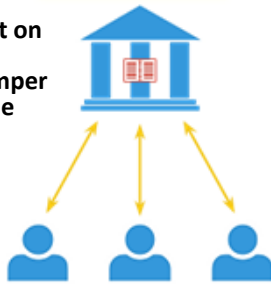
MeitY has released National Strategy on Blockchain

To understand Blockchain, we need to understand "distributed ledger":

- ❑ **Ledger:** a book that records all transactions
- ❑ **Centralized ledger:** ledger is kept in one place
- ❑ **Distributed ledger:** ledger is kept in different places

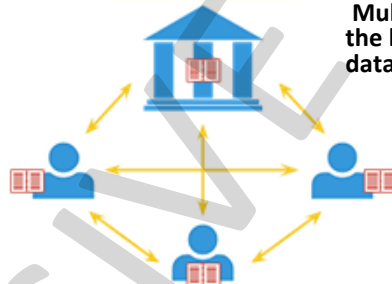
Centralized ledger

Everyone is dependent on the central party. Central party could tamper data without anyone knowing about it.



Distributed ledger

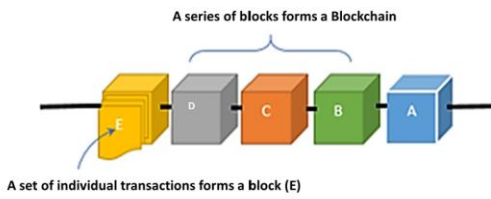
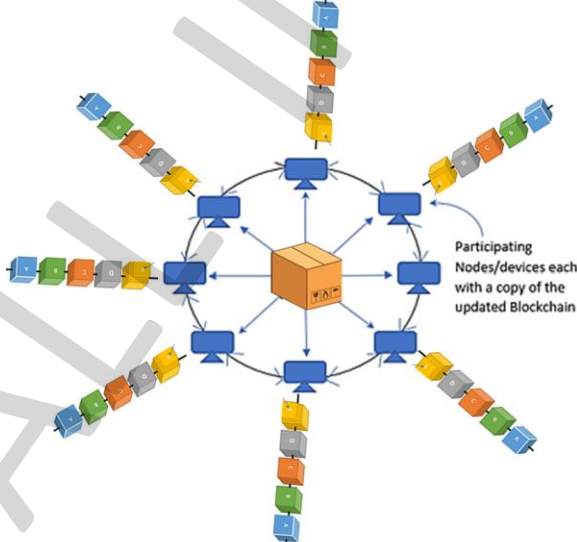
Multiple parties hold the ledger. Tampering data in one ledger will be of no use.



What is Blockchain?

- A Blockchain is a distributed ledger, that chronologically records transactions.
- It uses cryptography to securely recording transactions.
- Data in a Blockchain is not stored in any single location.
- Absence of centralised database reduces chances of data corruption.
- There is no central authority.

How does a Blockchain work? (see steps given on next page)



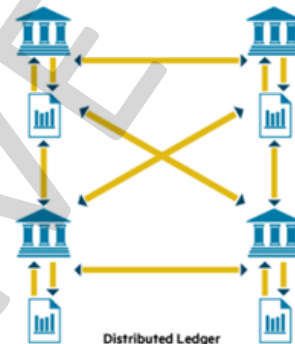
How Blockchain works: (Transactions → Blocks → Nodes → Chain)

- Transactions are recorded and grouped into blocks.
- Each block is identified by a unique code called hash.
- Blocks are sent to number of participants (nodes) for record purpose.
- Each node adds the new block to existing chain of blocks.

Mention some applications of Blockchain:

- Cryptocurrencies (discussed as separate topic)
- e-Voting in elections. Blockchain can allow voters to vote from far away cities.
- Reducing health insurance claim frauds where single hospital bill is claimed with multiple insurance companies. Sharing of health records can prevent this.
- Prevent Banking frauds. Sharing of KYC and asset hypothecation can prevent frauds like keeping single property as collateral with multiple banks. For example 'Bankchain' by SBI.
- Logistics: to track movement of goods in supply chain using all stakeholders are nodes.
- Critical citizen information like land records can be maintained as Blockchain powered tamper proof distributed ledgers.

Due to various applications of Blockchain, World Economic Forum (WEF) estimates that 10% of the global GDP will be stored on Blockchain by 2025.



What are the challenges associated with implementing Blockchain on wide scale?

- High initial investment cost in creating the framework.
- Immense use of electricity as each transaction involves thousands of nodes.
- Data privacy issues as data is stored in multiple places.
- Creating a legal or regulatory framework will be difficult due to decentralised nature of technology.
- More data centres will be needed. Electronic manufacturing has not yet picked up in India.

What are some recent government initiatives in the field of Blockchain:

- Andhra Pradesh experimented Blockchain for land records & vehicle registrations.
- West Bengal is issuing Blockchain based Birth certificates to newborns to prevent manipulation in data.
- NITI Aayog is building a platform 'IndiaChain' as a common Blockchain infra for various govt. departments. It will help apply Blockchain in many areas like maintaining land records, identity management, subsidy distribution, educational certificates authentication, etc.

What are Presidio Principles? (Blockchain Bill of Rights):

16 principles by WEF to protect rights of participants of Blockchain systems. Broadly:

- Right to Information about the system. Participant has right to know how the system is being operated and potential risks.
- Right to own and manage data. Participant should be able to give and revoke consent to future data collection.
- Right to data protection. Participant's data should be secured and used only for the purpose for which it was provided.
- Right to recourse. Participant should be able to rectify false data and access grievance redressal mechanism.

National Strategy on Blockchain by MeitY

Blockchain can bring lot of value addition in e-Governance:

- (Government procedures involve multiple departments)
- Inter-departmental processes can be tracked, it will increase **transparency** and accountability in the system.
- Blockchain, as single source of truth, can be used for **verification of transactions** by various departments
- Blockchain can be used for **smart contracts**, inter-department communication and tamper evident **storage**.
- Blockchain can help officials to **verify documents** by comparing provided copy with BC copy.

Global Efforts:

- **China:** Blockchain-based Service Network (BSN) helps companies deploy BC faster and cheaper by providing standard developer tools.
- **UAE:** "Smart Dubai" initiative aims to make Dubai the first city fully powered by Blockchain.
- **USA:** Food and Drug inspection is using BC to bring transparency in health data processing.
- **UK:** Food standards agency is using BC to track distribution of meat to increase traceability.

Indian scenario:

- **MeitY** has released **National Strategy** on Blockchain
- BC based **property registration** is being piloted at Shamshabad District, **Telangana**.
- **Centre of Excellence** (CoE) in BC has been established by National Informatics Centre.
- **NITI Aayog** has piloted various use cases in BC with Govt departments and Private agencies. These use cases include land records, pharmaceutical supply chain, fertilizer subsidy disbursement, educational certificates.

Challenges to the adoption of Blockchain Technology

TECHNOLOGICAL CHALLENGES:

- **Performance and Scalability challenges:**
 - **Decentralized** architecture of Blockchain means it will be **slower** than traditional systems
 - Data is **replicated at each node**, this may lead to **performance issues** (higher computing power)
 - Data in BC cannot be modified, and is **stored forever**. This will become an issue as the chain of blocks grow.
- **Skillset and Awareness related challenges:**
 - Requires **skilled manpower** in multiple technologies
 - Underlying **technology** that builds Blockchain is **still emerging**
 - Hiring blockchain experts is **more costly** than hiring software developers.
 - Manpower who knows both Domain & Technology is **rare to find**.
- **Security, Privacy and regulation challenges**
 - Data is stored on **every node** on the network, this increases **risk to privacy**.
 - Regulations for BC applications are still **ambiguous**.

LEGAL CHALLENGES:

- **RBI** has imposed certain **restrictions** on virtual **currencies** based on Blockchain technology
- **IT Act 2000** schedule-I does not include **wills, negotiable instruments**, etc.
- **IT Act 2000** section-43A does not have **safeguards** from the perspective of **privacy** when applied to Blockchain.
- **Right to be forgotten** can't be achieved since in BC **data cannot be deleted**.
- **Localisation of data** will be difficult as BC stores data across **multiple nodes**.

Need for National Level Blockchain Framework:

- It can help in:
 - creating a **shared infra**
 - **cross domain** application development
 - **scaling up** already deployed applications
- On the indigenous BC platform, **domain specific chains** will be hosted, like property chain, health chain, education chain.
- Following services can be integrated with Unified Blockchain Framework:
 - **e-Sign:** it helps citizens digitally sign the documents
 - **E-Pramaan:** It helps in authentication of citizens when accessing govt services
 - **DigiLocker:** a cloud account to store documents

Cryptocurrency

In March 2020, Supreme Court struck down a ban on trading of Virtual Currencies (including cryptocurrencies) in India, which was imposed by the Reserve Bank of India (RBI) in April 2018.



Real currency
in Real storage



Real currency
in Real storage



Real currency
in Virtual storage



Virtual currency
in Virtual storage

CAUTION: following points are not directly relevant

2018 April:

RBI issued circular prohibiting banks/NBFCs from providing services in relation to virtual currencies. Internet and Mobile Association of India (IMAI) had challenged RBI's circular.

Arguments by IMAI:

- Cryptocurrencies are **not currency**, but commodity.
- **No law** prohibits cryptocurrencies.
- **Article 19(1)(g)** gives freedom of business & trade. Since no law bans cryptocurrencies, trading in cryptocurrencies is "legitimate" business activity.
- **Other countries** have allowed as well as launched their own cryptocurrencies.

Supreme Court in March 2020:

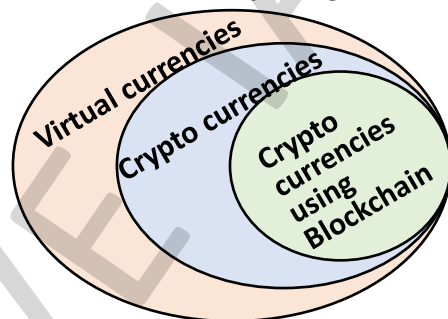
- 1) **No bank/NBFCs suffered any loss** on account of virtual currency exchanges.
- 2) RBI itself said that **virtual currencies are NOT banned** in India.
- 3) RBI/Govt. have not provided people with any **alternative**.
- 4) Further, the court also pointed out the **Centre's failure** to introduce an official digital rupee despite two draft Bills and several committees.
- 5) Virtual Currency (VC) are **neither commodity, nor real money**.
- 6) The Court held that the RBI directive came up short on the following five-prong test to check **proportionality**:
 - i. Direct and immediate impact upon **fundamental rights**.
 - ii. The larger **public interest** sought to be ensured.
 - iii. Necessity to restrict citizens' **freedom**.
 - iv. Inherent harmful nature of the act prohibited or its capacity or tendency to be **harmful** to the general public.
 - v. The possibility of achieving the same object by imposing a **less drastic restraint**.

Other countries:

- China, Russia, and Vietnam have imposed **near total prohibition** on any transactions using cryptocurrency.
- US, UK, Japan, Canada, Singapore, and Australia have **accepted the use** of VC in some form or the other. Japan accepted Bitcoin as legal property in 2017.

Virtual and Cryptocurrencies:

- There is **no globally accepted definition** of virtual currencies.
- Some call them **commodity**, others **method of exchange** of value.
- Satoshi Nakamoto**, widely regarded as the founder of the cryptocurrencies, defined bitcoins as a **new electronic cash system** that's **entirely peer-to-peer**, i.e. there would be **no central regulator**. This is because they would be placed in a globally visible ledger and all users would be able to see and keep track of the transactions taking place.
- Virtual currency** is the larger umbrella term for all forms of non-fiat currency being traded online.
- Cryptocurrencies** are a type of virtual currency that have an extra layer of security, in the form of encryption algorithms. Cryptographic methods give security to currency as well as the network on which they are being traded.
- Most cryptocurrencies now operate on the Blockchain**, which allows everyone on the network to keep track of the transactions occurring globally.



Advantages Of Crypto Currencies:

- It is difficult to create **counterfeit** cryptos compared to physical notes and coins.
- People get rare **choice** to choose among multiple currencies.
- They are digital hence **easy to use** compared to physical currency.
- International usage is simple as there is **no forex charges** and no control of central banks.
- They are **highly secure** as it is practically not possible to change information blocks of thousands of computers.

Issues Related To Crypto Currencies:

- Cryptocurrencies may be used for **speculative trading**, instead of payments.
- Volatility of value**: They experience high price volatility compared to physical currencies.
- Money supply**: Central banks control on money supply in the economy will weaken. Monetary policy may become ineffective and irrelevant.
- Difficult to Regulate**: They are decentralized, hence not easy to regulate.
- Cyber frauds**: they are new hence, people know little about them, making them vulnerable to phishing attacks and frauds.
- Irreversibility**: Transactions are irreversible, so there is no way to reverse wrong payment
- Money-laundering**: Transaction are completely anonymous, hence they can be used for money-laundering and terrorist funding activities.
- Tax Evasion**: Due to anonymity they can be used to hide actual income.
- Electricity**: authenticating each transaction requires processing by thousands of computers, hence needs large amount of electricity if adopted on wide scale.

The crypto conundrum: (newspaper 02-11-2021)

- **Value** of cryptocurrencies has been **increasing**, but its **not sustainable**.
- Cryptos don't have significant **use value** (like commodities) or **exchange value** (like shares).
- Currently, there is **speculative trading** in cryptos.
- In future, if cryptos become serious **rival to fiat** currencies, then **govt will ban** them.
- Governments control money supply. Cryptos are like a **challenge to authority** of governments.

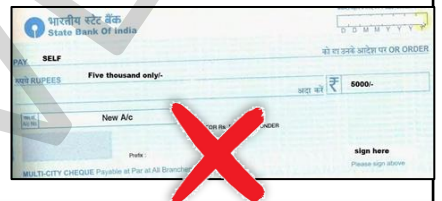
Legal tender:
 Money recognized by law of and **cannot be refused** by any citizen of the country

Legal tender / fiat money

Fiat money:
 (Dollar, Euro, Rupee, etc.)
 Money with **no intrinsic value**.
 Not backed by gold (physical commodity)
 Backed by govt authority
 Problem: print as much as one wants

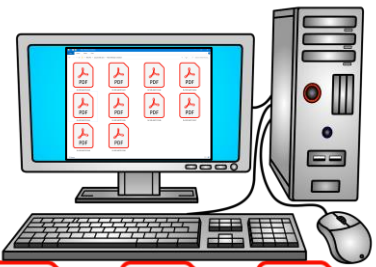
Prelims 2018:
 Which one of the following statements correctly describes the meaning of **legal tender** money?
 (a) The money which is tendered in courts of law to defray the fee of legal cases
 (b) The money which a creditor is under **compulsion to accept** in settlement of his claims
 (c) The bank money in the form of cheques, drafts, bills of exchange, etc.
 (d) The metallic money in circulation in a country

❖ **Coins** are issued by Central **Govt**.
 ❖ **Notes** are issued by **RBI**.
 ❖ But **One Rupee note** is issued by Central **Govt**. It has sign of **Finance Secretary**



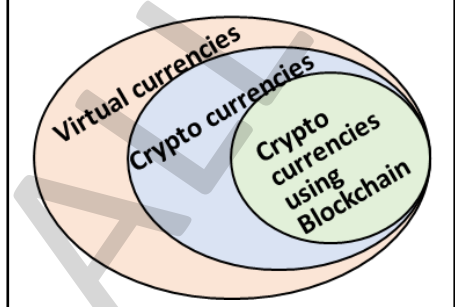
Central Bank Digital Currency

- Legal tender issued by a central bank in a **digital form** only (no physical form)
- It is the same as a fiat currency and is **exchangeable** one-to-one with the fiat currency.
- It can be **spent only electronically**.



In India, cryptocurrencies (e.g. Bitcoin) are **not banned**

Regulated by Central bank → **Digital** currency
Not regulated by Central bank → **Virtual** currency



Digital Renminbi (Digital RMB; e-CNY)
 Central bank digital currency issued by China's central bank
 First digital currency to be issued by a major economy
 It is a **legal tender**, has **same value** as physical renminbi
 Can be transferred between two **offline** devices

El Salvador:
 first country to adopt **Bitcoin** as **legal tender**
 Note: Bitcoins in Japan are legal property, not legal tender

Subhash Chandra Garg Committee 2019:

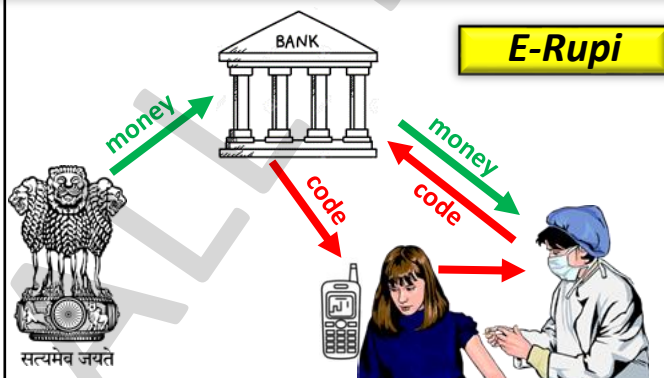
- ❑ recommended **ban** on **private** cryptocurrencies:
 - volatility, instability, security risk, risk of funding illegal activities.
- ❑ highlighted **benefits** of **official** digital currency:
 - Promote **cashless** society
 - Increase in **Financial Inclusion**
 - Encourage development of **Fintech** sector
 - Provide a **real time picture of economic activity** and hence better GDP estimates and efficient monetary policy formulation
 - **Traceability of transactions** will help in controlling corruption and money laundering
 - **Counter** the monopoly of **private** sector issued cryptocurrencies

Reduce **cost** of printing and transporting.

Reduce scope for **counterfeiting**.

Challenges:

- ❑ **Digital Divide:**
 - smart phone, internet connectivity
- ❑ **Low Financial Literacy:**
 - people vulnerable to fraud
- ❑ **Security risk:**
 - cyber attack at individual or network level

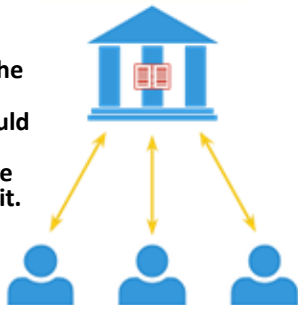


- electronic **voucher**
- **not** digital/virtual **currency**
- **person**-specific and **purpose**-specific
- can be shared via **SMS** or QR code
- Developed by **NPCI**, MoHFW, etc.
- Beneficiary need not have bank account or smart phone
- Not restricted to health sector or public sector (private companies can also use, e.g. fuel for fleet)

Blockchain

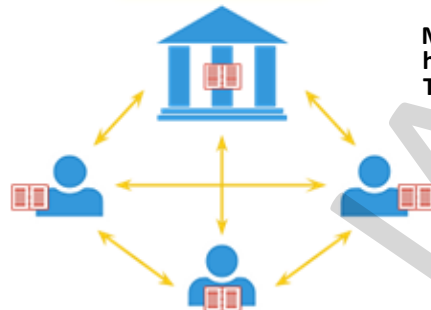
Centralized ledger

Everyone is dependent on the central party. Central party could tamper data without anyone knowing about it.

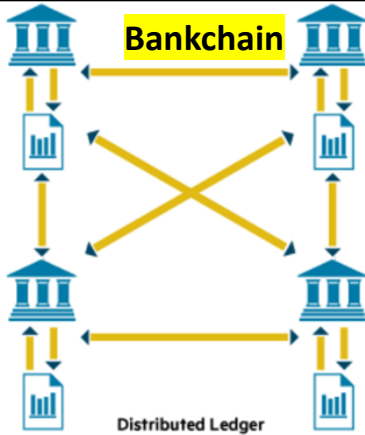


Distributed ledger

Multiple parties hold the ledger. Tampering data in one ledger will be of no use.



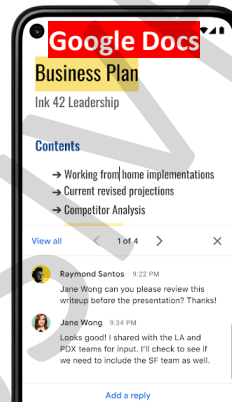
Bankchain



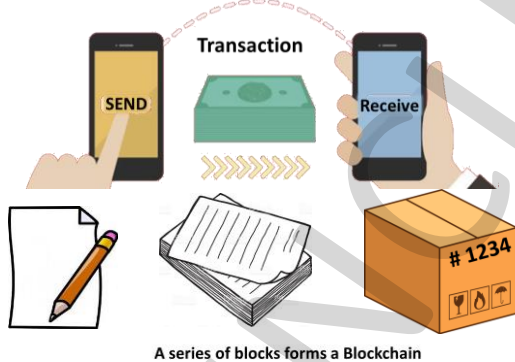
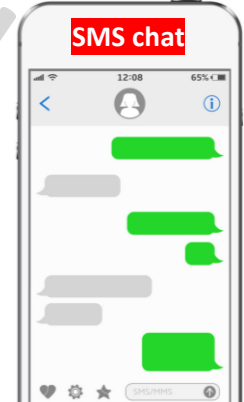
Distributed Ledger

- By SBI in 2017, includes many private banks
- KYC, consortium lending, asset hypothecation, etc.

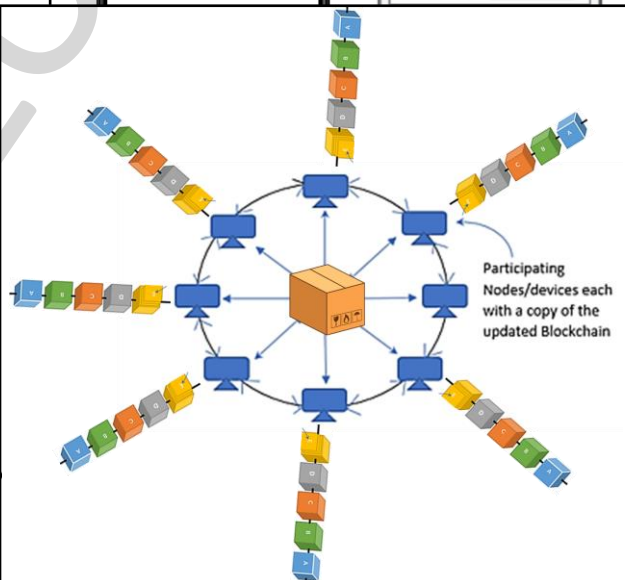
Digital Ledger Distributed Ledger Editable



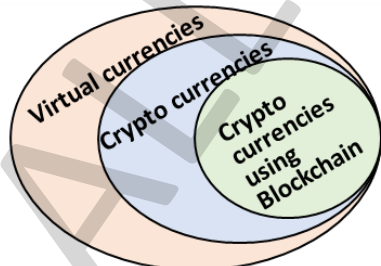
Digital Ledger Distributed Ledger Non-Editable



A set of individual transactions forms a block (E)



Cryptocurrency



- Usually **not issued by Central bank** of country
- Anyone with computer can mine.
- Same value across the world
- Problems: anonymity, electricity, volatile value, money supply
- Examples: Bitcoin, Ethereum, Ripple, Litecoin, Tether

I read I forget, I see I remember | See explanation of this PDF on [YouTube](https://www.youtube.com/c/allinclusiveias) www.youtube.com/c/allinclusiveias

All-Inclusive GS-2 & GS-3 MAINS 2021

Class-17

Drones

Drone: Aerial vehicle without human pilot on board.

Applications:

- Defence:** reconnaissance, strike; e.g. DRDO Rustam; USA's Predator
- Law enforcement:** crowd management; traffic control;
- Agriculture:** monitor crop health; spray insecticides
- Miscellaneous:** e-commerce product delivery, vaccine delivery to remote areas, make GIS maps; Search & rescue after disasters; photography, recreation, smuggling across borders.

Need to regulate drones:

- Can cause damage to **people and property** on ground.
- Can interfere with **air traffic** control, especially near airports.
- Can be misused for unauthorised **surveillance**, especially of **sensitive areas**.
- **Terrorist attacks** can be carried out without fear of being caught.

Challenges:

- Accessibility:**
 - Easy **access** to product/technology by both state and non-state actors.
 - Easy **operation**, no sophisticated training required.
- Low risk:**
 - No chance of any defence **personnel** being captured by enemy.
 - Difficult to trace the **operator**.
 - Much **cheaper** than fighter jets / bombers.
- Detection:**
 - Small **size** makes detection difficult by radar.
 - Can be mistaken for **bird**, difficult to **see** if at good altitude.
- Counter-measures:**
 - Difficult to shoot down by conventional **guns**.
 - Need new technologies/weapons, still **under development**.

Steps taken / should be taken:

- Greater **surveillance** at borders with both **man and machine**, involving **local** people also.
- **Anti-drone systems** are being developed by DRDO, private sector, academia, etc.
- **International collaboration** to develop/procure systems from other countries.
- Using **attack** drones against enemy.

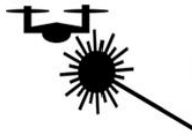
- 'Digital sky platform'** → Portal to register drones, and get permission to fly it.
- 'No permission, No take-off' policy** → Take permission each time you want to fly a drone
- Drone **Rules 2021** by Ministry of **Civil Aviation**
 - It is mandatory to get drones registered, except Nano drones (< 250 grams)
 - If weight > 500 kg, Aircraft Rules 1937 shall apply
 - Airspace has been partitioned into **Red Zone** (flying not permitted), **Yellow Zone** (controlled airspace), and **Green Zone** (automatic permission)

National Counter Rogue Drone Guidelines:

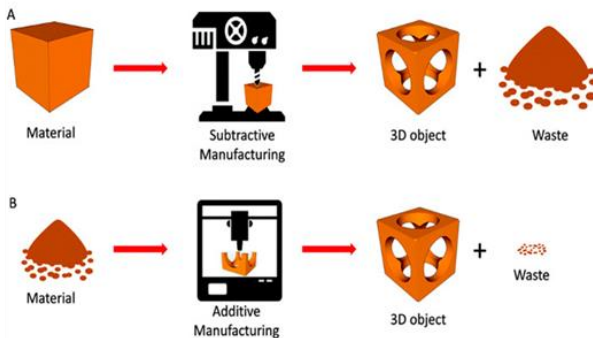
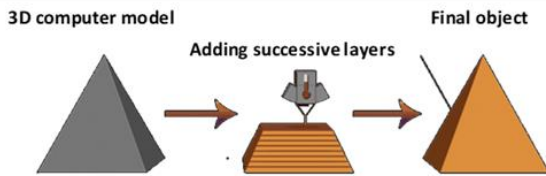
- By Ministry of Civil Aviation in 2019, to handling the threats from Unmanned Aircraft Systems
- Outlines three models to counter rogue drones, based on threat perception:
 - **Full-scale model** with detectors like radars and full countermeasures. (for places like Rashtrapati Bhavan, Parliament house)
 - **Mid-segment model** with some counter measures (for places like power plants, oil refineries)
 - **Basic model** (important govt offices)

Methods to control drones:

- **Sky fence**: disrupt signals to prevent drone from entering an area
- **Drone gun**: jam signals to bring it down to the ground.
- **Laser**: damage drone by high energy laser beam
- **Net**: throw a net around drone with a gun
- **Bigger drone**: use a bigger drone with net to catch smaller drone



Additive Manufacturing



3D Printing

From Prelims 2021

What it is?

- ❑ Manufacturing by adding successive layers (just like buildings are made!!!)

Benefits?

- ❑ Direct CAD model to manufacturing
- ❑ Totally automated
- ❑ Negligible material wastage
- ❑ High customization possible

Applications?

- ❑ Almost anything that's made in factories
- ❑ Also, biological organs, tissues, implants (knee, hip), etc

National Strategy on Additive Manufacturing

Objectives: (Don't learn the following)

- Promote all **sub-sectors** of AM sector: machines, materials, software, and design.
- Encourage **global** AM leaders to **set up** their operations in India.
- Encourage **local** manufacturers to **adopt** AM technology (give financial incentives)
- Strengthen India's **collaborations** with global AM leaders.
- Bring together industry, academia and govt on a **single platform**.
- Position India as **global hub** of AM.
- Promote creation of Indian **IPR**.
- Encourage domestic manufacturing, **reduce import dependency**.

What is AM?

- Technology that constructs 3D objects from CAD model by **adding material layer by layer**.
- **Materials used in AM:** Thermoplastics, Metals, Ceramics, Biomaterials (e.g. bio-ink made from stem cells)
- Addition of material can happen by powder deposition, resin curing, filament fusing.

Other countries:

- Global market share in AM → 36% USA, 26% EU, 14% China, 1.4% India
- **USA:** US Navy has world's largest 3D concrete printer to make 500 sq. ft. barracks in 40 hours. (Can India use in Ladakh?)
- **China:** world's first 3D printing educational institute in Guangzhou. Installed 3D printers in all 4 lakh elementary schools during 2015-17.
- **UK:** established National Centre for AM
- **South Korea:** introduced National Certification test for 3D printing in 2018

Steps taken to promote AM in India:

- 3D printing **Lab** and **certificate** course at **National Institute of Electronics** and Information Technology, **Aurangabad**
- **Atal Tinkering Labs** (under Atal Innovation Mission) provide Do-it-yourself kits on 3D printing.
- **Department of Heavy industries** and Wipro are building India's first industrial grade 3D printer.
- **Wipro** has launched 'Addwize' program to help companies adopt AM.

Benefits of AM:

- Decrease **cost** due to less use of labour.
- Manufacturing will become a **single step** process.
- Democratization of **innovation** by empowering individuals to design and fabricate.
- Reduce use of raw material, **efficient use** of natural resources, reduce carbon footprint.

Some applications:

- **Healthcare:** patient-specific customized implants (knee, hip, tooth)
- **Prototypes:** easy manufacturing and testing of prototype designs (no need to manually make the prototypes). This will encourage innovation and experimentation (colleges!)
- **Aerospace & Defence:** for highly specialised and complex parts needed in low volume. This will speed up the manufacturing process.

Challenges to adoption:

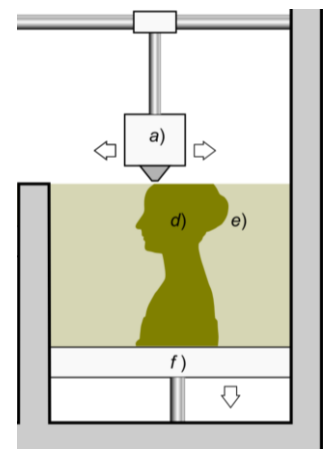
- **Cost of Equipment & Material** is high as most of them are imported.
- **Lack of formal AM Standards.** Standardization will ensure quality and build confidence.
- **Lack of AM Ecosystem.** Only few service providers and even they don't have latest technology.
- **Lack of skilled manpower** (trained & experienced) is a major obstacle in AM adoption.
- **Unemployment** in blue collar workers will increase, re-training programs will be needed.
- **Security issues:** It will become easy to create parts of nuclear centrifuge, missiles, guns, etc.
- **Ethical issues:** it is possible to print organs that are more advanced than regular human organs.
- **Legal issues:**
 - Who is **liable** if product malfunctions: Powder supplier or CAD designer or printer supplier
 - Does **download** of CAD file amounts to **import**?
- **Technical challenges:**
 - Slow fabrication speed
 - Limited types of options on AM suitable materials

Actionable recommendations:

- Create National Additive Manufacturing **Centre**
- Develop **standards** for quality assurance of AM products.
- Included AM in **courses** at IITs, NITs, ITIs.
- Strengthen existing **laws** to address challenges that may emerge.
- **Online courses** and National Skills Qualifications Framework **NSQF certification.**
- Incentivize companies to **re-skill** their **workforce**, allow use of **CSR funds** for this.

Process:

- **CAD model** is made in computer.
- **Slicing software** divides model into multiple layers.
- **3D printer** receives command from software.
- **Successive layers** are deposited to create 3D object.



Anti-Microbial Resistance**What is AMR?**

- It refers to the situation where microorganisms evolve and **no longer respond to medicines**.
- It makes **treatment difficult**, increasing risk of faster disease spread, severe illness and death.
- Such evolved microorganisms are also referred as '**Superbugs**'.
- e.g. **NDM-1**, a superbug first discovered in New Delhi in 2009 in a foreign patient.

Reasons for AMR:

- Using **incorrect doses** antibiotics to cure disease.
- Increasing trend of **self-medication**.
- Patients not completing **full course** of medicines. e.g. TB
- Using antibiotics in **livestock** and agriculture.
- Pharma companies discharging **effluents** into rivers.

Twin challenge before India?

- Antibiotics are **cheap** as well as **effective**. They help poor people quickly overcome illness and get back to work.
 - But, **more use** of antibiotics means **more AMR**.
- So, its beneficial immediately, but dangerous in long term.

Way forward:

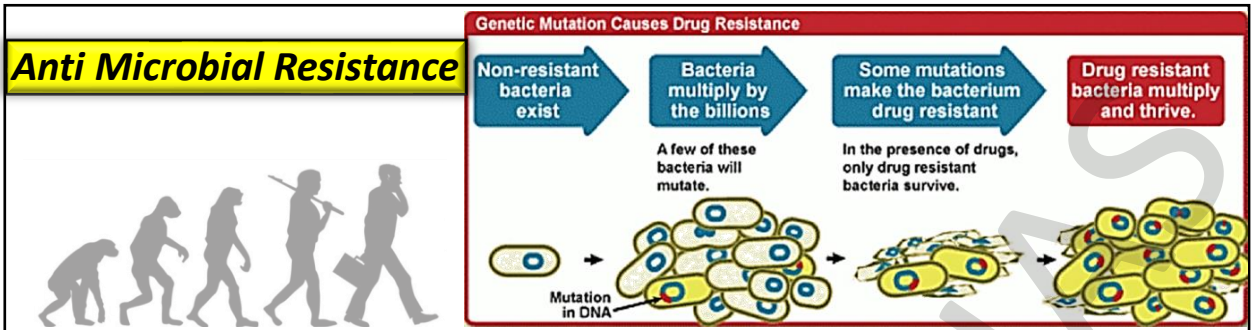
- Sensitize **doctors** not to over-prescribe antibiotics (done for quick relief)
- Action against **chemists** violating Schedule H-1 of Drugs & Cosmetics Rules 1945
- Awareness in **public** about dangers of frequently consuming antibiotics.
- Effluent treatment at **pharma** companies and hospitals.
- Encourage use of alternative systems of medicine like **Ayurveda**.
- To reduce use of antibiotics in animals, use **vaccination** and hygienic surroundings.

Steps by India:

- **Red line campaign** urging people not to use medicines marked with red line without prescription.
- **Schedule H1** under Drugs and Cosmetics Rules 1945 to prevent antibiotics overuse.

Global steps:

- **Global AMR Surveillance System** by WHO. Standard approach to collect and share AMR data.
- **AWaRe tool**: Access, Watch, Reserve. Online portal by WHO to guide governments and doctors on AMR.
- **Global AMR R&D Hub** by EU and 16 countries. Launched in 2018 in Berlin. India recently joined it.



Antimicrobials:
 medicines for infections e.g. antibiotics, antivirals, antifungals and antiparasitics

Antimicrobial Resistance:
 Bacteria, viruses, fungi, parasites change over time and no longer respond to medicines

Superbugs:
 multi- and pan-resistant bacteria that are not treatable with existing medicines.

Twin challenge before India?

- Antibiotics are cheap & effective. They help poor people quickly overcome illness at low cost.
- But, more use of antibiotics means more AMR.

New Delhi metallo-beta-lactamase 1 (NDM-1)

- A superbug, first found in New Delhi in 2009 in a Swedish national
- Origin: unknown (it may not be Delhi)

Prelims 2019:
 Which of the following are reasons for occurrence of multi-drug resistance in microbial pathogens in India?
 1. Genetic predisposition of some people
 2. Taking incorrect doses of **antibiotics** to cure diseases
 3. Using **antibiotics** in livestock farming
 4. Multiple chronic diseases in some people
 Select the correct answer using codes given below
 (a) 1, 2 **(b) 2, 3** (c) 1, 3, 4 (d) 2, 3, 4
 Also, waste water from pharma factories and hospitals

Reasons: (as per WHO website)

- Misuse/overuse of **antimicrobials**
- Lack of clean water and **hygiene**
- Poor disease **prevention**
- Poor access to quality, affordable medicines, vaccines and **diagnostics**
- Lack of awareness and **knowledge**
- Lack of enforcement of **legislation**

LOOK OUT FOR THE RED LINE

Awareness campaign: don't use medicines marked with red line, without a doctor's prescription.

H & H1 are schedules of Drugs & Cosmetics Rules, 1945

Schedule H Drugs?

- Sold only on doctor's prescription

Schedule H1 drugs?

- Chemist needs to record in a separate register: doctor, patient, drug, quantity.
- Since 2013; to control AMR due to antibiotics overuse
- These are 3rd & 4th generation antibiotics, anti-tuberculosis drugs and certain habit-forming drugs like psychotropic drugs.

Fixed Dose Combination:
 Medicines with two or more drugs in single dose

AWaRe tool:

- Access, Watch, Reserve
- portal by WHO to guide govts & doctors on AMR

Global AMR R&D Hub:

- 2018; Berlin, Germany
- India recently joined it

Interagency Coordination group on AMR:

- By UN in 2017
- for coordination

Global Leaders Group on AMR:

- formed by WHO, FAO, WOA
- on recomm. of ICG on AMR

World Organisation for Animal Health: 1924; Paris

- Inter-govt org; not UN body
- 182 members (India also)

Zoonoses

- ❑ **Zoonosis:** It is an infectious disease that has jumped from a non-human animal to humans.
- ❑ **e.g.** Plague, Rabies, Ebola, Corona viruses (SARS, MERS, SARS-Cov-2)
- ❑ It can be caused **by** bacteria, virus, fungi, parasite.
- ❑ It can spread **through** food, air, water.
- ❑ **People at high risk:** dealing with meat of wild animals, living near to wilderness, agricultural workers, etc.

Why are zoonotic diseases on rise?

- **Climate change** is creating stress on animals and their environment.
- **Pollution** of environment created by humans is exposing animals to new elements.
- Loss of **habitat** brings animals in close contact to humans.

Challenges in controlling zoonotic diseases:

- **Late identification** of disease in animals due to lack of regular testing.
- **Lack of cooperation** between veterinary doctors and MBBS doctors.
- **Mutation in pathogen** makes identification and treatment difficult.
- **Increased globalization** (movement) quickly spreads pathogens across the world.

Steps taken:

- **WHO** has issued **guidelines** to reduce risk of zoonotic diseases.
- Ministry of S&T has constituted a National Expert Group on **One Health**.
- Ministry of H&FW has been running (since 2004) **IDSP** Integrated Disease Surveillance Programme to detect outbreaks of epidemic prone diseases.
- **Manhattan Principles:**
 - Set of 12 principles finalised by Wildlife Conservation Society in 2004.
 - They recognize the link between human and animal health.

Way forward:

- Get early warning of human disease by **monitoring animal health**. For example, birds often die of West Nile Fever before people in the same area get affected.
- Easiest way to protect people is to **control zoonotic pathogens** in animals.
- Increase focus and expenditure on **veterinary health facilities**.
- Include One Health approach in **public health policies** of all countries.
- **Genome mapping** of pathogens to detect and track mutations.

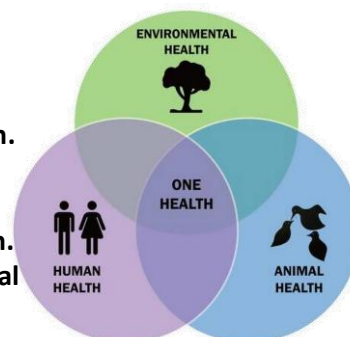
WHO guidelines (April 2021):

- **Stop markets** that sell **wild** animals.
- **Food markets** should have better **hygiene** and crowd control.
- **Food inspectors** should be **trained** to enforce regulations effectively.
- **Improve disease surveillance** mechanisms for early warning of outbreaks
- **Increase awareness** among all stakeholders (shopkeepers, people) about zoonotic diseases.

What is 'One Health'? Why is it important?

Zoonotic origins of Corona has increased focus on 'One Health'

- ❑ The term was first used in **2003-04** with reference to SARS disease.
- ❑ It means **interdependence** of human, animal & environmental health.
- ❑ Deterioration in health of any **one** of them **impacts** health of **others**.
- ❑ It is important because:
 - **60%** of all contagious diseases affecting humans have **zoonotic** origin.
 - 5 new human diseases appear every year. 3 of them are of animal origin.



Rare Disease

MoH&FW has released National Policy for Rare Diseases 2021

About rare disease:

- A disease that **affects small percentage of population**.
- WHO defines it as lifelong disease affecting less than **1 in 1000** people.
- Examples: Haemophilia, Thalassaemia, Sickle-cell Anaemia
- **80%** of rare diseases are **genetic** in origin.
- **7,000** rare diseases have been identified **globally**, and about **450** in **India**.
- Globally, around **6-8% people** suffer from rare disease.
- In India, **95%** of rare diseases have **no treatment**.

Why treating them is a difficult?

- **Early detection is difficult:**
 - Less awareness among **doctors**.
 - Unavailability of diagnostic **tests**.
- **Less R&D:**
 - **Small pool of patients** to understand the disease
 - **Small market size** does not justify high investment
- **Treatment:**
 - is either **not available**
 - or is very **costly**

Some initiatives:

- ❑ **USA:** Orphan Drugs Act **1983** gives companies incentives to develop orphan drugs.
- ❑ **EU:** maintains **Orphanet**, a database of orphan disease and drugs

Since no one wants to invest in their treatment, they are often called as '**orphan disease**' and the drugs to treat them as '**orphan drugs**'.

National Policy for rare disease:

- ❑ Create a **National Registry** for Rare disease
- ❑ It classifies 450 rare disease into **three categories:**
 - Need one-time treatment; e.g. Progressive Liver failure
 - Need long-term treatment, and cost is low; e.g. Severe food protein allergy
 - Need long-term treatment, and cost is high; e.g. Hunter syndrome
- ❑ **Early detection:**
 - ❑ Financial incentives to hospitals to upgrade diagnostic facilities
 - ❑ Set up Nidan Kendras to diagnose genetic disease
- ❑ **Financial support:**
 - ❑ To patient through **Rashtriya Arogya Nidhi** and **PM-JAY** to cover **40%** of the population
 - ❑ To hospitals to **upgrade diagnostic** facilities
 - ❑ Hospitals should report cases on a digital platform to encourage **crowd funding**
- ❑ **Affordable drugs:**
 - ❑ PSUs will be used to manufacture orphan drugs
- ❑ **Awareness generation** among all stakeholders (doctors, public)

UMMID: (initiative of DBT under MoS&T)

- **Unique Methods of Management** and treatment of **Inherited Disorders**
- Establish **Nidan kendras** to diagnose genetic diseases
- Train doctors in Human genetics, so that they better screen pregnant women and new born babies for inherited genetic diseases.

Rashtriya Arogya Nidhi:

- started in **1997** for financial assistance to BPL patients suffering major **life threatening** disease.
- Money is given as 'one time grant' to **Medical Superintendent** of the Hospital in which the treatment is being given (**not to bank account of patient**).
- In 2019, the scheme was closed for a short period, and then re-launched.

Genome Sequencing

What is Genome Sequencing?

- Genome is an organism's **complete set of DNA**.
 - It has all the info needed to **completely describe** the organism.
 - Genome sequencing means knowing the exact sequence of base pairs in genome.
- Base pairs → Gene → DNA → Chromosome → Nucleus → Cell → body

What are the benefits of genome sequencing?

- **Diagnosis:** Efficient diagnosis of rare genetic diseases.
- **Medicine:** It helps prepare customized medicine.
 - e.g. Andhra's Vysya community is susceptible to certain anaesthetics.
- **Biopiracy:** It helps prevent biopiracy
 - Companies using genetic benefits without compensating original communities
- **Science:** It helps map the evolution of different species.

Challenges:

- **Technology:** it uses sophisticated biotech tools and huge computing power
- **Finances:** projects run for years; employs talented people; expensive technologies.
- **Racism:** genetic differences may promote idea of racism

Gene Editing

What is Gene editing?

- It means changing the DNA of a living organism
- It is done by inserting, deleting, or modifying the genes.

Issues with Gene editing:

- It's **risky** as it has not been fully understood till now.
- There could be unintended **consequences**.
- Its effects could pass on to **future generations**.
- Ethical issues:
 - Consent:** It makes changes to future generations without their consent
 - Consequences:** future of babies produced with undesirable traits.
 - Inequality:** its super-expensive; hence out of the reach of masses.
- Example: He Jiankui affair, China 2018
 - Genome edited human twins were created, to make them HIV resistant
 - Process was illegally done; allegations of unintended outcome.

CRISPR-Cas9

- It is a gene editing technology.
- CRISPR guides** Cas9 to particular gene.
- Cas9** is the molecular **scissor** that does the cutting.
- It can be used to cut any DNA molecule at required site.
- 2020 Nobel Prize in Chemistry was given for developing this technology

Gene Therapy

ICMR has published guidelines for Gene therapy (products and clinical trials).

What is Gene therapy?

- ❑ It means introductions, removal, or change in genes of an individual, for the purpose of treating a disease. It is of two types:
 - ❑ **Germ line gene therapy**: gene modification is **passed** on to next generation. It is banned in India. e.g. three parent IVF
 - ❑ **Somatic cell gene therapy**: gene modification remains to the target individual, **not passed** to children. It is legal in India.
- ❑ Gene editing can be done in two ways:
 - ❑ **ex vivo**: gene editing done outside the body; then transplanted in patient.
 - ❑ **in vivo**: gene editing done directly to the target cells in the patient.

What are gene therapy products?

- Anything that introduces, removes, or changes the genes, for treating a disease.
- For the purpose of regulation, they are considered as 'new drug'.
- For example: Viral vectors, bacterial vector, gene editing technology, etc.

What is the need to regulate gene therapy products?

- **To prevent misuse**: creating genetically enhanced humans (sports/army/R&D)
- **To maintain societal ethics**: creating designer babies (color of skin/eyes/hair)
- **To promote research**: create enabling environment for research on genetic disease (estimated 7 crore Indians suffer from some type of genetic disease, e.g. thalassemia, sickle cell anaemia, etc.)

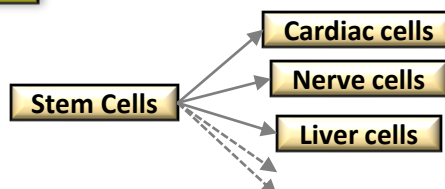
ICMR guidelines on gene therapy:

- The guidelines apply to **all stakeholders**: researchers, clinicians, patients, etc.
- Clinical trials must safeguard patient's safety, **human rights**, dignity, etc.
- Must follow basic principles like essentiality, **voluntariness**, risk minimization, etc.
- Must register all trials with '**Clinical Trials Registry of India**' (CTRI)
- Research institution must form **Bio-Ethics committee**.

Stem Cell Therapy

What are stem cells?

- Cells that can develop into other types of cells
- They are mainly of three types:
 - Pluripotent: e.g. Embryonic
 - Multipotent: e.g. Adult stem cells
 - Induced Pluripotent: cells reprogrammed as pluripotent



How are they useful in gene therapy?

- Extract from body → gene editing performed → Implanted back into body
- It has achieved some success in treating diseases like Alzheimer's.
- Experiments in China have shown success in treating Covid:
 - Mesenchymal stromal cells (MSCs) reduce overproduction of immunity cells.
 - They can also repair the extreme organ damage caused by covid.

Prohibitions under National guidelines for stem cell research 2017 (by ICMR):

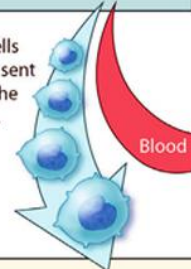
- Human germline gene therapy and reproductive cloning
- In vitro culture of embryos beyond 14 days of fertilization
- Transfer of xenogenic (non-human animal) cells into human host

CAR T-cell Therapy

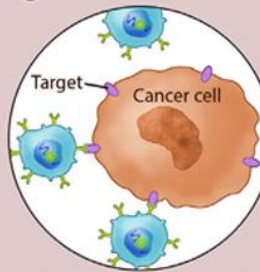
1 IN THE CLINIC
The white blood cells, including T cells, are separated out, and the rest of the blood is returned to the patient.

Blood is taken from the patient.

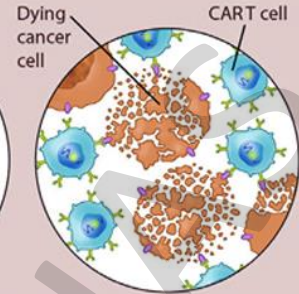
T cells are sent to the lab.



4 IN THE BODY



The receptors are attracted to targets on the surface of the cancer cells.



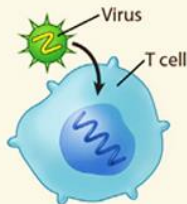
The CART cells identify the cancer cells with the target antigens and kill them. CART T cells may remain in the body for some time to help prevent the cancer cells from returning.

3 IN THE CLINIC

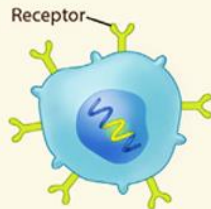
CART cells are put back into the patient's bloodstream, typically after chemotherapy is given to make space, and continue to multiply.

2 IN THE LAB/MANUFACTURING FACILITY

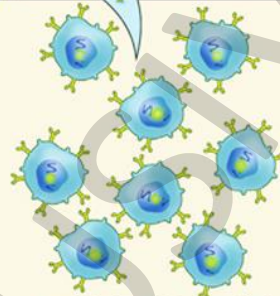
T cells are engineered to find and kill cancer cells.



An inactive virus is used to insert genes into the T cells.



The genes cause the T cells to make special receptors, called CARs, on their surfaces.



Modified T cells (now called CART cells) are multiplied until there are millions of these attacker cells.

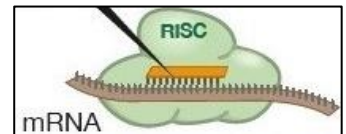
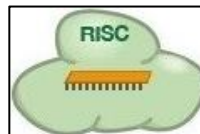
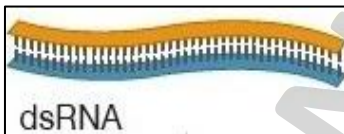
CAR T-cell therapy:

Chimeric Antigen Receptor

- Type of immunotherapy
- Take T-cells from patient (or donor)
- Genetically modify in lab
- Multiply to millions
- Insert into patient
- Will attack cancer cells
- Its like a Living Drug
- Examples: Yescarta, Kymriah, Tecartus, etc.

RNA interference

PYQs explained on page-6



RNA interference pathway:

- dsRNA → siRNA → two ssRNA
- Dicer enzyme splits dsRNA to siRNA
- Through RISC, ssRNA binds to mRNA
- A portion of mRNA get silenced

dsRNA: double stranded RNA

siRNA: small interfering RNA

ssRNA: single stranded RNA

RISC: RNA-induced silencing complex

Pest Resistant Plants: Several nematodes parasitise a wide variety of plants and animals including human beings. A nematode *Meloidegnye incognitia* infects the roots of tobacco plants and causes a great reduction in yield. A novel strategy was adopted to prevent this infestation which was based on the process of **RNA interference** (RNAi). RNAi takes place in all eukaryotic organisms as a method of cellular defense. This method involves silencing of a specific mRNA due to a complementary dsRNA molecule that binds to and prevents translation of the mRNA (silencing). The source of this complementary RNA could be from an infection by viruses having RNA genomes or mobile genetic elements (transposons) that replicate via an RNA intermediate. **NCERT class-12**

RNA interference:

- It is a **natural** process for **gene silencing**.
- It is part of **immune response** to foreign genetic material (e.g. by virus)
- It **prevents** manufacture of specific **proteins**.

RNAi pesticides:

- Identify protein necessary for pest
- Create dsRNA to interfere in its formation
- Deliver it to pest through crops.

I read I forget, I see I remember

See explanation of this PDF on [YouTube](https://www.youtube.com/c/allinclusiveias) www.youtube.com/c/allinclusiveias

Prelims 2011:

At present, scientists can determine the arrangement or relative position of genes or **DNA sequence** on a chromosome. How does this knowledge benefit us?

1. It is possible to know the **pedigree** of livestock.
2. It is possible to understand the causes of all human **diseases**.
3. It is possible to **develop disease resistant** animal breeds.

Which of the statements given above is/are correct?

- (a) 1 and 2 only (b) 2 only
 (c) 1 and 3 only (d) 1, 2 and 3

Prelims 2017:

With reference to agriculture in India, how can the technique of **Genome Sequencing**, often seen in news, be used in immediate future?

1. Genome sequencing can be used to identify **genetic markers** for **disease resistance** and **drought tolerance** in various crop plants
2. This technique helps in reducing the time required to **develop new varieties** of crop plants.
3. It can be used to decipher the **host-pathogen relationships** in crops.

Select the correct answer using the code given below:

- (a) 1 only (b) 2 and 3 only
 (c) 1 and 3 only (d) 1, 2 and 3

Note: Health & disease outcomes are determined by interactions between genome & environment.



Human Genome Project:

- 1990-2003
- Genome sequencing
- US/UK/China etc

IndiGen Project:

- identified 5.6 crore nucleotide variants
- 1,029 Indians
- 32% of them are unique to Indians
- Lead by CSIR

Genome India Project:

- Genome sequencing
- 10,000 Indians
- Lead by IISc etc



Earth Biogenome Project:

- ✓ Since 2018
- ✓ Target is all eukaryotic biodiversity in 10 years

Indian Initiative on Earth Biogenome Sequencing:

- Part of Earth Biogenome project
- ✓ National Institute of Plant Genome Research
- ✓ Target is 1,000 species in 5 years

Some DBT programs on Genetics:

- Unique Methods of Management of Inherited Disorders (UMMID)**
Identify genetic disease in pregnant women and new born babies; Establishes NIDAN Kendras for this purpose.
- Genome India:**
Genome sequencing of 10,000 Indians
- Human Microbiome Initiative of select endogamous populations**
Influence of lifestyle on microbiome using genomics in tribals
- Programme on Monogenic disorders**
Disorders due to mutations in a single gene; for specific regions
- National Genomics Core**
Database & Computing facility for academia and industry

Use/benefits of DNA tech:

- Forensic investigation
- Faster justice delivery
- Chemicals for industries
- Prevent genetic defects
- Accurate diagnosis
- Treating diseases
- Pharmacogenomics (Role of genome in drug response)
- Personalized medicine
- Crops: high yield, disease resistant, drought resistant, high nutrition, etc.

National SARS-CoV-2 Genome Consortium

- by DBT, MoHFW, CSIR, ICMR
- To assess corona virus variants

National Biomedical Resource Indigenization Consortium

- PPP; by DBT
- For innovations against Covid

Biotechnology Industry Research Assistance Council (BIRAC)

- PSU under DBT
- wide role

The Indian EXPRESS

Explained: Mapping the 'Indian' genome

SOCIAL ISSUES: The question of heredity and racial purity has obsessed civilisations, and more scientific studies of genes and classifying them could reinforce stereotypes and allow for politics and history to acquire a racial twist.

In India a lot of politics is now on the lines of who are "indigenous" people and who are not. A Genome India Project could add a genetic dimension to the cauldron.

"Selective breeding" has been controversial since time immemorial, and well before the DNA was discovered. But eugenics acquired a dangerous context with the Nazis deliberating on the theme at length and its mention came up in the Nuremberg trials. Post World War-2, it has been a very touchy issue.

I read I forget, I see I remember | See explanation of this PDF on **YouTube** www.youtube.com/c/allinclusiveias

Covid-19

Why covid-19 spread much faster than SARS 2003?

- Spike protein of the novel coronavirus is 98% similar to spike protein of the SARS coronavirus.
- But, it has 10-20 times **higher affinity** to bind with cell receptors.
- Hence, it has higher human to human transmission than SARS.

Steps taken by govt. to control corona:

- Screening of people at **airports**, quarantine facilities set up.
- COVID-19 was declared as a "**notified disaster**".
- **Lockdown** to prevent spread of virus.
- **EG-6** formed under NITI Aayog CEO to involve NGOs in providing food and shelter to poor.
- **Free** distribution of wheat/rice/pulses under NFSA 2013.
- **Awareness** campaigns on use of hygiene, masks, social distancing, etc.
- Masks and hand sanitizers were declared as **essential commodities** under Essential Commodities Act, 1955.
- **PM CARES** fund set up to provide relief to the needy.

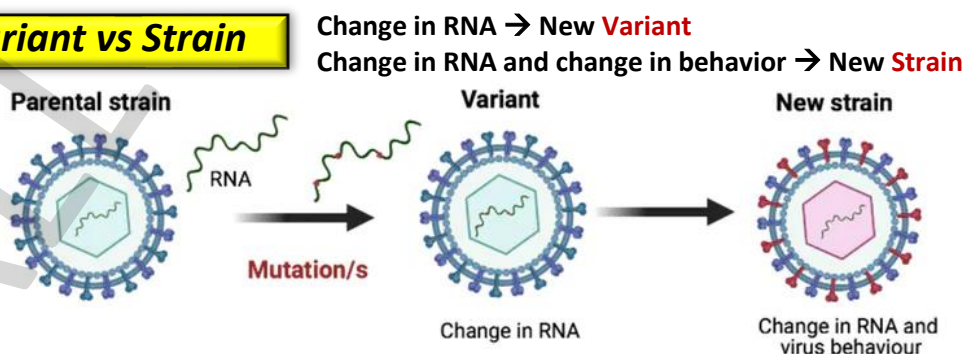
Herd immunity

- ❑ **Immunity** in a certain percentage of population **protects others** from the contagious disease.
- ❑ Herd immunity may develop:
 - **Naturally**: when most people are exposed to the virus
 - **Artificially**: by large scale vaccination

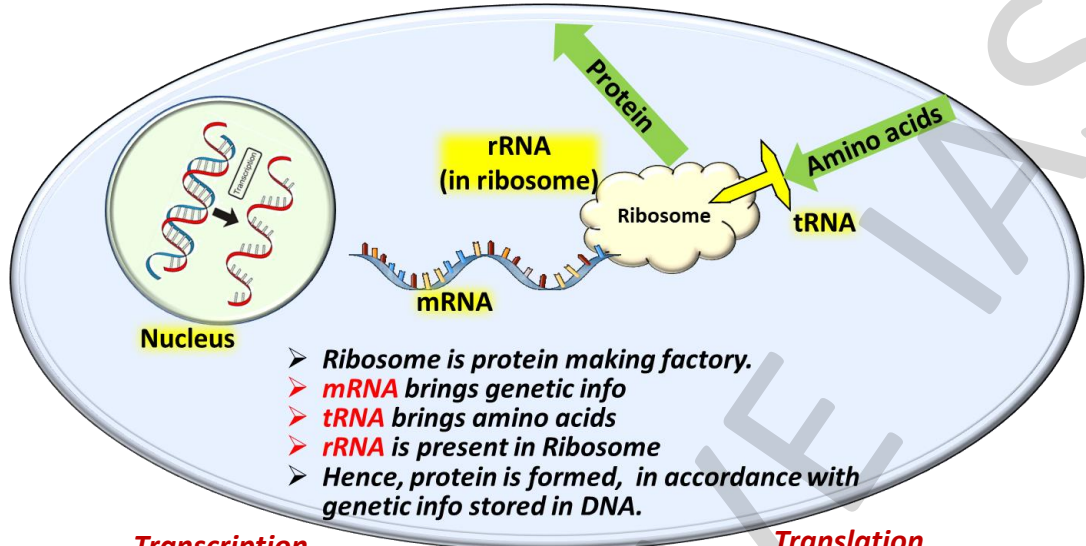
Challenges in achieving herd immunity:

- ❑ **60-70%** of population need to develop immunity.
- ❑ **Vaccine hesitancy** in people as there are doubts on safety/need of the vaccine.
- ❑ How long **antibodies** remain in individuals is not clear; varies from person to person.
- ❑ **Mutation** in the virus may make existing immunity useless.
- ❑ **Ethical dilemmas**: giving vaccine preference to some over others; letting virus spread so that people naturally develops herd immunity (Britain initially)
- ❑ Vaccination may protect only the individual, it may **not stop him from spreading** the virus to others.

Variant vs Strain



DNA vs RNA

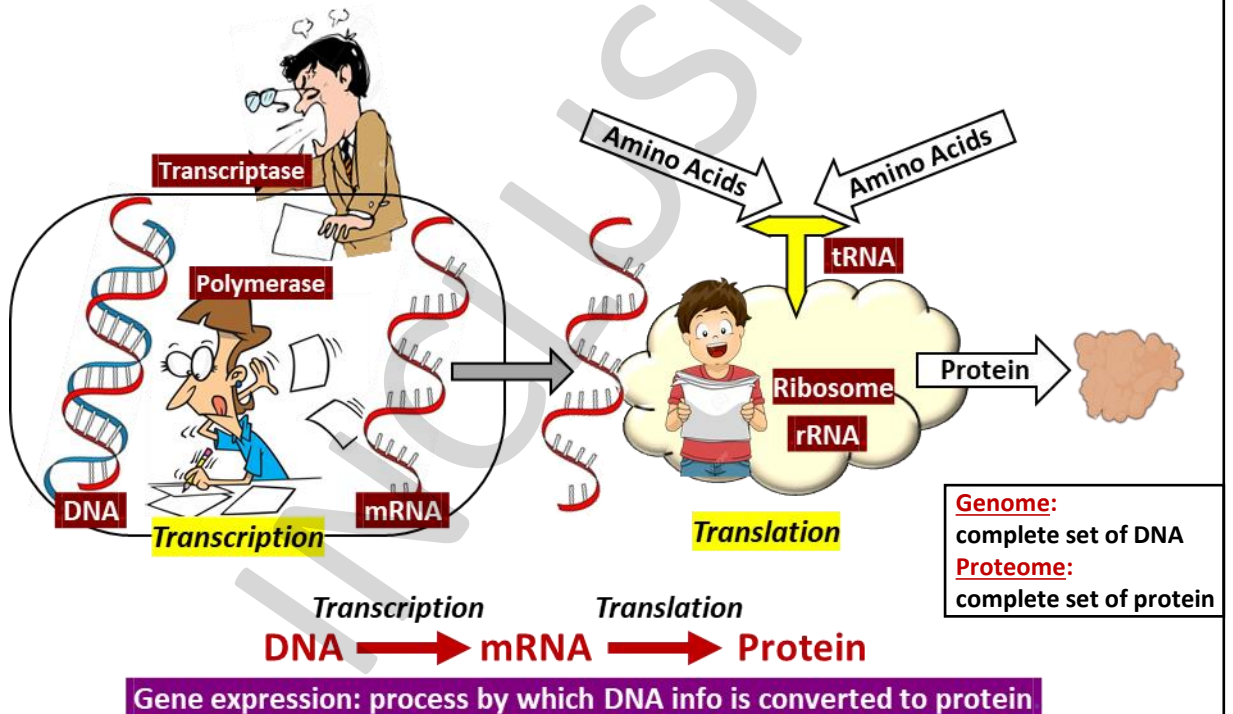


Transcription

process by which DNA info is copied to RNA

Translation

process by which RNA is used to produce proteins



DNA is Book

RNA is Transcript

Transcriptome is set of all Transcripts

Transcription is process DNA → RNA

RNA Polymerase is enzyme that does the process

Transcriptase is enzyme that catalyses the process

Reverse Transcription is process RNA → DNA

DNA Polymerase is enzyme that does process

Reverse Transcriptase is enzyme that catalyses RT

Prelims 2016:

In the context of the developments in Bioinformatics, the term 'transcriptome', sometimes seen in news, refers to

- (a) a range of enzymes used in genome editing
- (b) full range of mRNA molecules expressed by an organism
- (c) description of the mechanism of gene expression
- (d) a mechanism of genetic mutations taking place in cells

Polymerase: enzyme that makes long chain of nucleic acids

RNA Polymerase: enzyme that makes RNA

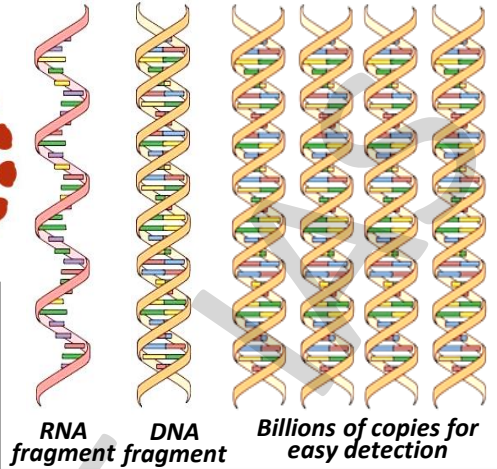
DNA Polymerase: enzyme that makes DNA

I read I forget, I see I remember

See explanation of this PDF on [YouTube](https://www.youtube.com/c/allinclusiveias) www.youtube.com/c/allinclusiveias

Reverse Transcription - Polymerase Chain Reaction (RT-PCR Test):

- ❑ Reverse Transcription RNA fragment converted to DNA fragment.
- ❑ 'Polymerase Chain reaction' creates billions of copies of DNA fragment.
- ❑ PCR test invented in 1983; Inventor got 1993 Nobel Prize in Chemistry.



Next Generation Sequencing (NGS tests):

- ✓ Uses modified NGS machines (for genome sequencing)
- ✓ RT-PCR analyses only small section of virus.
- ✓ NGS analyses entire genome of virus.
- ✓ It can even track mutations in the virus.

GISAID Global Initiative on Sharing All Influenza Data

- Launched in 2008; HQ: Munich, Germany; Managed by Germany; EpiFlu is name of its database
- It provides open-access to genomic data of influenza viruses and SARS-CoV-2

Prelims 2007:

What is the broad area in which Nobel Prize winners for 2006 in Physiology/Medicine, worked to get the Prize?

- (a) Prevention of weakening due to ageing
- (b) Flow of genetic info**
- (c) Immunology and disease resistance
- (d) Adult stem cell research

Prelims 2019:

'RNA interference (RNAi)' technology has gained popularity in the last few years. Why?

1. It is used in developing gene silencing therapies.
2. It can be used in developing therapies for the treatment of cancer.
3. It can be used to develop hormone replacement therapies.
4. It can be used to produce crop plants that are resistant to viral pathogens

Select the correct answer using the code given below.

- (a) 1, 2 and 4**
- (b) 2 and 3
- (c) 1 and 3
- (d) 1 and 4 only



	DNA	RNA
Structure	Helix; Double-stranded; Long chain of nucleotides; Guanine, Cytosine, Adenine, Thymine	Helix; Single-stranded; Short chain of nucleotides; Guanine, Cytosine, Adenine, Uracil
Function	Stores genetic info	Transfers genetic info
Propagation	Self-replicating	Synthesized from DNA
Location	Nucleus, Mitochondria	Nucleus, Cytoplasm, Ribosome
Stability	More stable, less reactive	Less stable, more reactive
UV	Vulnerable to damage	Resistant to damage



3-Parent baby

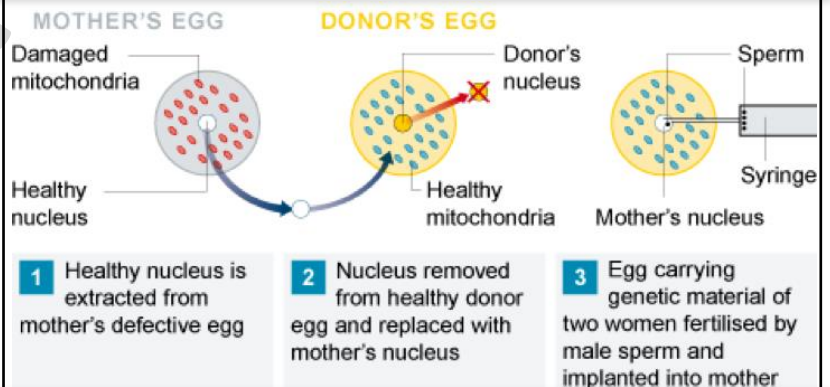
Prelims 2001:

Which organelle in the cell, other than nucleus contains DNA?

- (a) Centriole
- (b) Golgi apparatus
- (c) Lysosome
- (d) Mitochondria**

Mitochondrial DNA

circular, inherited from mother



Spinal Muscular Atrophy:

loss of motor neurons; progressive muscle wasting; due to mutation in SMN1 gene; treated by Zolgensma

I read I forget, I see I remember | See explanation of this PDF on www.youtube.com/c/allinclusiveias

Virus

Prelims 2016:

Which of the following statements is/are correct? Virus can infect:

1. Bacteria 2. Fungi 3. Plants
Select the correct answer.
(a) 1, 2 (b) 3 (c) 1, 3 (d) 1,2,3

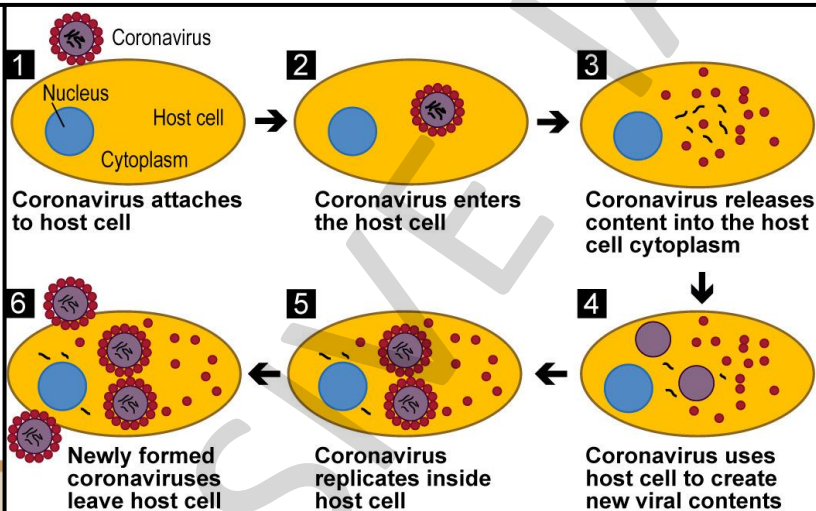
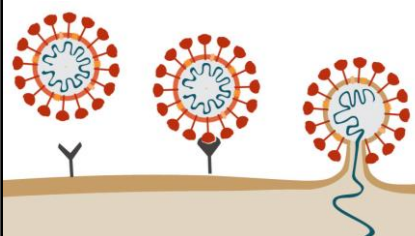
Prelims 1997:

Antigen is a substance which

- (a) Lowers body temperatures
(b) Destroys harmful bacteria
(c) Triggers immune system
(d) Is used as antidote to poison

SARS-CoV-2

- Shape: spherical
 - Size: 50-200 nm (not mm)
 - Genetic material: RNA
 - RBD is on spike of virus
 - ACE-2 is on host cell
- RBD: Receptor Binding Domain*



Diagnostic test:

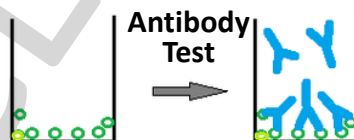
- ✓ Tells if person is currently infected.
- ✓ Rapid Antigen, RT-PCR, NGS

Rapid Antigen Tests:

- ✓ detects virus in minutes.
- ✓ Misses many positive cases.
- ✓ Negative cases need confirmation by RT-PCR or NGS test

Antibody tests:

- ✓ Tells if person was infected in past.
- ✓ Rapid Antibody, ELISA, IgM, IgG, Sero-survey



- ✓ IgM, IgG are antibodies
- ✓ IgM forms first, does not stay for long.
- ✓ IgG forms later, remains longer.

IMMUNITY:

Immunity is of two types:

1. Innate immunity:

- non-specific type of defence, present at time of birth
- skin, acid in stomach, saliva, tears, interferons

2. Acquired immunity:

- pathogen specific, characterised by memory.
- Low intensity primary response, then high intensity secondary response.
- By two special types of lymphocytes present in our blood, B-cells and T-cells

Blood:

- RBC carry oxygen
- WBC fight infection
 - Macrophages: eat
 - B-cells: make antibodies
 - T-cells: kill, help, regulate

Active immunity:

- ✓ Your body produces antibodies.
- ✓ Vaccine or actual disease
- ✓ Long lasting

Passive immunity:

- ✓ you get antibodies from someone.
- ✓ Mother to child, Plasma therapy, etc.
- ✓ Short lived

Cytokine storm, Septic shock, sepsis: body's over-reaction to infection. Can cause organ failure / death

I read I forget, I see I remember

See explanation of this PDF on [YouTube](https://www.youtube.com/c/allinclusiveias) www.youtube.com/c/allinclusiveias

Vaccines

Vaccine development process:

Six stages of vaccines development usually takes around 12-15 years:

- 1) **Exploratory:** identify natural or synthetic antigens that might help prevent disease
- 2) **Pre-clinical:** use tissue-culture or animal testing to test if the vaccine will produce immunity
- 3) **Clinical development:** Three phases of vaccine trials are done.
- 4) **Regulatory approval:** Company applies for license; govt. evaluates test data, gives approval.
- 5) **Manufacturing:** pharma companies do mass manufacturing of vaccine
- 6) **Quality control:** Continuously track whether the vaccine is performing as anticipated.

Covax:

- Formed in April 2020 by WHO, CEPI, GAVI
- Global initiative for equitable access to vaccines

Vaccine Gap

Rich countries hoarded vaccines, created surplus stocks, now 24 crore doses will expire. On the other hand, just 9% of Africa is vaccinated.

Reasons:

- ❖ Inadequate infra in poor countries. Many vaccines need **minus 70 degree temperature**, facility for which is not available in poor countries.
- ❖ Rich countries purchase vaccines at **high price**. This acts as **incentive for R&D** on new variants, and increase in production capacity. **Poor countries can't afford** expensive vaccines.
- ❖ Rich countries have surplus stock, but many people not taking them due to **vaccine hesitancy**
- ❖ Upholding national interest. **Governments have obligation** to protect their citizens.
- ❖ Rich countries took **financial risk** by pre-booking multiple vaccines, some of them were unsuccessful.

Issues:

- ❖ It **prevents equitable access** to vaccines to all humans.
- ❖ Least developed countries have **less money and bargaining power**.
- ❖ **New variants may emerge** in unvaccinated areas, which may spread to developed world as well. No one is safe until everyone is safe.
- ❖ People are at **higher risk in developing countries** and are allocated even lesser resources.

Things like social distancing, work from home, sanitizer, handwash with running water, early diagnosis, experimental drugs, ventilators, good healthcare infra.... All these are available in developed countries, and poor countries lack them. So, **poor countries are more vulnerable to covid**. Vaccine nationalism allocates vaccines to lower risk population at expense of high risk population.



Vaccine hesitancy

- ❑ Refusal to get vaccinated, despite vaccine being available and affordable.
- ❑ In USA, vaccine are absolutely free and easily available
 - ❑ Dec 2021: 15% adults in USA are without single dose
- ❑ Reasons people give to avoid vaccination:
 - ❑ Covid not life threatening for healthy people
 - ❑ Fear of adverse effects of vaccine
 - ❑ Vaccines are not effective
 - ❑ Was infected in past, have natural antibodies

Strengthening vaccine trust

Public acceptance of covid vaccines in India is amongst the **highest** in the world.

- 78% adults have received 1st dose
- 36% adults have received 2nd dose

What more can be done?

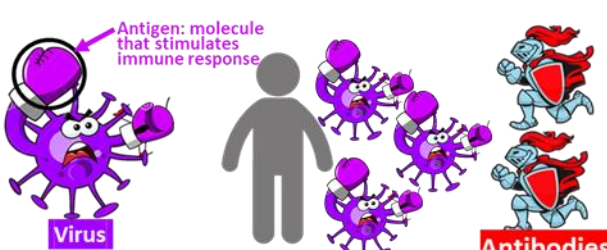
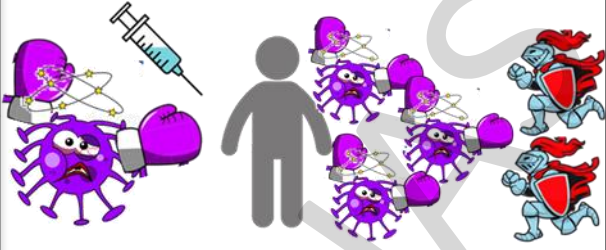
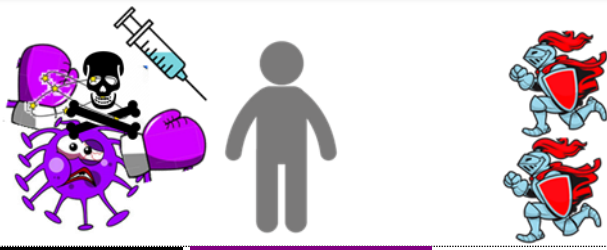
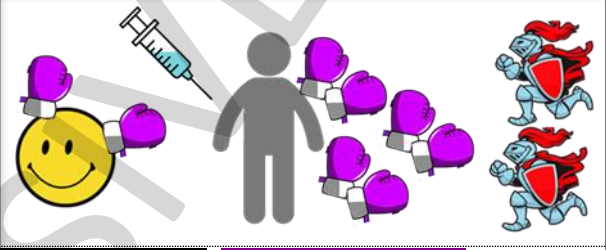
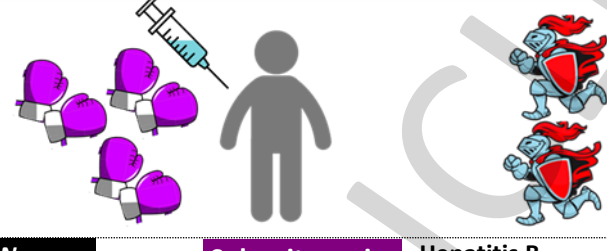
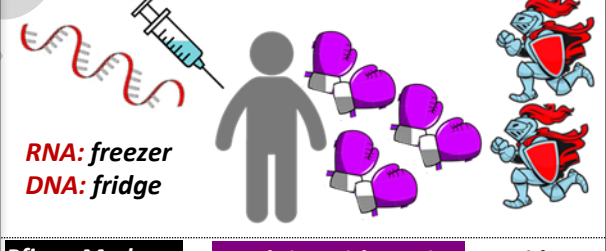

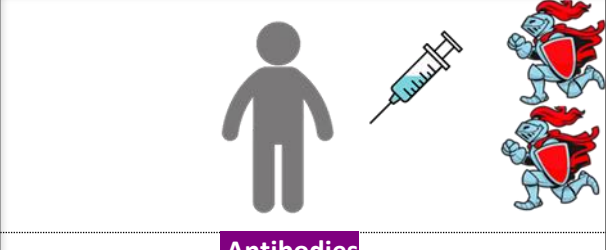
Some people are against all vaccines, but others are fence sitters (influence their opinion)

- ❑ **Message:** Vaccine is the norm. Ask everyone "Teeka lagwaya kya?"
 - ❑ **Messenger:** community leaders, Bollywood stars.
 - ❑ **Campaign:** like Do boond Zindagi ke (Polio)
 - ❑ **Misinformation:** can be countered by data from trusted sources (govt) and more peer discussions to dispel myths.
- India had many successful vaccine programs in the past (declared Polio free in 2014).
 - Repeating the same should not be difficult.

Keeping the faith

- ❑ Bharat Biotech has so far failed on multiple fronts.
 - **Late development**, hence late Phase-3 trials, govt gave permission without data
 - **Late permission** from WHO, took 20 weeks, compared to 4 weeks for Covishield
 - **Slow production**, as of the 107 crore shots in India, 12% are Covaxin, 88% are Covishield
- ❑ WHO has granted Emergency Use Listing to Covaxin.
 - Now **export** to other countries **will be easier**.
 - Bharat Biotech must now **ramp up production**, there is a huge international market to be served. (Only **1%** population of low-income countries have received both doses, WHO target is **40%**)

Types of Vaccines

 <p>Virus</p> <p>Antigen: molecule that stimulates immune response</p> <p>Antibodies</p> <p style="text-align: center;">Virus</p> <p><i>Too few:</i> Virus kills us <i>Too many:</i> Army kills us Cytokine storm</p>	 <p style="text-align: center;">Live Attenuated vaccine</p> <p style="text-align: right;">Measles</p> <ul style="list-style-type: none"> <input type="checkbox"/> Inserts weakened virus into our body <input type="checkbox"/> Strong and long-lasting response <input type="checkbox"/> Shouldn't be given to people with weak immunity
 <p style="text-align: center;">Inactivated vaccine</p> <p style="text-align: right;">Hepatitis A, Polio</p> <ul style="list-style-type: none"> <input type="checkbox"/> Inserts killed virus into our body <input type="checkbox"/> Not very strong response from body <input type="checkbox"/> Needs several booster shots 	 <p style="text-align: center;">Viral vector vaccine</p> <p style="text-align: right;">Ebola, Covid</p> <ul style="list-style-type: none"> <input type="checkbox"/> Inserts a different harmless modified virus <input type="checkbox"/> Has genetic instructions to create specific antigen <input type="checkbox"/> Cannot give us Covid
 <p style="text-align: center;">Subunit vaccine</p> <p style="text-align: right;">Hepatitis B</p> <ul style="list-style-type: none"> <input type="checkbox"/> Inserts antigens, instead of the whole virus <input type="checkbox"/> May use protein, sugar, capsid <input type="checkbox"/> May need booster shots 	 <p style="text-align: center;">Nucleic Acid vaccine</p> <p style="text-align: right;">Covid</p> <p><i>RNA: freezer</i> <i>DNA: fridge</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Inserts genetic instructions to create antigens <input type="checkbox"/> Doesn't enter Nucleus; doesn't affect our DNA <input type="checkbox"/> Cell kills mRNA after use <input type="checkbox"/> Cannot give us Covid <input type="checkbox"/> Faster than traditional methods
 <p style="text-align: center;">Toxoid vaccine</p> <p style="text-align: right;">Tetanus, Diphtheria</p> <ul style="list-style-type: none"> <input type="checkbox"/> Inserts Toxins created by the virus 	 <p style="text-align: center;">Antibodies</p> <ul style="list-style-type: none"> <input type="checkbox"/> Plasma therapy <input type="checkbox"/> Monoclonal antibodies

I read I forget, I see I remember

See explanation of this PDF on www.youtube.com/c/allinclusiveias

Prelims 2020:

What is the importance of using **Pneumococcal Conjugate Vaccines** in India?

1. These vaccines are effective against **pneumonia** as well as **meningitis** and **sepsis**.
2. Dependence on **antibiotics** that are not effective against drug-resistant bacteria can be **reduced**.
3. These vaccines have **no side effects** and cause no allergic reactions.

Select the correct answer using the code given below:

- (a) 1 only (b) 1 and 2 only (c) 3 only (d) 1, 2 and 3

Pneumococcal disease:

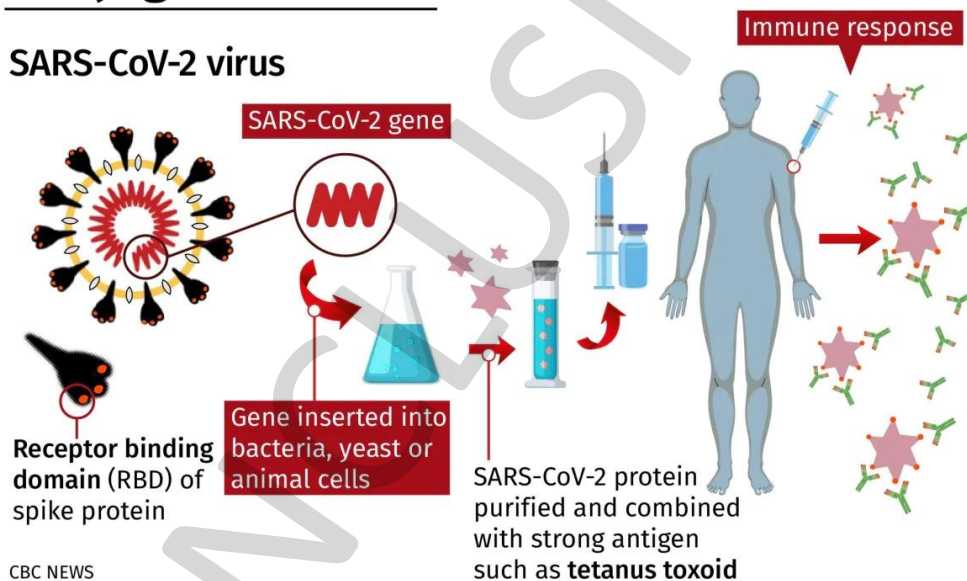
- infection by bacteria **Streptococcus pneumoniae**
- example: pneumonia, meningitis, sepsis
- significant contributor under-five mortality
- Pneumococcal Vaccine: vaccine against it.
- Pneumosil**: India's first indigenously developed pneumococcal conjugate vaccine; by Serum Institute of India

Conjugate vaccine

- combines a weak antigen with a strong antigen as a carrier so that the immune system has a stronger response to the weak antigen.
- Soberana 2**: world's first conjugate vaccine for COVID-19; by Cuba

Conjugate vaccine

SARS-CoV-2 virus



mRNA vaccines:

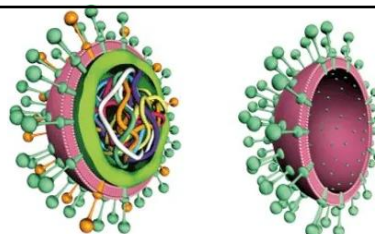
- Vaccines by Pfizer and Moderna were the first mRNA vaccines to be licensed for use.
- Before that no mRNA vaccine or drug has ever won approval.

ZyCoV-D:

- three-dose;
- by Cadila Healthcare (Indian)
- world's first DNA vaccine
- approved by India in Aug 2021

Plant based vaccines:

- Some antigens inserted into plants
- Plants produce Virus like particles (VLPs)
- VLPs extracted, and inserted into humans
- VLP is like virus, but has no viral genetic material



Alternative Medicine

Traditional Medicine;
Complementary Medicine;
Integrated Medicine;
Indian System of Medicine

What are Alternative systems of Medicines?

- ✓ System of medicine whose **effectiveness** has not been established using scientific methods.
- ✓ They were developed by indigenous cultures and have **long history** of use.

Indian System of Medicines:

- ✓ Ayurveda, Yoga & Naturopathy, Unani, Siddha, Homoeopathy, Sowa-Rigpa
- ✓ Either originated in India, or foreign systems that became part of Indian culture.
- ✓ Currently there are **8 lakh** registered AYUSH doctors in India.
 - ✓ 56% Ayurveda, 37% Homeopathy

Why are they becoming popular now?

- ✓ Non Communicable Diseases (NCDs)
- ✓ Life style disorders
- ✓ Long term diseases
- ✓ Multi drug resistant diseases
- ✓ Emergence of new diseases

What are the challenges in promoting Indian systems of medicine?

- ✓ Lack of scientific validity
- ✓ Drugs launched with exaggerated claims (Coronil by Patanjali)
- ✓ Presence of toxic elements (lead, mercury, arsenic) in many Ayurvedic medicines.
- ✓ Lack of raw material, quality control, professionals, etc.

What steps have been taken to promote Indian systems of medicine?

- ✓ 1995: **Department** of Indian System of Medicine & Homoeopathy under MoH&FW
- ✓ 2003: renamed to Department of **AYUSH**
- ✓ 2014: upgraded into **Ministry**
- ✓ 2019: National Research Institute for Sowa-Rigpa in **Leh**
- ✓ 31 AYUSH Information Cell in **28 countries** to promote AYUSH systems.
- ✓ More than 700 undergraduate and 200 Post-graduate **colleges**
- ✓ 12,500 dedicated AYUSH health and wellness centers to be developed under **Ayushman Bharat** Scheme.

National Ayush Mission?

Centrally Sponsored Scheme; 2014; Ministry of AYUSH; Four main components:

- Medicinal Plants:** promote cluster cultivation of medicinal plants and infra for entrepreneurs
- Quality Control of AYUSH drugs:** strengthening drug testing labs and certification mechanism
- AYUSH Services:** co-location of AYUSH facilities at Primary Health Centres (PHCs), Community Health Centers (CHCs) and District Hospitals (DHs).
- AYUSH Educational Institutions:** upgrading AYUSH educational facilities

Conclusion:

- Allopathy and AYUSH are not competitors. Integrated approach should be used.
- People should get best treatment, no matter which system it is from.

Pharma

India is known as pharmacy of the world, as it supplies:

- 20% of all generic drugs
- 50% of all vaccines
- 80% of all AIDS related drugs

Fixed dose combination (FDC) drugs are innovation of India's pharma industry.

Challenges:

- Dependent on **China** for 68% of **APIs**; 100% in case of some drugs.
- Drug **price control** orders by government.
- Increasingly strict **regulations** in export markets like USA.
- **Fake** medicines in Africa market, labelled as Indian, affect image and business
- Weak manufacturing base for **medical devices**; imports 85% of domestic demand.
- Weak **infra** for cold chain, roads, delay at ports for exports, etc.

Steps taken:

- 100% **FDI** allowed under automatic route for greenfield pharma.
- **Central assistance** of Rs 100 crore to set up **medical device parks**.
- Central assistance of Rs 1000 crore to set up **Bulk Drug Parks**.
- **Production linked incentive** scheme for bulk drugs (APIs)

Why India's pharma industry is largely located on the western coast?

Ports:

- easy **import** of raw materials to make drugs.
- easy **export** to African and European markets.

Other industries:

- Proximity to **petrochemical** hubs for raw materials e.g. Jamnagar refinery

Climate:

- Low **humid** climate is suitable for pharmaceuticals manufacturing.

However, more places have now emerged as pharma hub, like Baddi in Himachal, mainly due to govt. incentives.

Telemedicine

Telemedicine

real time two-way communication between doctor and patient for delivery of medical services.

Advantages of Telemedicine:

- **More accessibility:** can overcome geographic barriers; bring healthcare to remote areas.
- **Saves time:** patients no longer need to wait for hours at clinic/hospital
- **Less cost:** less expenses on travel by patients; need for office leave; maintenance of clinic, etc.
- **Safer:** no risk of spreading of infectious diseases among patients
- **Expertise:** For special cases, opinion of expert doctors can be taken easily.

Challenges:

- Low digital literacy
- Poor quality of telecom infra
- Restricted to consultation

Examples:

Government initiative: eSanjeevani and eSanjeevaniOPD

Private sector: Practo, Apollo247, Tata Health, etc.

Telemedicine guidelines issued by MoH&FW:

- Medical practitioner must be **registered** under Indian Medical Council Act 1956
- **Certain drugs** cannot be prescribed through telemedicine.
- Patient and doctor must **know each other's identity**, it should not be anonymous.
- **Privacy** of the patient must be maintained.

Trans fats

Prelims 2003:

Assertion (A): Unsaturated fats are **more reactive** compared to saturated fats.

Reason (R): Unsaturated fats have only **single bonds** in their structure.

(a) Both A & R are individually true and R is the correct explanation of A

(b) Both A & R are individually true but R is not the correct explanation of A

(c) A is true but R is false

(d) A is false but R is true

Prelims 2011:

A company marketing food products advertises that its items **do not contain trans-fats**. What does this campaign signify to the customers?

1. The food products are not made out of **hydrogenated oils**.

2. The food products are not made out of animal fats / oils.

3. The oils used are not likely to damage the cardiovascular health of the consumers.

Which of the above statements are correct?

(a) 1 only (b) 2 & 3 only (c) 1 & 3 only (d) 1, 2, 3

Prelims 2004:

Assertion (A): Fatty acids should be a part of the balanced human diet.

Reason (R): The cells of the human body cannot synthesize any fatty acids.

(a) Both A and R are individually true and R is the correct explanation of A

(b) Both A and R are individually true but R is not the correct explanation of A

(c) A is true but R is false

(d) A is false but R is true

Prelims 2008:

Assertion (A): In human body, liver has important role in **fat digestion**.

Reason (R): Liver produces two important fat-digesting enzymes.

(a) Both A and R are individually true and R is the correct explanation of A

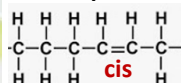
(b) Both A and R are individually true but R is not the correct explanation of A

(c) A is true but R is false

(d) A is false but R is true



Unsaturated fats
Liquid



Mono Unsaturated Fatty Acids (One double bond)

Found in olive oil, canola oil, avocados, nuts, etc.

Lowers bad cholesterol (LDL); raises good cholesterol (HDL)

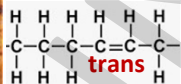
Poly Unsaturated Fatty Acids (2 or more double bonds)

Found in Sunflower oil, soybean oil, fish (Omega-3), walnut, etc.

Lowers both good and bad cholesterol



Trans fats
Semi-solid



Natural: cow, sheep, dairy

Artificial: by **hydrogenation** (heat vegetable oil in presence of hydrogen)

→ aka **Partially hydrogenated oils**; most common **Vanaspati**

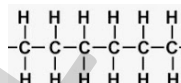
→ Longer shelf life, **more stable** to withstand repeated heating

→ **Lowers good** (HDL) cholesterol; **Raises bad** (LDL) cholesterol

→ Humans don't need Transfats



Saturated fats
Solid



Mainly in **animal foods** like meat, cheese, etc. B

But also in some **plant foods** like coconut oil & palm oil

FSSAI

Limit on Trans fats in food:

3% of total oil/fats (2% from 2022)

Excludes natural (dairy, meat, fish)

Heart-attack rewind:

Educate people about

dangers of Transfats



If TFA < 0.2g/100g

WHO

Transfats must be < 1% of daily energy intake

REPLACE initiative to eliminate transfats by **2023**

I read I forget, I see I remember

See explanation of this PDF on www.youtube.com/c/allinclusiveias

Nanotechnology

Nanotechnology: study and application of materials at nano-scale (1-100 nm)

Applications of nano tech:

- **Medicine:** Targeted drug delivery; cancer diagnosis
- **Clean water:** Filters for low cost water purifiers
- **Climate change:** Heat-resistant paints that reduce air conditioning load of buildings
- **Pollution:** Nanotech based catalytic converters to reduce pollution in exhaust
- **Electronics:** in chip design to bring more transistors on single chip
- **Defence:** lighter materials for missiles; stronger yet light bullet proof jackets

Nano-pharmaceuticals:

Nano-pharma: use of nanotech in bio-medical sciences. Uses:

- ❑ New molecular contrast agents for early cancer detection
- ❑ Some nanoparticles themselves acting as the drug.
- ❑ Some nanoparticles are used as carrier for targeted drug delivery. Benefits:
 - ❑ no side effect on other organs
 - ❑ improved efficiency

Nanotech in agriculture:

- **Nano-capsules:** for targeted nutrient delivery to plants (less nutrient run-off)
- **Nano-sensors:** in precision farming for soil nutrient level, moisture, etc.
- **Nano-barcodes:** to tag and track agricultural produce for quality purpose.
- **Nano-emulsions:** to kill bacteria without harming the plant.

Concerns:

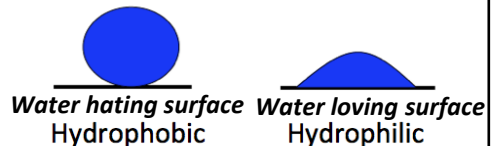
- **Food chain:** Through crops, NPs may enter into animals and humans.
- **Cytotoxic:** NPs may cause toxic reaction with human cells
- **Genotoxic:** NPs have potential to damage genetic material of animal cell

Challenges and way forward:

(see biotech class-12)

Nanomicelles: type of nanoparticles

- ❑ Have hydrophilic outer shell and hydrophobic interior
- ❑ Effective in targeted drug delivery, cancer treatment, etc.



Ministry of Earth Science

Eco-friendly Synthesis of Gold Nanoparticles from Antarctic Bacteria for Therapeutic Use

These GNPs can be used as a composite therapeutic agent clinical trials, especially in anti-cancer, anti-viral, anti-diabetic, and cholesterol-lowering drugs

Posted On: 29 JUN 2020 12:47PM by PIB Delhi

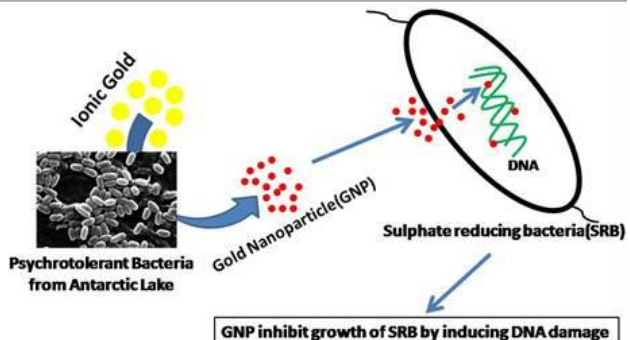
---By: Mohammad Faiyaz Anwar

The National Centre for Polar and Ocean Research (NCPOR) and the Goa University (GU) have successfully synthesized gold nanoparticles (GNPs) using psychrotolerant Antarctic bacteria through a non-toxic,

Gold Nano Particles:

- ❑ They have genotoxic effect on sulphate reducing bacteria
 - ❑ They melt at less temperature (300 °C) than gold (1064 °C)
 - ❑ They change colour in different settings.
 - ❑ They are stable, non-toxic and have various applications.
- NOMFET:** Nanoparticle Organic Memory Field-Effect Transistor
- ❑ Can mimic human synapse (neural junction)

Psychrotolerant Antarctic bacteria biosynthesize gold nanoparticles active against sulphate reducing bacteria



IPR

India saw four fold increase in Patents granted in last 5 years (6,326 in 2015-16 to 28,391 in 2020-21)

- ❑ **Intellectual Property** : creation of mind, like invention, artistic work, design, etc.
- ❑ **Intellectual Property Rights** : right of creator on his Intellectual Property
- ❑ IPR are enshrined as **human rights** in Article 27 of Universal Declaration of Human Rights.
- ❑ Internationally, they are administered through **WIPO** (UN specialized agency).
- ❑ IPR laws try to bring balance between **right of inventor** and possible **benefits to public** at large.

Why give legal protection to intellectual property?

- **Creators** need to be protected for disclosing their creations.
- Legal protection encourages **new research** (manpower and money).
- Brings **economic growth** by private investment and FDI.
- **Society** benefits by use of latest research.

Steps taken by India to promote IPR:

- **CIPAM** under DPIIT for focus on IPR related issues.
- All IPR records **digitalized** (helps faster application processing)
- '**Scheme for IPR Awareness** – Creative India; Innovative India
- International collaborations, e.g. Patent Prosecution **Highway** with Japan
- **L2Pro India** (learn to Protect) **portal** for e-learning about IPR protection

National IPR Policy 2016:

- **DPIIT** will be the nodal agency for all IPR issues and the policy
- Promotes **small-scale** mechanical inventions with '**utility patents**'
- It is in compliance with WTO **TRIPS** agreement.
- Retains the provisions on **Compulsory Licensing** and **Section 3(d)** of India's Patents Act (preventing ever-greening of patents)

Issues:

- **Enforcement** of the Copyright act is **weak**; piracy is widespread.
- Compulsory licensing and section 3(d) discourages FDI.
- IPR protection in agriculture is particularly weak due to **PPVFR Act 2001** (e.g. Pepsico potato case)

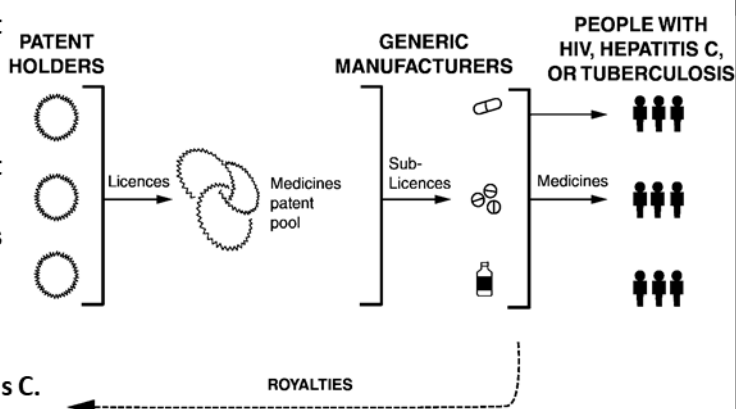
Patent Pool:

1. Different patent **owners** submit patents to a central party
2. Patents are **bundled** together
3. **Licences** are given to third parties
4. **Royalties** are shared among patent owners.

Indian Patents Act 1970 neither has guidelines on, nor prohibits Patent pool.

Medicine Patent Pool:

- ✓ formed in 2010; HQ in Geneva
- ✓ for cheaper drugs for HIV, TB, Hepatitis C.



IPR

60 years COPYRIGHT:

To protect original piece of work



Literary works (e.g. books, magazines, web pages)



Musical works (e.g. lyrics and score)



Artistic works (e.g. paintings, drawings and photographs)

Works Protected by Copyright



Sound recordings



Movies



Recordings of Live Performances

20 years PATENT:

for new invention, like a new drug



10 years GEOGRAPHICAL INDICATION:

To distinguish products of a region from that of other regions



Banaganapalle Mangoes of Andhra Pradesh



Tulapanji Rice of West Bengal



Tirupathi Laddu



Darjeeling Tea

DESIGN: 15 years

To protect new shape, configuration, etc.

CHAIR

Regn. No. 304323



Designer: Sangam Sinha, 2014 Batch, UG, Discipline: Furniture & Interior Design

10 years TRADEMARK:

To distinguish a company's products from others



Intellect : mental powers

Intellectual Property : creation of mind, e.g. artistic work

Intellectual Property Rights : right of creator on own creations

KAPILA program: Ministry of Education.

- Kalam Program for IP Literacy & Awareness
- FOR IPR awareness in college students

Office of Controller General of Patents, Designs & Trademarks:

- also known as **Indian Patent Office**.
- It administers laws on patent, design, trademark & geographical indication.
- Comes under **DPIIT** under MoC&I
- Its HQ is in **Mumbai**.

Compulsory licensing and Patent Pool:

- Economy class-3 page 38 on YouTube
- Hindi video from 41:35
- English video from 35:11

Evergreening of Patent:

- Renewing patent by making minor changes
- Prohibited by Section 3(d) of Patent Act 1970

Patent Law Treaty, 2000

- Simplifies** patent application **procedures**.
- Does **not** interfere with domestic patent laws
- Signed and ratified by around 40 countries (USA? Yes. **India? No**)
- It is administered by **WIPO**.

Singapore Treaty on Law of Trademarks, 2006

- Like Patent law Treaty, but for Trademarks
- Q. **Berne Convention 1886** is related to?
 - Copyright protection
- Q. **WIPO Copyright Treaty 1996** is related to?
 - Copyright in digital environment

Traditional Knowledge Digital Library

- Database of traditional knowledge about **Ayurveda, Unani, Siddha, Yoga**
- Created in 2001 by **CSIR** and Min. of Ayush; Inspiration: Turmeric, Basmati patents in USA
- access is available to **13 foreign Patent Offices**, but only for search purpose, not to be shared.

Bioprospecting: exploring biodiversity for commercially valuable properties.



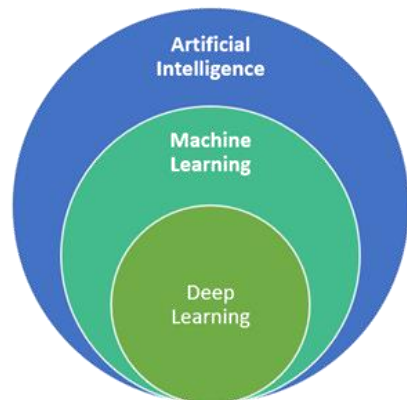
Biopiracy: commercial use of biodiversity with monopoly control.



I read I forget, I see I remember

See explanation of this PDF on **YouTube** www.youtube.com/c/allinclusiveias

Artificial Intelligence



What is Artificial intelligence?

- AI refers to a computer's ability to mimic human intelligence.
- It uses technologies like machine learning, deep learning, pattern recognition, etc.

AI: Machine mimics human intelligence.

ML: Machine improves with experience, by itself.

DL: Machine learns from vast amount of data

Significance of AI:

- ❑ **Agriculture:** accurate weather forecast; early warning of pest attacks; use in precision agriculture
- ❑ **Manufacturing:** decision support systems for inventory control, demand prediction
- ❑ **Services:** smart chatbot for customer support (SBI's SIA); early fraud detection
- ❑ **Health:** automated diagnostics; early warning of disease outbreak; faster development of new vaccine/medicine
- ❑ **Education:** personalized course module for each student as per need
- ❑ **Mobility:** self-driving cars; smart traffic signal to re-route heavy traffic

Issues with AI systems:

- ❑ **Legal issues:** fixing liability when law is broken by AI system
- ❑ **Inequality:** economic inequality will increase as skilled will gain more by using AI, whereas unskilled will lose bargaining power
- ❑ **Misuse:** deepfakes to malign political opponent; create social unrest; malign character.
- ❑ **Surveillance:** AI makes mass surveillance practical by use of public cameras, telephone conversations, written communications, etc.
- ❑ **AI Takeover:** advanced AI system may grow out of control of humans
- ❑ **Ethical issues:**
 - **Livelihood:** AI replaces humans, unlike computers which helps humans
 - **Bias:** Chatbots learn social biases (racism/casteism/communalism) e.g. Microsoft had to shut down 'Tay'
 - **Weapons:** Lethal Autonomous Weapons can wrongly trigger attack (anti-aircraft systems)

Challenges in developing AI systems:

- ❑ **Regulatory:** finding the optimum level of regulation (too less endangers public; too much kills progress)
- ❑ **Data security:** AI systems generally use lot of data; ensuring its fair use is difficult
- ❑ **Technological:** low computing power in most computers commonly available; also less number of supercomputers are available at national level
- ❑ **Human resource:** lack of talent to work on advanced technologies, despite having huge IT manpower

Steps being taken:

- ❑ **AIRAWAT:** AI Research, Analytics and Knowledge Assimilation platform. India's first AI-specific cloud computing infrastructure.
- ❑ **Center of Excellence** in Artificial Intelligence (CoE in AI) by NIC for AI solutions for NIC's projects.
- ❑ **"OECD Principles on AI"** to promote AI that is trustworthy and respects human rights and democratic values.
- ❑ IN **USA**, its mostly **self-regulation** by tech giants like Google and Microsoft.

Robots

Applications:

- To **automate** routine processes in companies.
- To serve **patients** suffering from infectious diseases, e.g. Karmi bot for covid
- To do jobs **unsuitable** for humans, e.g. Bandicoot to clean sewers.
- To cleanup sites after nuclear **disaster**, e.g. Japan Fukushima reactor blast 2011
- To do **risky** jobs like bomb defusal, e.g. Daksh by DRDO

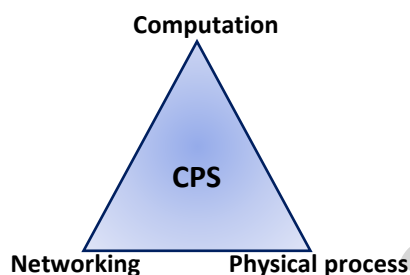
Challenges:

- **Expertise:** robots are technologically challenging to build and maintain.
- **Hardware issues:** designing robots need custom hardware components; India lacks facility for the same.
- **Cost:** High investment cost is needed to deploy robots
- **Job loss:** robots are replacing workers in factories, can lead to social unrest

China has 189 robots for every 10,000 worker while India has just 3.

Cyber Physical Systems

Cyber + **Physical** = **Cyber Physical System**
[computer, network] [machines] [integration of cyber & physical elements]



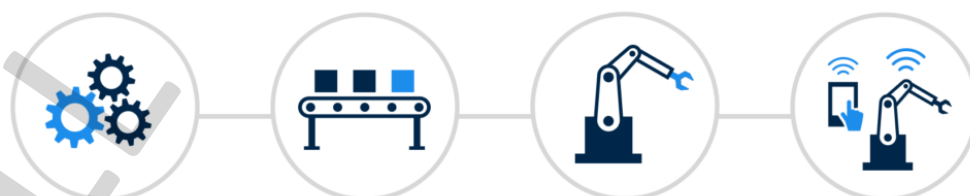
What is a Cyber Physical System?

- A computer based system that does work in real world.
- It is formed by integration of computation, networking, and physical process.
- e.g. self-driving cars; autonomous weapons; smart lighting; robots; traffic control systems; smart health sensors.

National Mission on Interdisciplinary Cyber-Physical Systems:

- NM-ICPS is a 5-year mission launched by Department of SnT in January 2019.
- Technology hubs will be established to connect universities, companies and government departments.
- It has focus on four areas:
 - Technology development
 - Human resource development
 - Entrepreneurship development
 - International collaborations

The Four Industrial Revolutions



Industry 1.0

Mechanization and the introduction of steam and water power

Industry 2.0

Mass production assembly lines using electrical power

Industry 3.0

Automated production, computers, IT-systems and robotics

Industry 4.0

The Smart Factory. Autonomous systems, IoT, machine learning

Big Data

What is Big data?

- It refers to data sets so large that conventional systems cannot process them.
- It is characterized by three V's:
 - **Volume**: amount of data is huge
 - **Velocity**: speed of data generation is very high
 - **Variety**: data can be structured, semi-structured, un-structured

Why India needs to develop big data capabilities?

- With a **population** of 1.3 billion, Big Data holds tremendous significance for India.
- For **policy making**. e.g. understand savings and expenditure pattern of population
- For targeted delivery of welfare schemes, e.g. **Aadhaar**
- To prevent **market** manipulations, e.g. **Data lake** project of SEBI
- To catch income **tax** evaders (Low IT base), e.g. **Project Insight** of IT department.
- To improve competence of PSBs, e.g. Economic Survey 2020 suggests creation of **PSBN** on lines of GSTN
- To boost **intelligence** gathering through surveillance of communication systems.
- **IoT** is inevitable; it will generate lots of data due to number of connected devices.

Challenges:

- **Lack of data Scientists**: India has less than 10% of data scientists available globally
- **Security**: ensuring security of huge amounts of data is difficult
- *see Artificial intelligence topic for more points*

Steps being taken:

- **NITI Aayog** is developing '**National Data & Analytics Platform**' as a single source for various data.
- '**Big Data Management Policy**' drafted by **CAG** for auditing big data generated in public sector.

Edge Computing

Edge computing?

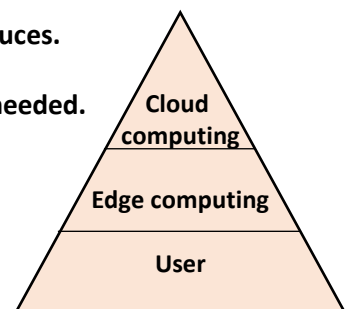
- Computing that's done near the source of the data.
- It is like a cloud near to the user.

Benefits:

- **Faster** response time, i.e. lower latency, as server is close to user.
- Less global **outages** as dependence on central servers reduces.
- **Scalable** as the pressure to expand servers at a central location reduces.
- Can help in meeting **data localization** regulations.
- Increases **data security** as less data transfer over long distances is needed.

Challenges:

- Arranging associated **infra**, like power, becomes difficult.
- Needs more hardware as need for **backups** increases.
- Security **vulnerability** of remote servers is higher.



5G

1G	2G	3G	4G	5G
Calls	SMS, email	Video call	HD videos	IoT

What is 5G?

- It is the next generation **mobile network technology**, after 4G LTE networks.
- It is superior to 4G as:

	4G	5G
Users/km ²	1 lakh	10 lakh
Peak speed	1 Gbps	20 Gbps
Latency	50 ms	1 ms
Encrypted?	Yes	Yes*

All values approximate

Why India needs 5G? (Applications)

- **Internet:** 5G is reliable alternative to physical laying of optical fibers to houses.
- **Cloud:** increasing use of cloud requires higher and continuous data usage.
- **IoT:** higher connection density reduces chances of network jams.
- **Tele-surgery:** Low latency enables tele-control of surgical robots by mobile network.

Challenges?

- **Investment:** 5G infra may need Rs 5 lakh investment. 5G needs more towers as it can't carry data over long distances.
- **Backhaul:** 80% of telecom towers are connected by microwaves (100 Mbps), instead of optical fibers (100 Gbps).
- **Debt:** Telecom companies have existing debt of Rs 4 lakh crore. 5G spectrum auction will increase the debt. Users will be burdened.
- **Business case:** there are very few use-cases of 5G that can generate profit for Telcos.
- **Import dependence:** 90% of our telecom demand is imported, mostly from China.
- **Security:** Huawei is the leader in 5G, but has close proximity to Chinese govt.

Steps taken:

- **5G High level Forum** formed in 2017 to recommend policy initiatives and action plans.
- **5G test bed** created for collaboration between universities and companies.
- **5G hackathon** organized by DoT to develop 5G applications in various fields.

Way forward:

- Identify sufficient number of **use-cases** before moving forward.
- **Collaborate** with western 5G providers (**Nokia, Ericson**), don't depend on them either.
- Collaborate with **other countries** for suitable alternative to Huawei e.g. the proposed D-10 club by UK.
- Encourage completely **indigenous** 5G tech by liberally sponsoring **research** projects in universities.

ISRO**Brief history:**

- **1962:** INCOSPAR (Indian National Committee for Space Research)
- **1969:** ISRO superseded INCOSPAR (*still under DAE*)
- **1972:** Department of Space set up
- **1975:** Aryabhata, first Indian satellite, launched by USSR
- **1980:** Rohini, first satellite launched by Indian vehicle SLV-3
- **1993:** PSLV's first flight

Achievements:

ISRO has reputation of launching cost-effective space missions.

- ❑ **Communication:** INSAT and GSAT satellites.
- ❑ **Remote sensing:** Cartosat series, Bhuvan portal
- ❑ **Navigation:** IRNSS and GAGAN
- ❑ **Defence:**
 - RISAT-2 (2009) for border surveillance
 - GSAT-7 (2013) for Navy; GSAT-7A (2018) for Army and Air Force
 - EMISAT (2019) for electronic intelligence gathering
- ❑ **Astronomy:** Astrosat (2015) India's first multi wavelength space observatory
- ❑ **Space Exploration:** Chandrayaan-1 & 2; MOM
- ❑ **International Relations:** South Asia Satellite (GSAT-9) for SAARC countries, launched in 2017; used for DTH, telemedicine, tele-education, disaster management support, etc.
- ❑ **Education:** EDUSAT (2004) (GSAT-3) exclusively for distance-education
- ❑ **Commercialization:** satellite launches for private sector and foreign companies through ANTRIX and NewSpace. (Antrix has 1,700 crore annual revenue)
- ❑ **Outreach programmes:**
 - Village Resource Centres to work with panchayats and NGOs.
 - Young Scientist program to give knowledge about space to school students.
 - Samvad with students where ISRO chairman interacts with students.
 - Launching satellites made by students, like Anusat, Studsat, etc

Upcoming missions:

- **Chandrayaan-3:** in 2022, as a repeat of Chandrayaan-2, but without orbiter.
- **Aditya-L1:** solar observatory at Lagrangian point-1 of Earth-Sun system
- **Shukrayaan:** Venus orbiter mission (related news: phosphine on Venus)
- **XPoSat** X-ray Polarimetry Satellite: to study polarized X-rays from cosmic objects
- **Gaganyaan:** to carry three Indians to LEO for 7 days.
- **IDRSS** Indian Data Relay Satellite System: for continuous communication during Gaganyaan

Challenges:

- ❑ **Low global share:**
 - India has just 2% share in global space industry (\$7 billion of \$350 billion)
- ❑ **Dependent on government support.**
 - Countries like USA have huge private participation (Falcon rocket of SpaceX, Boeing Starliner). NASA has a 'Tipping Point' program for partnerships with private companies.
- ❑ **Attracting young talent:**
 - Talented youth prefers high-paying MNC jobs.

Private sector in Space

Recently, Indian Space Association (ISpA) was launched. It is an industry association of space and satellite companies.

What is the need to involve private sector?

- ❑ **Increasing Demand:** Demand for space-based services in India is far greater than what ISRO can provide.
- ❑ **Faster growth:** Private sector will bring faster growth of space sector, just like it did after 1991 LPG reforms.
- ❑ **Fiscal pressure:** ISRO's annual budget has crossed 13,000 crore and is expanding. Private sector will bring in investment.
- ❑ **Talent:** Restricting space activities to ISRO prevents use of talent hidden in private sector.
- ❑ **Focus on R&D:** ISRO will be able to focus more on R&D and defence applications, as private companies will do the routine tasks like making communication satellites, making PSLV, etc. (e.g. NASA)
- ❑ **International cooperation:** It is easier for private companies to establish partnerships with foreign companies to get latest technological solutions.

Steps taken:

- **Space Technology Park** where ISRO has set up range of facilities for use by industry.
- ISRO has **outsourced** manufacturing of 27 satellites to private companies.
- **NewSpace**, founded in 2019, to facilitate transfer of ISRO technologies to industry.

Challenges:

- It's a highly **risky business**. Private companies may not be able to bear failures.
- **Dual-use technologies** and Critical information may fall in wrong hands.
- **Revenue loss** to ISRO. Antrix current revenue of about Rs 1,700 crore will reduce.

Way forward:

- Pass the **Space Activities Bill** to lay down space rules, to regulate & promote pvt sector in space.
- Set up an **independent regulator** to ensure level playing field.
- ISRO to **mentor** product-specific startups that can later be scaled up.
- Establish **think-tank** for key insights on space related issues, trends, etc.

Indian space program has come a long way from 1960s when components of rockets were transported by bicycles. But to compete globally, ISRO needs support of the versatile private sector.

Private companies in space race:

- Blue Origin (Jeff Bezos),
- Virgin Galactic (Richard Branson)
- SpaceX (Elon Musk)

World's first space tourist:

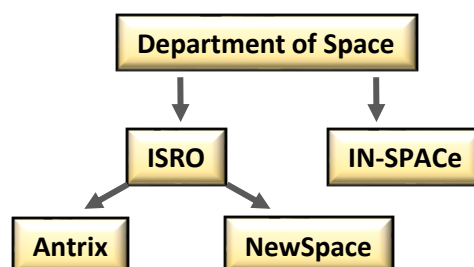
Dennis Tito in 2001 (went to ISS in Russian Soyuz rocket)

Indian origin women in space:

- 1) Kalpana Chawla
- 2) Sunita Williams
- 3) Sirisha Bandla

NewSpace vs In-Space

- ❑ **1992 ANTRIX** focusses on selling ISRO's products and services like satellite launch.
- ❑ **2019 NEWSPACE** also focusses on increasing private industry participation in space programmes.
- ❑ **2020 INSPACE** is currently stated to promote private industry in space program, but in future, it will become **regulator** of space activities in India.
- ❑ **INSPACE** is not a commercial arm of ISRO.
- ❑ **Antrix & NewSpace** are both commercial arms of ISRO.



Sun

Parker Solar Probe

- launched in 2018. In December 2021, it became first spacecraft to touch the sun.
- It has flown through Sun's upper atmosphere (Corona) and sampled particles and magnetic fields there.
- It is humanity's first visit to a Star
- It will trace how energy and heat move through the solar corona
- It will explore what accelerates the solar wind and the energetic particles.
- It will increase our understanding of sun, stars, solar system, universe

Why do we study the Sun and the solar wind?

(<https://www.nasa.gov/content/goddard/parker-solar-probe-humanity-s-first-visit-to-a-star>)

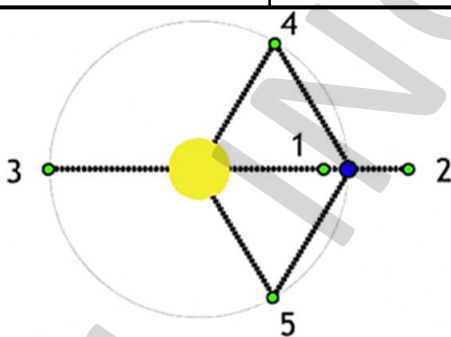
- The Sun is **the only star we can study** up close. By studying this star we live with, we learn more about stars throughout the **universe**.
- The Sun is a source of light and heat for life on Earth. The more we know about it, the more we can understand **how life on Earth developed**.
- The Sun also affects Earth in less familiar ways. It is the source of the **solar wind**; a flow of ionized gases from the Sun that streams past Earth at speeds of more than 500 km per second (a million miles per hour).
- Disturbances in the solar wind shake **Earth's magnetic field** and pump energy into the radiation belts, part of a set of changes in near-Earth space known as space weather.
- Space weather can change the orbits of satellites, shorten their lifetimes, or interfere with onboard electronics. The more we learn about **what causes space weather** – and how to predict it – the more we can protect the satellites we depend on.
- The solar wind also fills up much of the solar system, dominating the space environment far past Earth. As we send spacecraft and astronauts further and further from home, we must **understand the space environment** just as early seafarers needed to understand the ocean.

Some Solar missions:

- NASA: Parker; EIZIE
- Europe: Solar Orbiter
- ISRO: Aditya L-1
- Japan: Solar-C_EUVST

Alfven waves:

- occur in plasma, need magnetic field to exist
- travel in direction of magnetic field



Aditya L-1

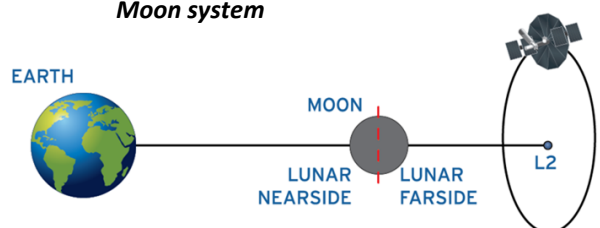
- 1,500 kg; 2022 launch
- First Indian mission to study the Sun.
- It will be inserted in a **halo orbit** around the L-1, at **15 lakh km** from Earth. (earlier plan was for LEO)
- Reason: L-1 gives **continuous view** of the Sun, without any obstruction or eclipse.

What are Lagrangian points?

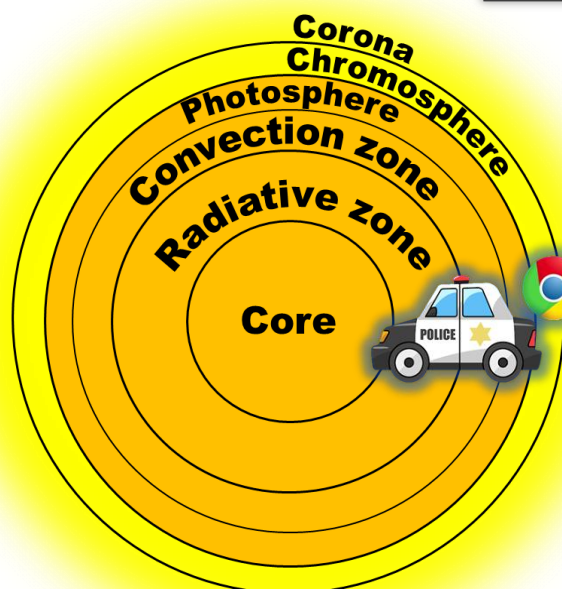
- These are positions in space where a small object will **maintain its position** relative to the large orbiting bodies.
- For a two body system, there are **five** Lagrangian points.
- Although a Lagrange point is just a point in empty space, its peculiar characteristic is that **it can be orbited**.

Chinese satellite in Halo orbit around L-2 of Earth Moon system

EARTH-MOON
L2 POINT,
HALO ORBIT



Sun

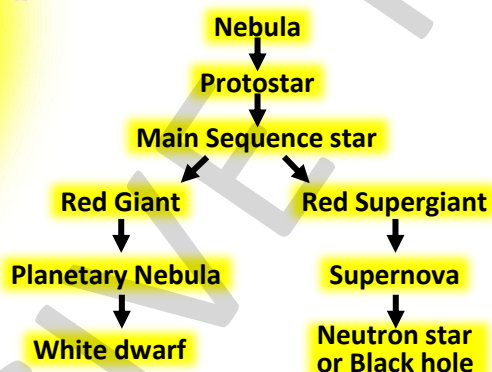


Temperature: Core 15 million K;
Photosphere 6,000 K; Corona 1 million K

You were trying to go to core of the sun:

1. You encounter **CORONA**virus
2. You search on **CHROME** how to tackle corona
3. You find that calling **PCR** is the best way
4. PCR transports you to the **CORE**

Star life Cycle



Stellar nucleosynthesis:

- Universe is made of matter & energy.
- Hydrogen** is the most abundant element in the universe.
- In stars, **fusion** causes hydrogen to combine to form **Helium**.
- Fusion continues** to form other elements also, mainly till iron.

Chandrasekhar limit is the maximum mass of a stable white dwarf star. It is about **1.4 times** solar mass.

Sun is in **main-sequence** stage; will become **white dwarf**.

Helium Flash

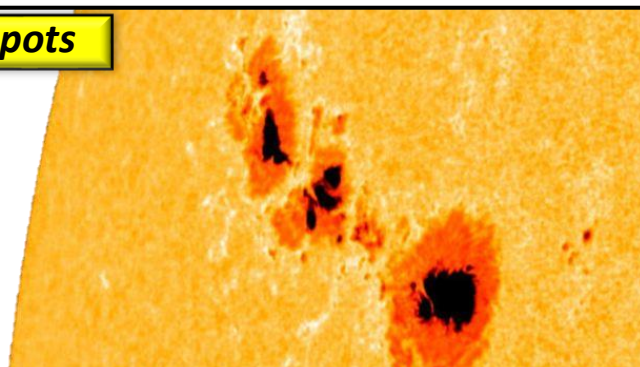
- nuclear fusion of Helium into carbon in Red Giants
- Like a chain reaction; lasts only few minutes
- Also produces Lithium; so some stars have more lithium than their planets

Sunspots

- They are **dark** spots on Sun
- They have **less temperature**
- They are caused by strong **magnetic field**
- They usually follow **11 year solar cycle**

Solar maxima:

- period of greatest sun **activity**
- Large number of **sunspots** appear.
- Large solar **flares** appear.



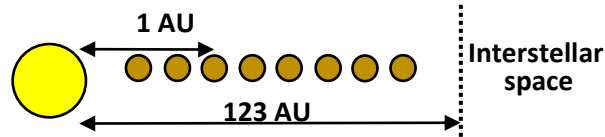
Solar maxima → more sunspots → more solar flares in surroundings → **more heat on earth**
Solar minima → less sunspots → less solar flares in surroundings → **less heat on earth**

Note:

- Solar flares are sometimes accompanied by Coronal Mass Ejections
- Solar wind / Solar flares/ Coronal Mass Ejections all contain plasma/charged particles, and can disturb electronic equipment on earth.

I read I forget, I see I remember | See explanation of this PDF on **YouTube** www.youtube.com/c/allinclusiveias

Voyager Program



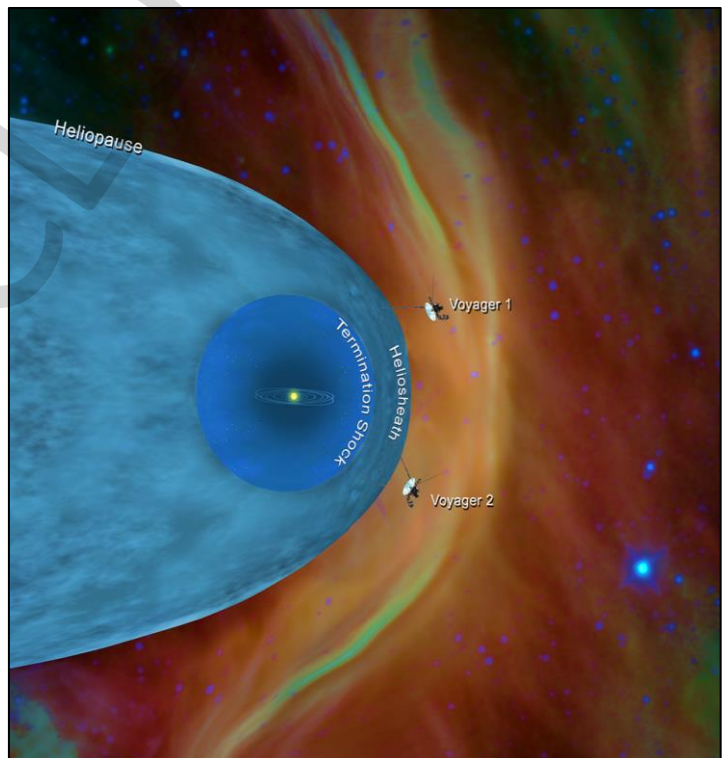
- ❑ **Heliosphere:** vast bubble from sun to planets
- ❑ **Heliopause:** outermost edge of the heliosphere
- ❑ It is usually considered as **solar system's boundary**
- ❑ **Interstellar space** lies beyond heliopause.
- ❑ In August 2012, **Voyager 1** became the first spacecraft to enter interstellar space.
- ❑ In Nov. 2018, **Voyager 2** became the second spacecraft to enter interstellar space
- ❑ **Astronomical Unit (AU)** is the average distance between Earth & Sun (15 crore or 150 million km)

Voyager program:

- Two spacecrafts launched by NASA in **1977**.
- Mission: study Jupiter and Saturn
- But they did much more than the initial mission.
- Voyager 2 also studied Uranus and Neptune.
- Currently, they are in **interstellar space**, and still sending us information.
- They detected increase in density of space outside the solar system.

Heliosphere

Outermost atmospheric layer of Sun
120 AU in interstellar wind side
More than 350 AU in opposite direction



Mars

Why study Mars?

- It is the planet that is **closest** and most **similar** to earth.
- To learn about **changes** that can fundamentally change a planet.
- To establish **future home** for humans.
- To expand human **understanding** of planetary evolution; solar system, universe.

Mars Orbiter Mission (MOM):

- ❑ India's 1st interplanetary mission; Unmanned; No lander/rover
- ❑ Launched by **PSLV** in November 2013; reached in September 2014.
- ❑ India became **4th country** to reach Mars; 1st from Asia; 1st in maiden attempt
- ❑ It has **five payloads** in the orbiter which helped in following:
 - prepared an **atlas and albedo** map of Mars through detailed pics
 - Close distance photos of its two **moons** Phobos and Deimos
 - Found that **dust storms** can rise up to hundreds of kms.

Moon

Why study the moon?

- Moon as a **base** for future space missions. e.g. Artemis Mission of NASA
- Moon as a **test bed** for technologies for future space missions. e.g. lander, rover, human habitat, etc.
- Moon as a **mine** for oxygen, water and metals.
- To expand human **understanding** of earth's formation; solar system, universe.
- Attracts **youth** to science, increases scientific temperament in **public**, more **international** cooperation.

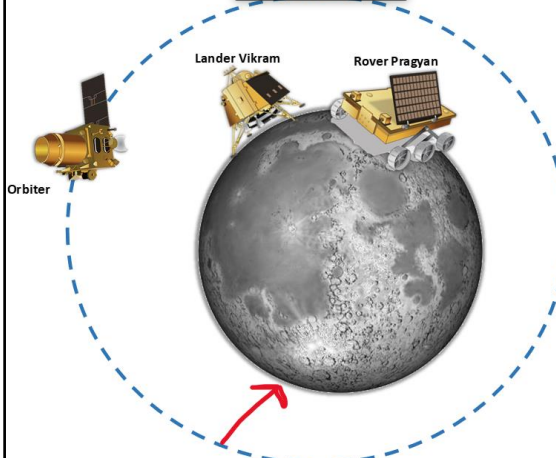
Importance of lunar south pole?

- ❑ **Outpost**: It is the best place for outpost because:
 - permanently shadowed **craters** have water and minerals.
 - **mountain** peaks get sunlight for up to 95% time (solar power)
- ❑ **Astronomy**: ideal place to set up ground radio observatory for sub 30 MHz signals.

Given its importance, NASA's Artemis program plans crewed landing at south pole in 2024.



Moon



	Chandrayaan -1	Chandrayaan -2
Year	2008	2019
Launch vehicle	PSLV-XL	GSLV Mk-III
Orbiter	Yes	Yes
Lander	Yes; Planned crash landing	Yes (Vikram); Planned soft landing, but crashed
Rover	No	Yes (Pragyan); failed due to lander's crash
Major achievements	<input type="checkbox"/> Moon impact probe stuck South Pole; <input type="checkbox"/> India 4 th country to have flag on Moon ; <input type="checkbox"/> Confirmed lunar ice (water)	

Lunar South pole:

- Mountains permanently sunlit (energy)
- Craters permanently shaded (water)
- Rich in minerals

Lunar Polar Exploration Mission (Lupex):

- By ISRO (India) and JAXA (Japan)
- To explore lunar **south pole**.
- After 2023**, not much finalised yet.

Moon landings:

- First:** 1959, Russia, Luna 2
- Soft:** USA, Russia, China
- Far side:** only Chang'e 4
- Humans:** only USA

- Total **12 men** have landed on moon.
First - **Neil Armstrong**; Last - **Gene Cernan**.
- 1st mission - **Apollo 11**: 20 July 1969 (Tranquility base)
- Last mission - **Apollo 17**: 14 December 1972
- Apollo 11: **Neil Armstrong & Buzz Aldrin** walked. Michael Collins in orbit.

Artemis : NASA mission to again send humans to Moon by 2024, but this time with long term perspective, to help in future space missions, like for Mars manned missions.

Orion is the spacecraft that will carry humans.

Spacecraft - Orion

Space Launch System is the rocket that will take spacecraft to space. (like India has GSLV/PSLV)



Gateway

Gateway is a small spaceship that will orbit around Moon, like ISS orbits around Earth.



Artemis Accords:

agreements between participants; India? No

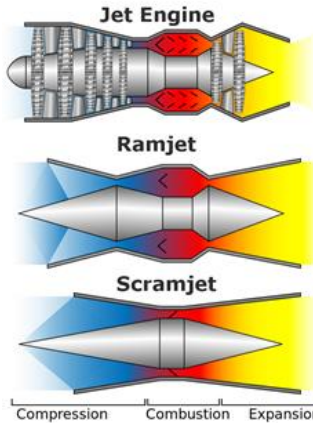
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Hypersonic

Supersonic: faster than speed of sound (Mach number > 1)

Hypersonic: more than 5 times faster than speed of sound ($M > 5$)

- ❑ **DRDO** recently tested Hypersonic technology demonstration vehicle.
- ❑ It used **ISRO's** Advanced Technology Vehicle.
- ❑ It is based on **scramjet** engine technology.

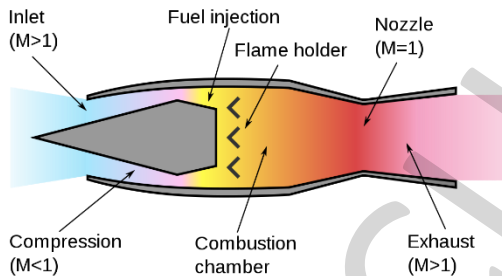


Ramjet engine:

- It does not have rotating compressor.
- It uses forward motion to compress incoming air.

Scramjet engine:

- supersonic-combustion ramjet
- airflow remains supersonic throughout the engine



Working:

- Incoming air is compressed due to forward motion of engine.
- Fuel is mixed with hot compressed air
- Ignition produces thrust.

Benefits of hypersonic flight:

- ❑ In defence, it **increases range and speed** of missiles, can evade enemy's defence mechanism, and intercept incoming missiles.
- ❑ In passenger aircraft, it can **reduce duration** of long distance flights.

Benefits of Ramjet:

- No need to carry **oxidizer** (70% of propellant weight)
- Vehicle becomes **lighter, faster, long range**.

Limitation:

- Does not work when vehicle is **stationary**
- Needs **additional** propulsion system, i.e. assisted take-off
- Can't work at higher **altitudes** where oxygen level drops.
- Efficiency drops after **Mach 6**.

Applications:

- India uses ramjet engine in **BrahMos** and **Akash** missiles.
- **BrahMos-II** will use scramjet engine.

Nuclear energy

Also see class-44

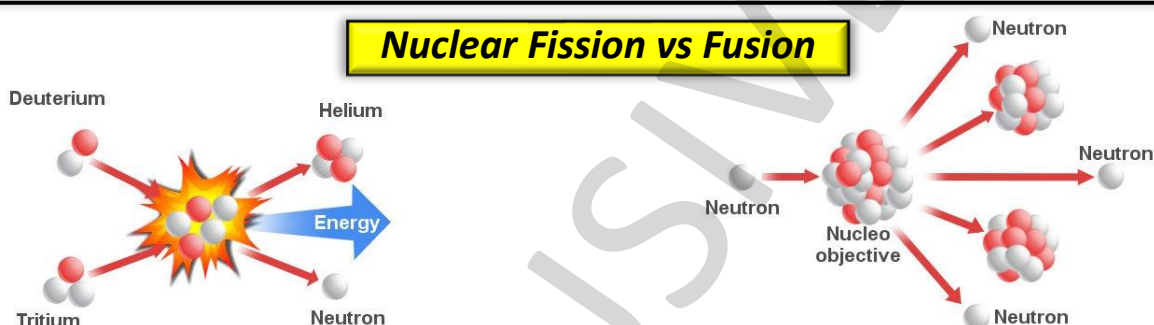
Why India needs nuclear energy?

- **Coal:** coal reserves will run out in a few decades. India needs reliable alternative.
- **Hydro:** Receding Himalayan glaciers will reduce water in dams in future.
- **Solar/Wind:** they are renewable but are unreliable, as they are weather dependent.
- **Climate change:** Nuclear reactors do not emit GHG, hence are eco-friendly

Challenges in scaling up nuclear energy:

- **Technology:** advanced technology, needs skilled people, international collaboration
- **Uranium:** low domestic resource; imports are difficult
- **Waste:** both the reactor and mining generates radioactive waste
- **Risk:** risk of accident at reactor (Chernobyl, Fukushima)

Nuclear Fission vs Fusion



Nuclear Fusion	Nuclear Fission
Two light nuclei combine together	Heavy nucleus splits into lighter nuclei
Mostly Deuterium and Tritium are used	Mostly uranium and plutonium are used
Energy produced is more than that in fission	Energy produced is less than that in fusion
No long-lived radioactive waste produced	Long lived radio-active waste is produced
No chain reaction; plasma cools if disturbed	Chain reaction; can go uncontrolled

Advantages of fusion:

- **Fuel:** abundant fuel (hydrogen from water), instead of uranium
- **Safe:** plasma cools in seconds is disturbed; no chain reaction.
- **Eco-friendly:** produces water, not radioactive waste
- **Space travel:** future space travel can use Hydrogen present in interstellar space.

Issues related to India's participation in ITER: (next page)

- Since 2017, India has not fulfilled its in-cash contribution.
- India has deputed only 25 scientists/engineers there, against sanction of 100. This gives China to increase influence.
- India deputed a junior person in comparison to heads of states by other nations at the recent high profile global virtual event.

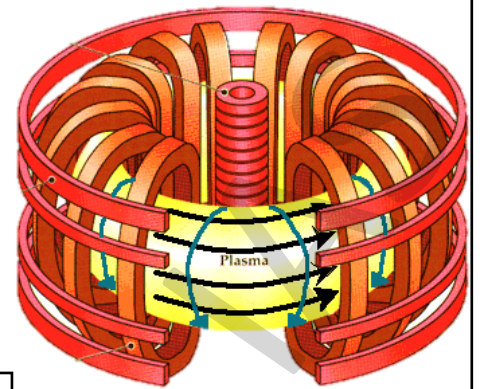
Nuclear Fusion - ITER

International Thermonuclear Experimental Reactor:

- ✓ for nuclear Fusion (not fission)
- ✓ World's largest tokamak, under construction in France
- ✓ Members: USA, Russia, EU, India, China, Japan, Korea

ITER-India:

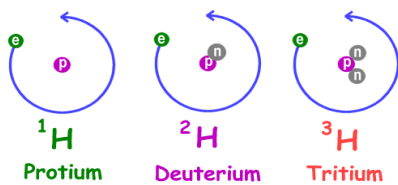
- ✓ Project under Institute of Plasma research, Gandhinagar
- ✓ It is to deliver India's in-kind contribution to ITER.
- ✓ India became full member of ITER in December 2005



Tokamak:

- ✓ Doughnut shaped device that uses powerful magnetic field to **confine hot plasma**
- ✓ It is one way to achieve make a **fusion reactor**.

Three Isotopes of Hydrogen



Isotope:

- ❖ Same number of protons, but different no. of neutrons
- ❖ Remember: Elements are identified by number of protons

Prelims 2008:

In which of the following locations is the ITER project to be built?

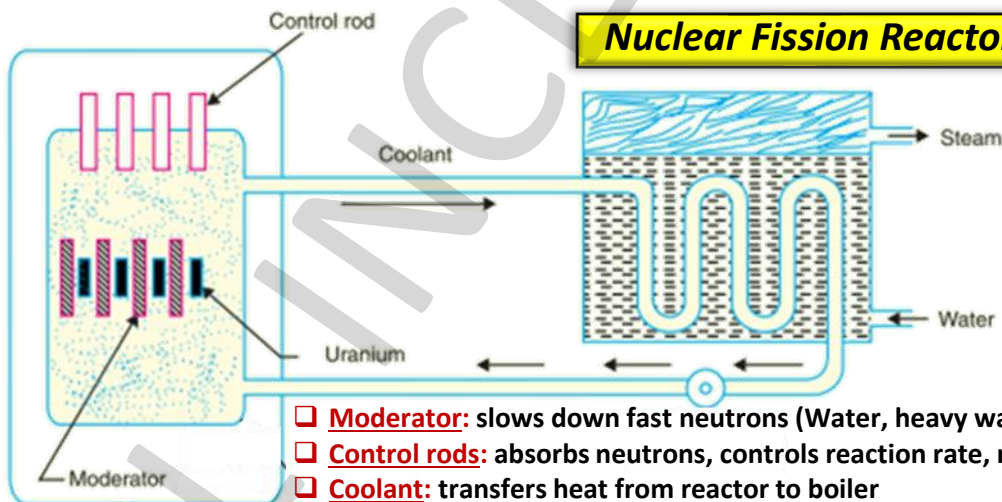
- (a) Northern Spain
- (b) Southern France**
- (c) Eastern Germany
- (d) Southern Italy

Prelims 2016:

India is an important member of the ITER. If this experiment succeeds, what is the immediate advantage for India?

- (a) It can use thorium in place of uranium for power generation
- (b) It attain a global role in satellite-navigation
- (c) It can drastically improve efficiency of its fission reactors in power generation
- (d) It can build fusion reactors for power generation**

Nuclear Fission Reactor



- ❑ **Moderator:** slows down fast neutrons (Water, heavy water, D₂O Graphite)
- ❑ **Control rods:** absorbs neutrons, controls reaction rate, made of Cadmium
- ❑ **Coolant:** transfers heat from reactor to boiler

Uses of Depleted Uranium:

- ✓ Nuclear weapons;
- ✓ Radiation shield in medical equipment.
- ✓ Tank armour; Armour piercing ammunition
- ✓ Counter-weights in aircrafts, etc.

Manhattan Project:

- ❑ US project for nuclear weapons
- ❑ 16 July 1945 **Trinity test:**
1st detonation of a nuclear weapon
- ❑ 06 August 1945 **Little Boy** in Hiroshima
- ❑ 09 August 1945 **Fat Man** in Nagasaki

I read I forget, I see I remember

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Hydrogen

National Hydrogen Mission:

- ❑ It aims to make India a global hub for green hydrogen production and exports.
- ❑ Components: create infra, demonstrate applications, encourage R&D, develop standards for hydrogen technologies

Benefits of using Green Hydrogen:

- ❑ It is a **clean** source of energy, it can help India achieve its **Paris** agreement targets.
- ❑ It can be used to **decarbonize** polluting sectors like **transportation**.
- ❑ It can be used to **store and transport** renewable energy.
- ❑ Hydrogen **Fuel cell cars** can be refuelled in 5 minutes, compared to hours needed for electric cars.
- ❑ It can **reduce import bill** as currently India imports 85% of its oil and 53% of its gas needs.

Challenges:

- ❑ **Technology** is still at nascent stage. Research is needed for large scale commercial use.
- ❑ **Investment** in setting up renewable energy, and hydrogen manufacturing plant.
- ❑ **Safety** issues in handling and storing Hydrogen, as it is flammable and lacks smell which makes detecting leakage difficult.

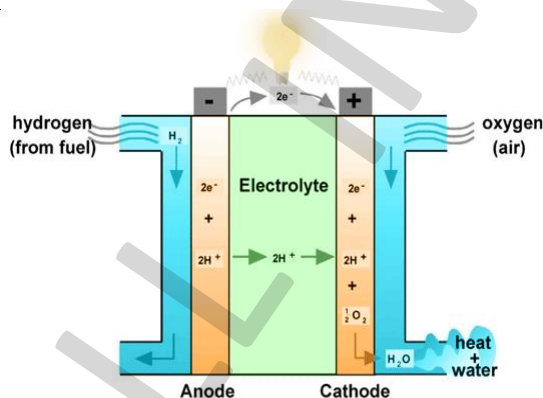
Steps taken:

- ❑ National Hydrogen Mission launched in 2021
- ❑ Hydrogen Fuel cell program by Department of Science and Technology.
- ❑ Delhi running H-CNG buses by mixing Hydrogen in CNG.
- ❑ National Hydrogen Energy roadmap 2006 for public and private efforts for hydrogen energy development.

Fuel Cell

What is a fuel cell?

- A fuel cell is like a battery that does not need to be recharged.
- It produces electricity as long as fuel is supplied.
- It takes hydrogen as fuel, and performs redox reaction, to generate electricity.



How does a fuel cell work?

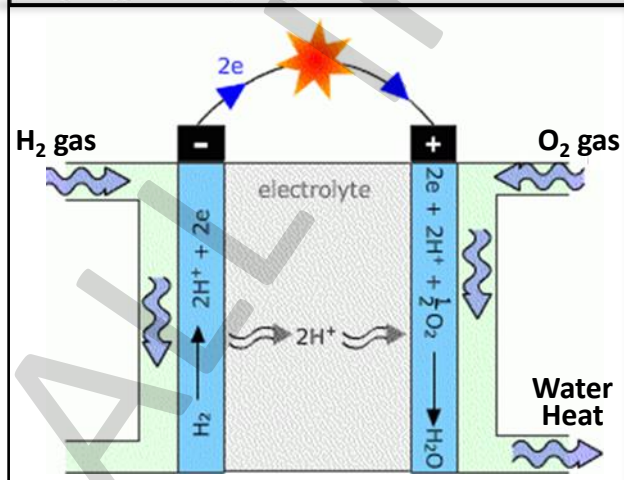
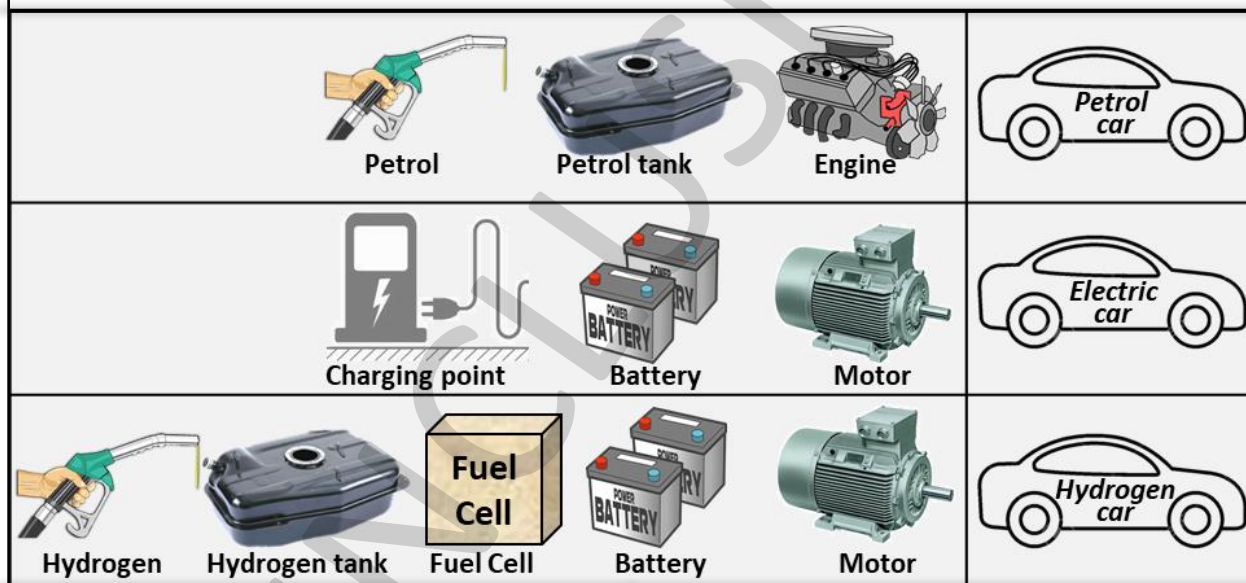
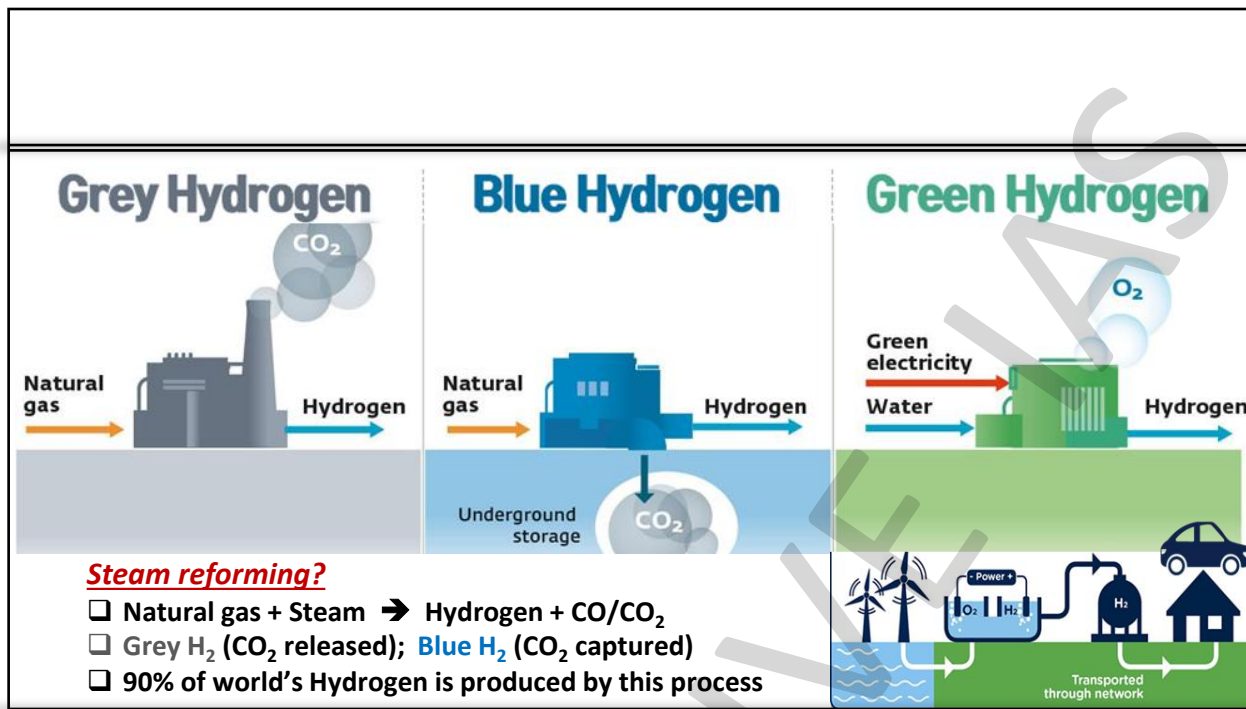
- A fuel cell has a cathode and an anode.
 - **Anode** is given **Hydrogen**.
 - **Cathode** is given **oxygen** (air).
- **At Anode:** a catalyst separates Hydrogen into **proton** and **electron**.
 - **Electron** goes through a **wire**, creating electricity.
 - **Proton** passes through **electrolyte**, towards cathode.
- **At Cathode:** proton, electron and oxygen meet to produce water.

Advantages of Hydrogen Fuel cell:

- It is the most **abundant** element in the Universe.
- No harmful emission (H become H₂O)
- Used in Cryogenic engine of **space** rockets

Disadvantages of Hydrogen Fuel cell:

- **Technology** still developing
- **Expensive**
- Dangerous to handle due to high **flammability**



Prelims 2015:
With reference to 'fuel cells' in which hydrogen-rich fuel & oxygen are used to generate electricity, consider the following statements.

1. If pure hydrogen is used as a fuel, the fuel cell emits heat and water as by-products.
2. Fuel cells can be used for powering buildings and not for small devices like laptop computers.
3. Fuel cells produce electricity in the form of Alternating Current (AC).

Which of the above statements are correct?

(a) 1 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3



- H-CNG:** Hydrogen added to CNG
- Engine **modification** not required.
- Improves fuel **efficiency** (5%).
- Efficiency increases with load, hence good for **buses**.
- Reduces **pollution:** CO₂, CO, NO_x, etc.
- Issues: **expensive**, handling, production

Hydrogen fuel $\begin{cases} \text{Mix with CNG} \\ \text{Fuel cell} \end{cases}$

Prelims 2019:

In the context of proposals to the use of hydrogen-enriched CNG (**H-CNG**) as fuel for buses in public transport, consider the following statements :

1. The main advantage of the use of H-CNG is the **elimination** of carbon monoxide emissions.
2. H-CNG as fuel **reduces** carbon dioxide and hydrocarbon emissions.
3. Hydrogen up to **one-fifth** by volume can be blended with CNG as fuel for buses.
4. H-CNG makes the fuel less **expensive** than CNG

Which of the statements given above is / are correct?
 (a) 1 only (b) 2 and 3 only (c) 4 only (d) 1, 2, 3 and 4

Electric vehicles

FAME (2015, 2019):

- Faster Adoption and Manufacturing of Electric Vehicles
- Scheme by **Ministry of Heavy Industries;**
- to promote electric vehicles.
- Part of National Electric Mobility Mission Plan

State EV Policy:

Karnataka was the first state to have an EV policy (2017)

Advantages:

- Running cost (Rs 1/km vs Rs 8/km)
- Eco-friendly

Disadvantages:

- Initial cost (30-40% due to battery)
- Range limitation (200-500km)
- Raw material import dependence e.g. Lithium

Real Time Market in Electricity

Energy Exchange:

Just like a company's shares are traded on BSE/NSE Electricity/REC/ESCs are traded on IEX/PXIL

India Energy Exchange / Power Exchange India Ltd.

Earlier: day-ahead, week-ahead

Now: Just one hour ahead also

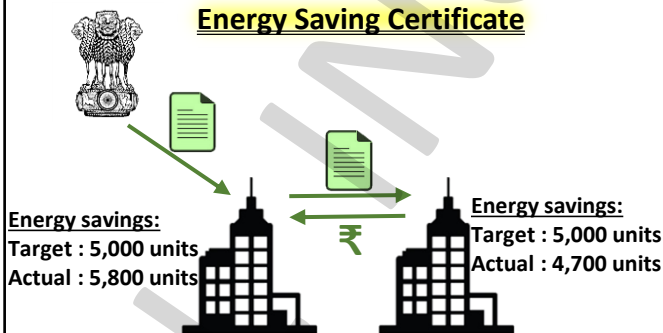
India Gas Exchange:

- Subsidiary of IEX
- for trade in imported LNG.

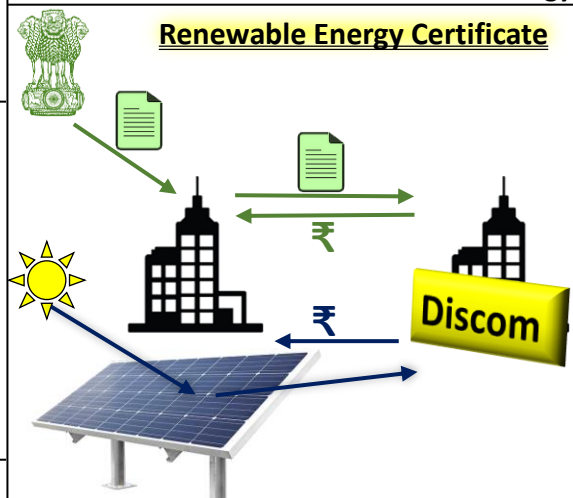
Green Term Ahead Market:

- for short-term trade in Renewable energy

Energy Saving Certificate



Renewable Energy Certificate



Energy Transition:

- Petrol to electric, coal to nuclear, etc.
- Energy Transition Index by? **WEF**
- Fostering Effective Energy Transition initiative? **WEF**

Energy Intensity:

- Energy used to produce one unit of GDP
- **Low EI** can indicate **labor intensive** economy.

Renewable Purchase Obligation:

It is necessary for Discoms to meet certain part of energy need from Renewable sources.

Renewable Energy Certificates:

Purchase certificates instead of purchasing renewable power

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Exports

Why India has low share in global exports? (India 1.7%, USA 9%, China 13%)

- **Import substitution policy:** protectionism made domestic industries uncompetitive
- **Interest rates:** High interest rate makes exports costlier
- **Tax:** High corporate income tax reduces incentive to manufacture in India
- **Labour laws:** Labour laws discourages labour intensive manufacturing
- **Awareness:** low awareness among businesses about export promotion schemes
- **Value chains:** Low level of participation in global value chains

What can be done to boost exports? (High Level Advisory Group)

- ❑ **Technology:** use new tech like Big Data analytics, industry 4.0 to increase competitiveness
- ❑ **Interest rate:** reduce cost of capital to average of 10 best performing OECD countries
- ❑ **Tax:** reduce corporate income tax rate to 18% (competitors have 15-20%)
- ❑ **Trade Promotion:** Set up a Trade Promotion Organization for evidence-based policymaking.
- ❑ **Champion sectors:** promote the already identified 12 champion sectors
- ❑ **Global value chains:** Use regional trade agreements to become part of Global value chains.
- ❑ **WTO:** Constitute an inter-ministerial group to make national official thinking on WTO related issues.

Additional info:

- **70%** of India's export are from **five states** – Maharashtra, Gujarat, Karnataka, Tamil Nadu and Telangana.
- Weakened global trade during 2014-16 affected exporting capacity of China. **Bangladesh and Vietnam** used this to boost exports, but India missed the opportunity.

Global Value Chain

- ❑ **Value chain:**
 - activities done to make a product, from inception to sale, and beyond.
- ❑ **Global value chain:**
 - value chain spread across different firms in different countries.
 - GVC accounts for 50% of global trade.

Why are GVCs important?

- **Hyper-specialization:** GVCs promote specialization in specific parts. e.g. China's button town makes 60% of all buttons on earth.
- **Productivity:** availability of higher-quality or less costly intermediate parts increases productivity.
- **Technology transfer:** long term firm-to-form relation promotes knowledge and tech sharing.
- **Employment:** GVCs increase number of jobs due to increased exports.

Concerns:

- **Gains** are not equally distributed across countries.
- Economy becomes more vulnerable to **external shocks**.

Export in Network Products

Why Assemble in India?

- Assembly is a highly **labour intensive** activity. Hence, by promoting assemble-in-India, millions of jobs can be created.
- China created **7 crore jobs** during 2001-06 by focusing on labor-intensive exports.
- Today, increase in **wages** is making **China** lose on low-cost final assembly business.
- Global Value Chains (GVCs) are changing due to US-China **Trade War**. Firms are looking for alternative locations.
- India has **abundant labour**, must grab this opportunity.
- By integrating Assemble-in-India with Make-in-India, India can create **4 crore jobs by 2025** and about 8 crore by 2030.

Why China performed better than India in exports?

Share in world exports: India 1.7%; China 12.8%. China focused on the following:

- High degree of **specialization** in production
- High level of export penetration in **rich countries**
- Large scale** in the chosen sectors of specialization
- High level of participation in **GVCs**

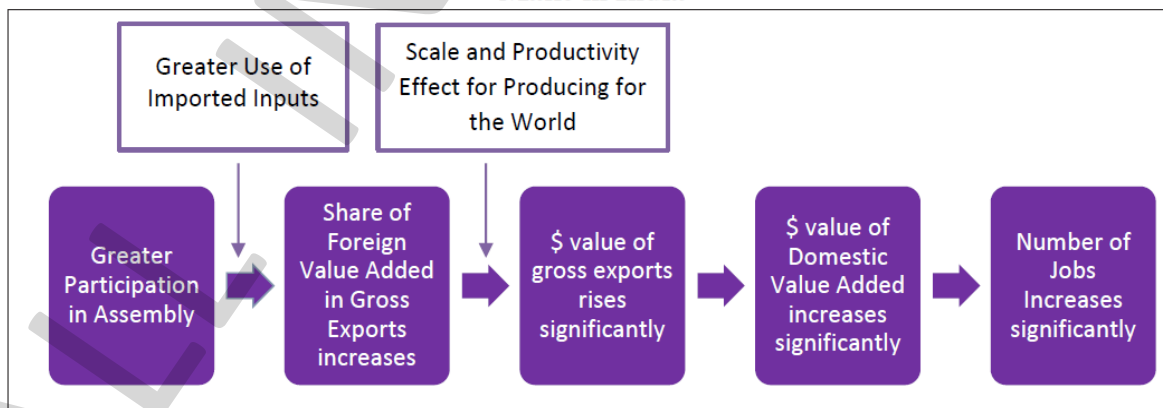
How China increased participation in Global Value Chains (GVCs)?

- China's exports focused not just on labour intensive industries.
- In capital intensive industries, China focused on **labour intensive stages** of production.
- China became major **assembly hub** for capital intensive products.
- China integrated its **domestic industries** with GVCs.

How does being part of Global Value Chains (GVCs) help in creating jobs?

Due to the huge size of the global market, production is on **large scale**, thereby creating millions of jobs.

Figure 8: The Conceptual Framework for Gains from “Assembling in India” as part of “Make in India”



For job creation, which Industries should India specialize in?

1. Traditional labor-intensive industries

1. e.g. textiles, clothing, footwear, toys.
2. **Buyer driven** model.
3. Company (e.g. Nike, Adidas) in developed countries concentrates on design, branding, marketing, etc.
4. Physical production is done by firms in developing countries, through sub-contracting.

2. Final assembly of network products.

1. e.g. computers, electronics, vehicles
2. **Producer driven** model.
3. Each country specializes in a particular process.
4. Skill intensive work (like R&D) in developed countries, and labour intensive work (like assembly) in developing countries. e.g. Apple, Sony.

Network Products:

Production processes are globally fragmented

- Share of NPs in **India's** exports: **10%** (5% road vehicles)
- Share of NPs in **China's** exports: **50%**
- Total trade in NPs can be classified into two categories:
 - Assembled end products:** labour intensive, creates jobs for masses
 - Parts & components:** creates high-skilled jobs

Automobile industry:

- 1981: Maruti Udyog Limited established by Gol.
- 1982: agreement with Suzuki
- Next few years: parts imported, only assembly done in India.
- Late 1980s: domestic manufacturing of parts expanded.

Mobile handset manufacturing:

- Between 2013-2017:
- Import of **handsets declined** from \$ 4.4 billion to \$ 3.3 billion.
- Import of **parts increased** from \$ 1.3 billion to \$ 9.4 billion.

Way forward:

- Immediate** focus on **assembly** activities; **long-term** focus on **parts & components**.
- Reduce import **tariffs** for intermediate inputs.
- Pro-active **FDI policy**, because MNCs are vehicles for a country's entry into GVCs.
- Prevent supply disruptions due to **political** disturbances, **labour** disputes, etc.

RCEP

Regional Comprehensive Economic Partnership:

- Free Trade Agreement between 15 countries.
- ASEAN + China + Japan + South Korea + Australia + New Zealand
- India was part of negotiations, but decided not to sign.
- India has been given the option to join it later.

Why did India pull out of RCEP?

- **Industry:** Indian industries, especially MSMEs, would face strong competition from cheap imports due to RCEP.
- **Services:** Indian demands to increase free trade in services were not accepted.
- **Trade deficit:** India's trade deficit with RCEP countries has doubled in last five years from \$54 billion to \$105 billion
- **China:** Due to its size and position, China can exert undue influence in RCEP which can hurt Indian interests.
- India already has bilateral FTAs with ASEAN, Korea and Japan and negotiations are underway with Australia and New Zealand. So, for India, RCEP is nothing but an indirect FTA with China.

Possible implications of not joining RCEP:

- It will create the impression that India is a strong **protectionist** country.
- It will leave Indian industries **uncompetitive** as they are currently.
- Indian **exports** will grow slowly compared to RCEP members.
- Closer ties among RCEP members may negatively impact India's ties with them.

FDI

FDI process:

- **Government route:** take prior permission from respective Ministry.
- **Automatic route:** no permission needed, just inform RBI after investing.
- **Above 5,000 crore:** need approval from Cabinet Committee on Economic Affairs
- **Recent changes:** Only 'govt route' for entities sharing land border with India
- Two areas where private sector is **not allowed:** Atomic energy, railway operations.
- In railways, 100% FDI under automatic route is allowed in infra, high speed rail, etc. but not in railway operations.

Chinese investment in India:

- **Till 2014,** India-China trade relation was mainly **transactional**, i.e. limited to trade.
- Since 2014, Chinese 'investment' in India has seen sudden jump: **\$1.6 billion** in 2014 to **\$26 billion** in 2019.
- Fearing further rise, by **opportunistic acquisitions** due to covid induced distress, Govt. amended FDI policy.

Benefits of Chinese FDI:

- Indian startups need **capital** to grow, which is not easily available domestically.
- FDI also brings experience and **technological** know-how.

Issues with Chinese FDI:

- **Financial data:** investments in fintech companies gives China access to financial and personal data of millions of India. e.g. Alibaba acquired 25% stake in Paytm in 2015.
- **Snooping:** investments in telecom sector gives China opportunity to spy on all communications and people. e.g. use of Chinese smartphones by public; Huawei gear by telecom companies
- **State owned companies:** 50% of Chinese investment in India are from China's state owned companies, as they are closely related to private Chinese companies investing in India.

WTO

WTO is an intergovernmental body, formed in 1995, to regulate international trade.

Challenges:

- Membership:** not all countries are part of WTO, e.g. Iran, Iraq, Lebanon, etc.
- Decision:** Decision making is by consensus, this makes negotiations impractically long. e.g. Doha round
- Dispute:** Dispute settlement mechanism non-functional due to delay in appointments.
- Special treatment:** Developed countries want WTO to discontinue special treatment to developing countries.
- Regional trade agreements:** they undermine the relevance of WTO
- Misuse:** WTO permits members to take any action to defend “essential national security interests”. Misused by USA to impose unusually high tariffs on steel and aluminum.
- TRIPS:** Developed countries allege flouting of TRIPS by developing countries (generic medicine, compulsory licenses, etc.). Developing countries oppose ever-greening of patents by developed countries.

Relevance of WTO:

- WTO provides a **rules-based trading system**, reducing arbitrary unilateral actions.
- By removing trade barriers it stimulates **global growth**.
- It functions as **arbitrator** in inter-country trade disputes.
- WTO regulates 98% of global trade flows.
- The average value of tariffs has reduced by 85% since 1942.
- Trade as a share of GDP has grown from 24% in 1960 to 60% in 2015.

Way forward:

- Pluri-lateral negotiations:** like-minded countries discuss and form rules on common issues.
- Decision making:** Like IMF, most decisions could be delegated to an Executive board of largest trading nations.
- Appointment:** appointments to dispute settlement body should be made independent of political control.
- Penalizing powers:** WTO should get powers to punish for willful non-compliance.

TRIPS flexibilities:

- They are ‘policy spaces’ for countries to mitigate the impact of patents.
- e.g. Exemptions from patentability, Compulsory Licensing, Parallel imports, etc.

Peace clause:

- Food security program cannot be challenged even if subsidy limits are breached.
- India has invoked peace clause for exceeding the limit on support to rice farmers.

Green box

- They don't distort trade
- Allowed without limit
- e.g. research, training, extension services, PM-KISAN, Rythu Bandhu

Blue box

- They limit production
- Allowed without limit
- e.g. farmers are paid to leave land fallow, for soil to regain fertility

Amber box

- They distort trade
- Limited to 5% in developed, 10% in developing countries
- e.g. subsidy on fertilizer, seed, electricity

Urban Cooperative Banks

- Cooperative banks grew from the concept of **credit societies**, where members pool in money and lend among themselves.
- Based on primary area of operation, they are of two types: **rural and urban**.
- **PMC bank crisis** has highlighted the poor condition of UCBs in India.

Urban Cooperative banks:

- ❑ **Registered** as cooperative society under State coop society Act or Multi-state Coop society Act 2002.
- ❑ **Banking** functions are **regulated** by RBI under Banking Regulations Act 1949 and Banking Laws (Co-operative Societies) Act, 1955.
- ❑ **Administration** is **regulated** by Registrar of Cooperative Societies.

Issues faced by UCBs:

- ❑ Controlled by **political** heavyweights, resulting in favoritism in loan sanction, write-offs, etc.
- ❑ **RBI's** control not as strong as on other scheduled commercial banks.
- ❑ **Risk concentration** as operations concentrated in a small area, small number of depositors.
- ❑ Problem in raising fresh **equity** to increase capital, due to cooperative nature.
- ❑ Lack of **talent** due to local hiring.

Steps taken:

- ❑ **System Based Asset Classification:**
 - ❑ UCBs with assets more than 1,000 crore have to use computerised systems for asset classification.
- ❑ **SARFAESI:**
 - ❑ Supreme Court has ruled that CBs can use SARFAESI Act 2002 to recover dues from defaulters.
- ❑ **Supervisory Action Framework:**
 - ❑ RBI has revised revise SAF for UCBs on lines of Prompt Corrective Action (PCA) framework applied on commercial banks.
- ❑ **Banking Regulation (Amendment) Act, 2020:**
 - ❑ It **extends powers** already available with RBI in respect of other banks, to Co-operative Banks.
 - ❑ RBI can **supersede Board of Directors** of CBs for 5 years in public interest.
 - ❑ It empowers RBI to **enforce reconstruction or amalgamation of bank**, even when the bank is not under **moratorium**. (*Moratoriums disrupt financial system, decrease people's confidence*)
 - ❑ CBs can issue **equity shares** to any person residing in its area of operation.

Way forward:

- End the system of **dual regulation** (Y H Malegam Committee)
- **Audit** by independent external auditors (Madhava Rao Committee)
- Increase **RBI's powers** on UCBs, including power to liquidate without involving other regulators. (R Gandhi Committee)

Mines and Minerals sector

Importance of mines and minerals sector:

- Contributes 2.4% to GDP
- Serves as base for manufacturing and power sector.
- India produces 95 minerals, including 4 hydrocarbons and 5 atomic minerals.

Mines and Minerals Amendment Act, 2020:

- Amends Mines and Minerals Act 1957 and Coal Mines Act 2015
- Composite license for prospecting and mining.
- Removes restriction on end-use of coal (captive as well as commercial sale)
- Statutory clearances of previous lessee will be transferred to new bidders for two years.

District Mineral Foundations:

- Set up under Mines and Minerals Act 2015 for mining affected districts
- It gets funds from mining company
- Funds are used to help people affected by mining (health, education, water, sanitation, infra, skill development, etc.)

Issues:

- Lacks representation from mining affected people.
- Identification of mining affected area is arbitrary, no proper method used.
- No social audit or performance audit conducted.
- Focus is on developing physical infra, not on human development indicators.

Electronics manufacturing

Electronics Manufacturing:

- Contributes 2.3% to GDP.
- Increased from Rs. 1.9 lakh crore in 2014 to Rs. 4.6 lakh crore in 2018
- India's share in global market increased from 1.3% (2012) to 3% (2018)

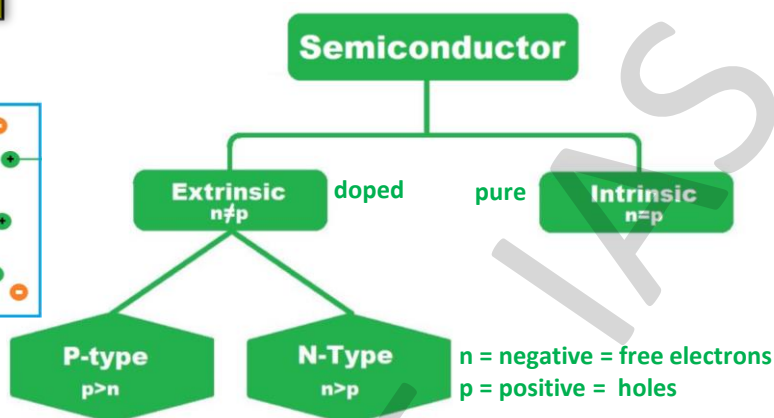
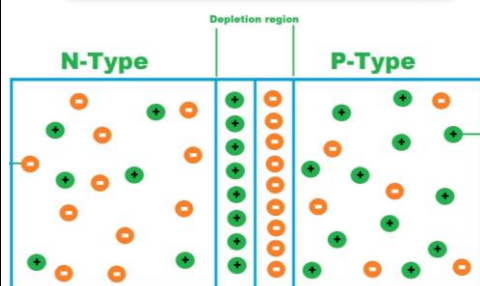
Need to boost electronics manufacturing:

- Major reason for trade deficit.
- Import dependence creates national security challenge.

Steps taken:

- 100% FDI under automatic route in Electronics Systems Design & Manufacturing
- National Policy on Electronics launched in 2012 to attract global and domestic companies
- Electronic Manufacturing Clusters Scheme which provides cost for development of infrastructure and common facilities (50% in Greenfield clusters and 75% of the cost for Brownfield clusters)
- Production-linked incentive manufacturing scheme.
- Scheme for Promotion of manufacturing of Electronic Components and Semiconductors (SPECS).

Semiconductors



Semiconductor:

- ❖ Critical part of **electronics**
- ❖ They have electrical **conductivity** between insulator (e.g. glass) and conductor (e.g. copper).
- ❖ Charge carriers are: **electrons**, ions and electron **holes**
- ❖ Conductivity can be controlled by Doping and temperature change.
 - ❖ **Temperature**: high temperature increases conductivity (opposite happens in metals)
 - ❖ **Doping**: intentional introduction of impurities
 - ❖ **Degenerate Semiconductor**: doped so much that it acts like conductor
- ❖ Some **examples** of semiconductors are silicon, germanium, gallium arsenide,
- ❖ After **silicon**, **gallium arsenide** is the second-most common semiconductor
- ❖ Chip shortage: Covid → factories shut → but demand increased

Semiconductor manufacturing

Need:

- **Domestic manufacturing** of cars and mobile phones is getting affected due to chip shortage.
- **Reduce import bill**, as India imports more than \$20 billion worth of semiconductors.
- Semiconductors as part of **defence equipment** have strategic role as well.
- **Global shortage** is forcing many countries to have own chip-making facilities, to reduce dependency on imports. (Why global shortage? Factories shut due to covid, demand increased due to Work/Study From Home)

Challenges: (think of factors of production)

- Large **investment** needed, more than 50,000 crore.
- Uninterrupted **power** supply and huge amount of ultra clean **water** is needed.
- India lacks **skilled manpower** for semiconductor manufacturing (no domestic industry)
- Chip making is a highly **complex process**, only a few countries have the expertise.
- It is difficult to **compete** with countries which have required infra and first mover advantage.

Way forward:

- Create supporting **infra**: power, water, skilled manpower
- Encourage **ATMP** assembly, testing, marking, and packaging as they need less investment than fabrication plants.
- **Policy** must be valid and stable for at least 10-15 years.
- **Collaboration** with global universities and companies.

Infra

Why infra needs push:

- Increasing **urbanization**. 31% live in urban areas now, will increase to 40% by 2030.
- To cater to rising **working** age population; 1 billion by 2030.
- Quality infra makes manufacturing and exports **competitive** e.g. reliable power supply, Dedicated Freight corridor
- Climate change related adverse weather events needs **disaster resilient** infra.

Challenges:

- **Financing:** Twin balance sheet problem (companies have excess debt; Banks have excess NPAs), Corporate bond market not well developed.
- **Regulatory issues:** procedural delays, land acquisition problems.

Types of investment models:

	EPC	BOT	HAM
Financing Risk	NHAI	Private company	Shared
Revenue Risk	NHAI	Private company	NHAI
Operating & Maintenance Risk	NHAI	Private company	Either party, depending on contract

- BOT model accounted for almost 96% of NHAI's all project awards in 2011-12.
- Certain problems faced; NHAI then gave most projects under EPC and HAM.
- But this impacted NHAI's finances.
- So, now a **revised BOT model** has been introduced:
 - Work order will be given only after acquiring at least 90% land.
 - Revenue re-assessment every 5 years, instead of 10 years.
 - Dispute resolution board to be set up, will deliver verdict in 90 days.

Hybrid Annuity Model:

- During construction:
 - 40% of construction cost borne by NHAI
 - 60% of construction cost borne by private company
- After completion:
 - NHAI responsible to collect toll
 - NHAI reimburses to private company as annual payments

Railways

Private participation in railways

Need:

- Current **capacity** is not enough to meet demand.
- **Services** are of sub-standard quality (hygiene, food, delays, etc.)
- Brings in **competition**, encouraging service improvement.

Challenges:

- **No independent regulator.** Bibek Debroy committee had said that IR acting as regulator will be 'conflict of interest'.
- **Under-investment.** Private player don't have long term contract, hence will be reluctant to invest, as happened in Britain.
- **Unfair competition.** IR cross-subsidizes passenger fares with freight fares. Private players can't do this.

Organizational restructuring of Indian Railways

Creation of IRMS:

- Eight Group-A services will be merged into a single service IRMS.

Railway Board:

- Will be reorganized on functional lines, instead of departmental lines.
- Departmental: mechanical, electrical, etc. Functional: Infra, operations, etc.

Health services:

- Indian Railway Medical Services to be renamed as IRHS.

Benefits:

- Railway departments work in silos, no coordination, unhealthy competition.
- Unification of service will bring coherent vision, and expedite decision making.

Issues:

- Technical and non-technical services have been merged. Bibek Debroy committee suggested merging 8 services into two.
- Departmentalism will continue, as departments will still exist (and are needed).
- Strong resistance from officers

Major Port Authorities Act 2021

- India has a long coastline of **7,517 km**.
- Sea ports handle **90%** trade by volume, **70%** by value.
- Of 204 ports, **12** are **major ports**. They handle 55% of traffic.

Challenges that Indian ports face:

- **Depth** not enough to cater to modern big ships.
- Lack of **infra** to handle increased international trade.
- Poor **connectivity** to interior areas, industrial belts.

Major Port Authorities Act 2021:

- It **replaces** Major Port Trusts Act, **1963**
- A compact Board with professional independent members will strengthen decision making and strategic planning.
 - Simplified composition (13 members instead of 19)
 - Has representation from State, Defence, Railways, Customs.
 - Full powers to enter into contracts, and fix tariffs
 - Can create master plan for any development or infra
 - Acts as a regulatory body and as landlord while private firms carry out port operations

Other steps taken:

- **Sagarmala** project to strengthen port infrastructure and improve connectivity to ports.

Coal Mining

Background:

- Coal Mines (Nationalization) Act, **1973** led to **nationalization** of coal mining
- Only govt. owned **Coal India Limited** was allowed to sell coal **commercially**.
- **Private sector** was allowed coal mining only for **captive use**.
- Companies in sectors like steel, power, cement, etc. applied for permission for captive mining, coal **blocks allocated**.
- But due to kickbacks, **SC cancelled** coal blocks allocated during **1993-2014**.
- Govt. brought **Coal Mining Act, 2015** for mandatory auction; **other reforms** also introduced.

Benefits of commercial coal mining:

- **Auction** of mines brings more **revenue** to government.
- Ending CIL monopoly brings in **competition**, and new **technology** in mining.
- **Reduces coal shortages** at power plants; reduces import dependence.
- Note: **cost** of electricity may rise as companies win contracts after auction process.

Other steps taken:

- Mandatory **coal washing** has been discontinued. This will reduce cost of coal.
- **Single window clearance** system for smoother process.
- Requirement of **prior experience** for bidding has been removed.
- **100% FDI** under automatic route allowed in coal mining.
- **Coal linkage swapping** liberalized to reduce transportation costs.
- **Rebate on revenue sharing** for early production, excess production and use for coal gasification.

MSME

Importance of MSME sector:

- Employs 12 crore people.
- Accounts for 30% GDP and 45% exports.
- Inclusive growth since many MSMEs are in rural areas.

Challenges faced by MSME sector:

- Most are **family run**, hence, less professional management
- **Small size** → no economies of scale → high cost of manufacturing
- Poor quality **supporting infra**, like power, water, roads
- Tough **competition** from imported products
- Lack of **branding**, marketing strategy
- Difficulty in getting **credit** (lack of credit history, poor quality of assets for collateral)

Some recent steps to promote MSME sector

- In principle approval for **loans** up to Rs 1 crore within **59 minutes**
- **2% interest subvention** for incremental credit up to Rs 1 crore
- All companies with a turnover of more than Rs 500 crore to be mandatorily on **TReDS**
- All **CPSUs** to procure at least **25%** from MSEs instead of 20% of their total purchases
- Online filing on **Shram Suvidha Portal** under Labour Laws

Gaganyaan

Challenges:

- Replicating human environment:**
 - Maintaining optimum **temperature** & **humidity**, supplying **oxygen**, removing **CO₂**, etc.
 - Human **waste** storing/recycling technology, with limited **power/weight**.
- Dangers from space environment:**
 - There is **no atmosphere to protect** astronauts from Sun's radiation
 - Space radiation can **damage** human DNA, cells and tissues.
- Launch and re-entry systems:**
 - **GSLV Mk-III** has completed only 4 launches (PSLV has done 55 launches)
 - High temperature at atmospheric **re-entry** is a complicated process
 - eg Space Shuttle **Columbia** was destroyed due to high re-entry temperature (February 1, 2003)
- Competing needs for funds and manpower:**
 - **Defence satellites** for border security, Navy communication, etc urgently needed
 - **International projects** like NISAR satellites with NASA
 - **Commercial projects** like developing SSLV for more profitable launches for other countries

Due to the complicated nature of mission, two un-manned missions will be conducted before the final manned mission. (#1 empty, #2 robot vyommitra, #3 humans)

<https://www.isro.gov.in/frequently-asked-questions/gaganyaan>

Gaganyaan: Program to demonstrate indigenous capability to undertake human space flight mission to LEO.

Likely benefits of Gaganyaan programme:

- Develop advanced **technologies** for human space exploration
- Conduct scientific **experiments** in interest of the nation.
- Inspire **youth** to take up career in S&T
- Use human spaceflight programme as a potent **foreign policy** tool (just like SAARC / South Asia satellite)
- Develop capability to collaborate in global **space station** development

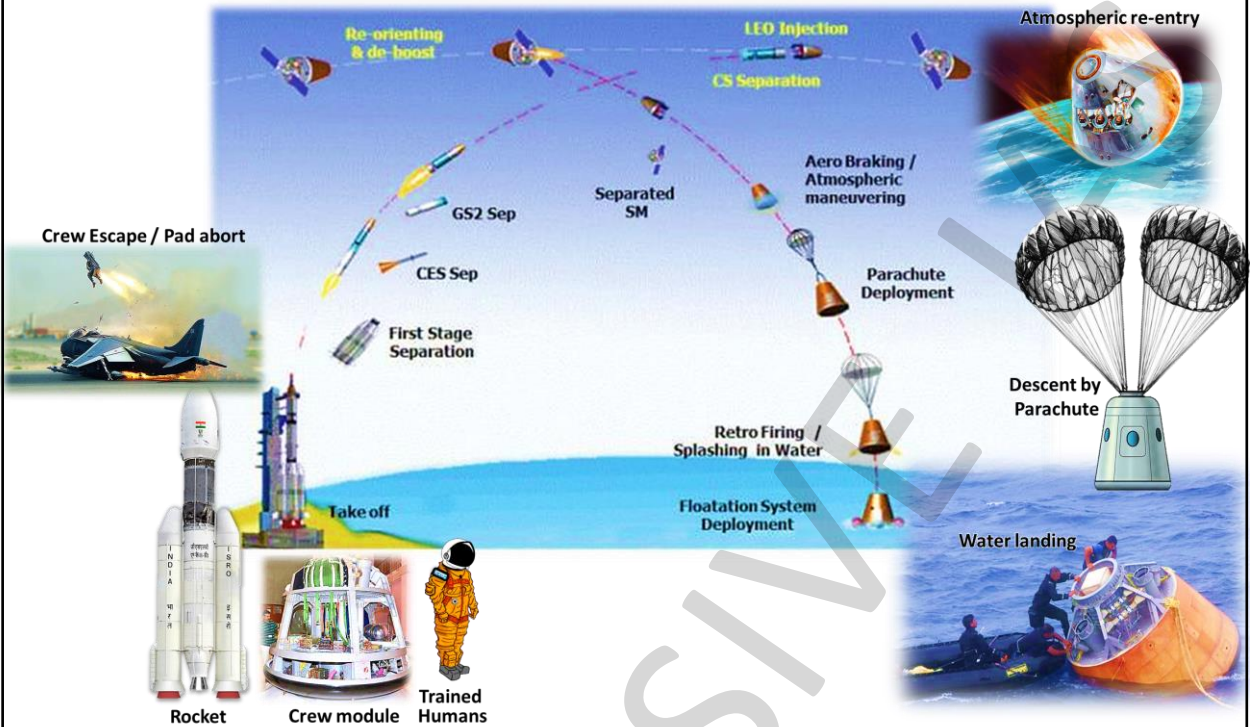
New technologies required for Gaganyaan programme:

- Human rated launch **vehicle**
- Crew **escape** systems
- Habitable** orbital module
- Life** support system
- Crew selection and **training** and associated crew management activities

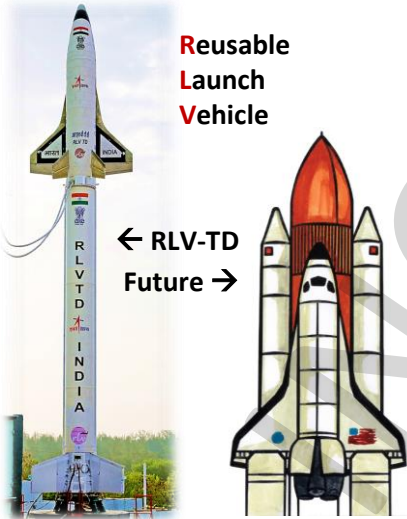
Plans after Gaganyaan programme:

- Develop capability for **sustained human presence** in space.
- Develop **Indian space station** to conduct scientific and industrial research.

Indian Human Spaceflight Programme



Timeline of Indian Human Space flight Programme:



ISRO recommends manned space mission

work starts under name "Orbital vehicle"

Space Capsule Recovery Experiment

Biggest challenge was launch vehicle. Developed by 2014

2001	2011	2021	Target
2002	2012	2022	
2003	2013	2023	
2004	2014	<input type="checkbox"/> GSLV Mk-III <input type="checkbox"/> Crew module Atmospheric Re-entry Experiment	
2005	2015	RLV-TD (looks like space shuttle, not for present Gaganyaan mission)	
2006	2016		
2007	2017	<input type="checkbox"/> Pad Abort Test <input type="checkbox"/> Gaganyaan announced	
2008	2018		
2009	2019		
2010	2020		

Gaganyaan programme:

- two unmanned missions
- one manned mission
- three Indians;
- in LEO (400km);
- for 7 days
- by GSLV Mk-III

Rakesh Sharma:

- the only Indian citizen in space
- 3 April 1984 in Soyuz T-11

Manned mission to space:

USSR, USA, China

April 12, 1961	1 st man in space	Yuri Gagarin
1963	1 st woman in space	Valentina Tereshkova
1965	1 st space walk	Alexei Leonov
July 20, 1969	1 st man on moon	Neil Armstrong

I read I forget, I see I remember

See explanation of this PDF on [YouTube](https://www.youtube.com/c/allinclusiveias) www.youtube.com/c/allinclusiveias

Speciality	Institute	Place
Design and development of launch vehicle technology	Vikram Sarabhai Space Centre	Thiruvananthapuram (Kerala)
Design, development and integration of satellites	U R Rao Satellite Centre	Bengaluru (Karnataka)
Spaceport of India, provides Launch Base Infra	Satish Dhawan Space Centre	Sriharikota (Andhra Pradesh)
Manned missions	Human Space Flight Centre	Challakere (Karnataka)
Remote Sensing Satellite data processing	National Remote Sensing Centre	Hyderabad (Telangana)
Space University (Asia's first, 2007)	Indian Institute of Space Science and Technology	Thiruvananthapuram (Kerala)



PSLV



Solid 1st stage and 6 Solid strap-on

- **1980: Satellite Launch Vehicle-3.** Capacity 40 kg satellite in LEO.
- **1987: Augmented Satellite Launch Vehicle.** Capacity 150 kg satellite in LEO. Used new technologies like strap-on.
- **1993: PSLV.** First vehicle with liquid stages. **Workhorse of ISRO.**
 - ✓ After 39 consecutively successful missions since 1994, had a unsuccessful launch in August 2017.
 - ✓ **Unmatched reliability;** called as '**Workhorse of ISRO**'; used to launch various satellites into **GTO** like satellites from the **IRNSS** constellation.
- **2014: GSLV Mk-III**

PSLV	GSLV Mk-III
1993	2014
Four stages	Three stages
No cryogenic	3 rd stage is Cryogenic
LEO: 1,750 kg	LEO: 8,000 kg
GTO: 1,425 kg	GTO: 4,000 kg
Prominent missions: <ul style="list-style-type: none"> ➤ Chandrayaan-1 in 2008 ➤ Mangalyaan in 2013 ➤ IRNSS/NavIC 	Prominent missions: <ul style="list-style-type: none"> ➤ Chandrayaan-2 in 2019

- Cryogenic engine:**
- Uses Liquid Oxygen and Hydrogen.
 - Benefits: More power to weight ratio
 - Drawback: technically very complex

GSLV



solid Liquid solid

SSLV

Small Satellite Launch Vehicle; Under development; for small satellites.

- ❑ NSIL will get it made with private players
- ❑ Will have 3 stages, all will use **solid fuel**
- ❑ **500 kg** satellite mass into **500 km** LEO

Prelims 2007:

Consider the following statements:

- In the year 2006, India successfully tested a full fledged **cryogenic** stage in rocketry.
- After **USA, Russia and China**, India is the only country to have acquired the capability for use of cryogenic stage in rocketry.

Which of the above statements are correct?

- (a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Prelims 2018:

With reference to India's satellite launch vehicles, consider the following statements:

- PSLVs** launch the satellite useful for **Earth resources monitoring** whereas **GSLVs** are designed mainly to launch **communication satellites**.
- Satellites launched by **PSLV** appear to remain permanently **fixed** in same position in the sky, as viewed from a particular location in Earth.
- GSLV Mk III** is a **four-staged** launch vehicle with the first and third stages using solid rocket motors; and the second and fourth stages using liquid rocket engines.

Which of the above statements are correct?

- (a) 1 only (b) 2 and 3 (c) 1 and 2 (d) 3 only

Artemis Accords

Also see:

Class-45 pg-6 for space treaty
Class-58 pg-6,7 for moon

What are Artemis Accords?

- ❑ **Bilateral** agreements of **US** with countries for **space exploration**.
- ❑ They are based on principles like: peaceful use, interoperability, emergency assistance, releasing scientific data, safe disposal of debris, etc.

Aim of Artemis program:

- ❑ Return **humans** to **moon** by **2025**
- ❑ Use moon as **base camp** for future missions to **Mars** and beyond.

Criticism:

- ❑ **It reinforces US hegemony**
 - The accords are bilateral agreements, and **not any international treaty**.
- ❑ **It excludes China due to 2011 Wolf amendment**
 - It prohibits **NASA** from cooperating with **China**
- ❑ **It violates Outer Space Treaty**
 - Outer Space Treaty forbids nations from **staking claim** to another planetary body
 - But the accords allows nations to **lay claim to resources extracted** from celestial objects

India should join because:

- ❑ **Learning opportunity for Indian Space programs:**
 - **Gaganyaan** mission may benefit from manned flight component of Artemis program
 - **Lupex** mission of India-Japan for moon may get a boost from Artemis program
 - **Chandrayaan-2** could not meet mission objectives (failed to soft land on moon)
- ❑ **Indian companies will benefit:**
 - Indian companies will become part of **global supply chain** of space components
 - Indian space **start-ups** may benefit from **capital** and **tech** inflow
- ❑ **India may be left behind**
 - India may not join **Russia-China** led **ILRS** program
 - **Japan**, S. Korea, **UK**, France, Australia, etc **have joined** Artemis program.
 - **By not joining either**, India will have no option but to **go alone**.

India should not join because:

- ❑ **It is not international treaty:**
 - Artemis accords are bilateral agreements with USA, not international treaty/convention
- ❑ **Indian Space Program will suffer:**
 - India will need to **align its resources** with Artemis program
 - This will create **shortage of funds and manpower** for programs like Chandrayaan, Gaganyaan, etc.
- ❑ **Maintain strategic autonomy:**
 - India should **join neither** US led Artemis, not Russia led ILRS.
 - India should make **project based associations** with countries, e.g. LUPEX
 - (But future of space is not about sending a rover to moon, its about setting up human habitations on moon, bringing back minerals, using moon as base for Mars mission, etc.)

Extra info: Moon Treaty 1979

(Agreement Governing the Activities of States on the Moon and other Celestial Bodies)

- ❑ Moon should be used for **benefit of all** countries
- ❑ Lunar resources should be **equitably shared** by all countries
- ❑ **No** country can lay sovereign **claim** to lunar resources
- ❑ Bans altering **environmental balance** of celestial bodies
- ❑ Bans any **military use** of celestial bodies

Moon Treaty is not relevant because:

- ❑ **Only 18** countries have joined the treaty
- ❑ USA, Russia, China, did not sign it.
- ❑ India signed it, but did not ratify.

Perhaps, India should formally exit the treaty, and join Artemis program.

Liquid Mirror Telescope

International Liquid Mirror Telescope

- ❑ It has a 4 metre wide rotating mirror, with a **thin film of liquid mercury**
- ❑ It has been set up at **Devasthal** in Nainital, Uttarakhand
- ❑ It has been jointly developed by India, Belgium, Canada, Poland and Uzbekistan.
- ❑ It is expected to start giving scientific data from October 2022.

Liquid-mirror telescope:

- ❑ Telescope whose mirrors are made of **reflective liquid**.
- ❑ **Mercury** is the most commonly used liquid.

How its different:

- ❑ **Conventional telescope**
 - They have highly polished **glass** mirrors.
 - They are **steered/tilted** to focus on targeted celestial object.
- ❑ **Liquid Mirror Telescope:**
 - They use reflective **liquid**, instead of glass.
 - They are **stationary**, hence cannot be steered/tilted to study particular object.

Construction:

It has a very **simple** construction, mainly three components are required:

- ❑ **Dish** with liquid metal (mostly mercury)
- ❑ **Air bearing** on which the dish sits
- ❑ **Drive** system (to rotate the dish)

Working:

- ❑ **Dish** is **rotated** at a constant speed around a vertical axis.
- ❑ Due to rotation, surface of **liquid** assumes **parabolic** shape.
- ❑ This parabolic reflector acts like a **mirror** of a reflecting telescope.

Advantage:

- ❑ Low cost: They cost **just 5%** of similar sized conventional telescope.

Disadvantage:

- ❑ They can only be pointed **straight up**. Hence, objects **cannot** be physically **tracked**.

Application / use:

(Students can simply write some general applications of telescope in astronomy like)

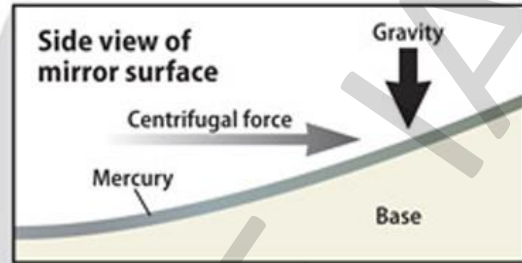
- ❑ Conduct astronomical **observations**
- ❑ Observe cosmic **events** like supernova
- ❑ Discover new **objects** in space like new planets
- ❑ Generate data to understand **expansion** of Universe

Extra info: Advantages of Space based telescope compared to Ground based telescope:

- ❑ No distortions (refraction, flickering) due to atmosphere.
- ❑ No light pollution from artificial sources of light.

Note: LMTs are Ground based telescopes.

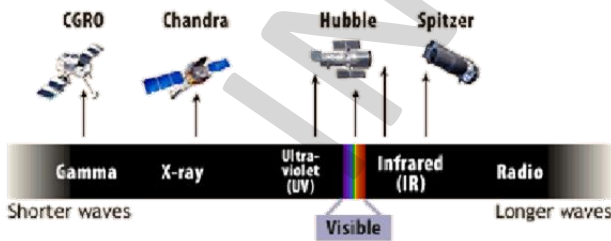
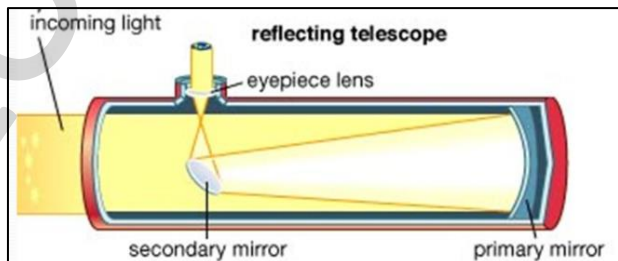
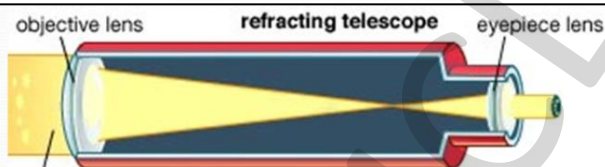
How liquid-mirror telescopes work



A **liquid-mirror telescope** uses a thin layer of mercury within a rotating dish to form a reflective surface to collect light and focus it. As the platform rotates, the combination of gravity and centrifugal force sculpts the liquid mercury into an extremely smooth parabolic surface. The telescope scans a wide swath of the sky directly overhead. *Astronomy: Roen Kelly*

From Prelims PT365 Science class-8 (pg-87)

Telescopes



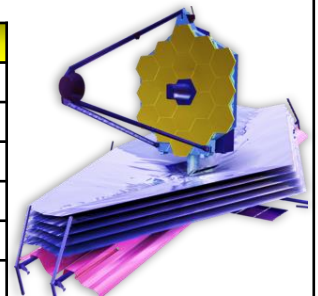
← Great Observatories program: (NASA)

Four powerful space-based telescopes

- 1990 Hubble Space Telescope
- 1991 Compton Gamma Ray Observatory
- 1999 Chandra X-ray Observatory
- 2003 Spitzer Space Telescope



Hubble	James Webb
1990	2021
LEO, 570 km	L 2, 15 lakh km
Visible light	Infrared
2.4m mirror	6.5m mirror
Both are reflecting telescopes	
First space observatory? No	Replacement of Hubble? No



Geospatial: Data associated with a particular location on earth.

Geospatial

Geographic Information System (GIS): IT system that displays geospatial data

Applications of GIS:

- ❑ **City/Village Planning:**
 - **Bhuvan Panchayat** of ISRO helps Panchayats in planning process
- ❑ **Disaster Management:**
 - Identify of **flood**/landslide prone areas, areas on path of upcoming **cyclone**, etc.
- ❑ **Navigation:**
 - **Mobile GPS** systems are useful because they host lots of GIS data
 - **Traffic layer** feature of Google maps helps police identify **real time congestion on roads**
- ❑ **Natural resource management:**
 - **India-WRIS portal** helps in integrated water resource management
- ❑ **E-Commerce:**
 - Amazon/Zomato and other **logistic** services use GIS data for fast and **accurate delivery**.
- ❑ **More transparency in govt projects:**
 - **Geo-tagging** of assets created under MNREGA

Issues:

- ❑ **Security threat:**
 - Sensitive areas (VVIP area, Military bases) are exposed by satellites images
 - Terrorist don't need to do physical recce if they use Google maps, Google Street view
- ❑ **Privacy concerns:**
 - Google Street view (recently launched in India) exposes people's face, car number plate, etc.
- ❑ **Need for regular updation:**
 - Data on map is useless if its not regularly updated

National Geospatial Policy 2021:

(It liberalizes geospatial sector and democratizes datasets generated by use of public funds)

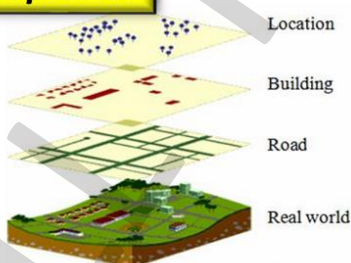
- ❑ It lets **Indian** companies collect map **data** and **license** it to **foreign** firms.
- ❑ Geospatial **data** produced **using public funds** will be **shared** as per 2012 policy (National Data Sharing and Accessibility Policy 2012)
- ❑ **Standardised** storage **format** of geospatial data to make it **interoperable**.
- ❑ **Standardised** curriculum will be developed for geospatial data **education**.
- ❑ **Significance:**
 - It will **reduce duplication of efforts** when multiple agencies collect same data.
 - Licencing provisions will **bring innovation** to the sector, eg Google Street View

Google Street View:

- ❑ **360-degree view photo**, taken by camera mounted on car, moving around city roads.
- ❑ Launched by Google in **partnership** with Indian companies (Mahindra and Genesys)
- ❑ Allows people to see exactly **how a place looks** like, even before going there.
- ❑ Not allowed for **restricted areas** like defence establishments.
- ❑ **Issues:** people's **face**, **car** number plate, **house** number, can be **misused**. (Hence Google blurs them)

Geospatial

geography + mapping



Three new geospatial data portal:

- 1) SOI GEO Spatial Data Dissemination Portal
 - 2) SOI SARTHI: WEB GIS application
 - 3) NATMO: Manchitran Enterprise Geoportal
- SOI: Survey of India
National Atlas & Thematic Mapping Organisation

Survey of India	1767	Dehradun	Ministry of Science & Tech
Geological Survey of India	1851	Kolkata	Ministry of Mines
Archaeological Survey of India	1861	Delhi	Ministry of Culture



bhuvan Beta
INDIAN EARTH OBSERVATION VISUALISATION

- ❑ since **2009**; by **ISRO**
- ❑ Just like Google Earth
- ❑ India specific; Lots of information to help govt. in e-governance

CERN

European Organization for Nuclear Research
1954, at France-Swiss border near Geneva

- ❑ CERN uses complex scientific instruments to **study fundamental particles**.
- ❑ Subatomic particles are **collided** at close to **speed of light**.
- ❑ This increases our **knowledge of fundamental laws** of nature.
- ❑ Mainly two type of instruments are used:
 - **Accelerators** boost particles to high speed, and makes them to collide.
 - **Detectors** records the results of these collisions.

Achievement/Contribution/Significance of CERN

- ❑ **High energy Physics:**
 - created **antihydrogen** atoms in 1995 (antimatter of hydrogen)
 - confirmed existence of **Higgs Bosons** in 2012
- ❑ **World Wide Web:**
 - It began as a CERN project named **ENQUIRE**
 - It was developed to help scientists **share information**
- ❑ **Computing:**
 - **LHC grid** uses power of computers around the world
 - It was developed to **process huge data** collected in experiments.
- ❑ **Medicine:**
 - **X-ray machines** that use fraction of the dose used by others.
 - **Hadron therapy** for cancer treatment (proton beam precisely targets tumour)

India's contribution:

- ❑ Since **1960s**, **scientists** from TIFR and Raja Ramanna centre have been working at CERN.
- ❑ In **1991**, India and CERN signed a **Cooperation Agreement**
- ❑ **LHC's magnet positioning system** and many other components were supplied by India.
- ❑ In recognition of such contributions, India got **Associate member** status in **2016**
- ❑ Today, India contributes about **1%** to CERN's **budget**.
- ❑ More than **400** Indian **scientists** and **engineers** are working at CERN
- ❑ Statue of Shiva/**Natraj** performing Tandav dance was gifted to CERN in 2004.

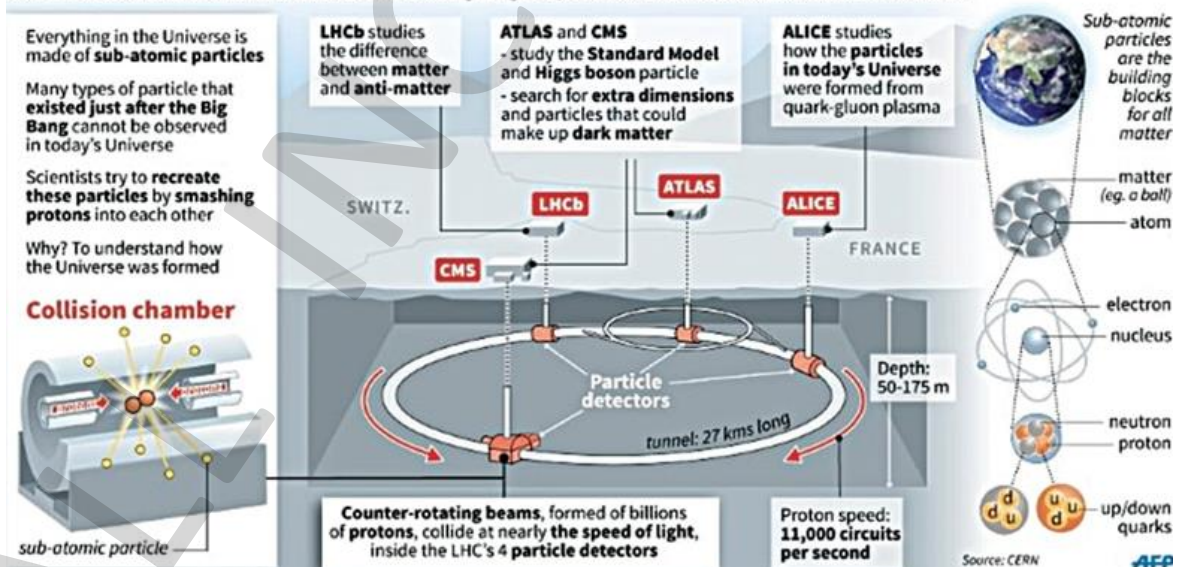
Higgs boson (popularly called as God particle)

- ❑ Proposed in 1964 by **Peter Higgs** and others to **explain why certain particles have mass**
- ❑ Its existence was confirmed in 2012 at CERN through ATLAS & CMS experiments at Large Hadron Collider

From Prelims class

LHC

The LHC recreates the conditions that existed after the Big Bang to try and understand the fundamentals of the Universe



CERN:

- ❑ European Organization for Nuclear Research
- ❑ 1954; HQ in Switzerland
- ❑ **India: associate member**
- ❑ Israel: the only non-European full member.
- ❑ 27 km long accelerator; 4 detectors

Large Hadron Collider:

- ❑ World's largest & highest-energy **particle collider**.
- ❑ Has 27 km long ring of superconducting magnets.
- ❑ High energy particle beams made to collide at near speed of light.
- ❑ Built by **CERN**
- ❑ **France-Switzerland** border near Geneva.

Neutrino

Neutrinos:

- ❑ **Elementary** particle with spin of $1/2$
- ❑ **Electrically** neutral
- ❑ **Mass** is so small that it was long thought to be zero.
- ❑ **Interaction** with matter is extremely weak. Hence, matter is almost transparent to them.

Creation:

Neutrinos are created by various **radioactive decays** like:

- ❑ **Natural** nuclear reactions eg in the **core of a star**
- ❑ **Artificial** nuclear reactions eg in nuclear **reactors/bombs**
- ❑ When **cosmic rays** or accelerated particle beams **strike atoms**

Importance:

- ❑ Their study can help answer fundamental questions on **origin of Universe** and **energy production in stars**
- ❑ They can help study places that **other radiation** (light or radio waves) **cannot penetrate**
- ❑ **Interior structure of earth** can be better studied by neutrinos

Detection

- ❑ **Difficult to detect because**
 - they do not carry electric charge, and have very low mass
 - Hence, they very weakly interact with matter.
- ❑ **Detectors are built underground**
 - to isolate the detector from cosmic rays and other background radiation.

India and Neutrino research:

- ❑ **1965 Kolar Gold Fields** (underground lab):
 - First cosmic ray neutrino interaction was detected
 - By physicists from India, Japan, UK
- ❑ **India-based Neutrino observatory:**
 - to be constructed in Tamil Nadu

India-based Neutrino observatory:

- ❑ **Project includes:**
 - Construction of an **underground laboratory**
 - Construction of an **Iron Calorimeter** detector for neutrinos.
 - Setting up **Centre for High Energy Physics** at Madurai for maintaining the underground lab
- ❑ **Benefits:**
 - Allow scientists to conduct advanced physics **experiments** (can write points from Importance)
 - Inspire **youth** to undertake research in **basic sciences** as career
- ❑ **Issues:**
 - **Tiger reserves** (Bandipur, Megamalai) are in close proximity to the site
 - **Watershed** of nearby rivers (Sambhal, Kottakudi) may be impacted

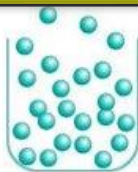
Fifth state of Matter



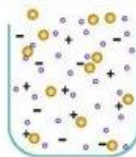
SOLID
Particles in fixed position



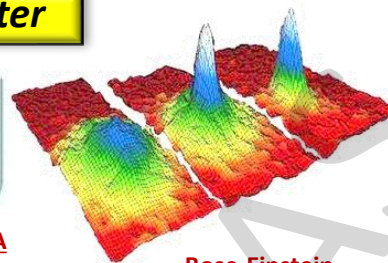
LIQUID
Particles flow around each other



GAS
Particles flow freely with high energy



PLASMA
4th state of matter.
Superheated matter.
Electrons ripped away.
Equal +ve and -ve
99% of visible universe



Bose-Einstein condensate
5th state of matter.

Four natural states of matter: Solid, liquid, gas, plasma.

Fifth state of matter: Bose-Einstein condensate

- Predicted by **Einstein** in 1924 based on paper by **S.N. Bose** but was made for the first time only in 1995.
- At near **zero kelvin**, molecular motion almost stops.
- There is almost no kinetic energy.
- Atoms clump to form just one '**super atom**'.
- They are extremely sensitive. Smallest disturbance increases the temperature and ends the BEC state.
- Recently also made in Cold Atom Lab in ISS

Boson:

- discovered by **Satyendra Nath Bose**
- follows Bose-Einstein statistics
- e.g. Photons, Higgs Bosons (God particle)

Prelims 2013:

The efforts to detect existence of **Higgs boson** particle have become frequent news in recent past. What is the importance of discovering this particle?

1. It will enable us to understand as to **why elementary particles have mass**.
2. It will enable us in near future to develop technology of **transferring matter** from one point to another without traversing the physical space between them.
3. It will enable us to **create better fuels** for nuclear **fusion**.

Select the correct answer

- (a) 1 (b) 2,3 (c) 1,3 (d) 1, 2, 3

Neutrinos

Neutrinos are second most abundant particles in the universe, after Photons

Experiments related to neutrinos:

- IceCube:** thousands of sensors below Antarctic ice (2.5km)
- ANITA: AN**tartic **I**mpulsive **T**ransient **A**ntenna Radio telescope in Helium balloon over Antarctica
- INO: I**ndian **N**eutrino **O**bservatory (Bodi West hills, Theni, TN)

Prelims 2010:

India-based Neutrino Observatory is included by the Planning Commission as a mega science project under the 11th Five-Year Plan. In this context, consider the following statements:

1. Neutrinos are **chargeless** elementary particles that travel close to the **speed of light**.
2. Neutrinos are **created in nuclear reactions** of beta decay.
3. Neutrinos have a **negligible**, but non-zero **mass**
4. **Trillions** of neutrinos pass through human body **every second**.

Which of the statements given above are correct?

- (a) 1 and 3 only (b) 1, 2 and 3 only (c) 2, 3 and 4

(d) 1, 2, 3 and 4

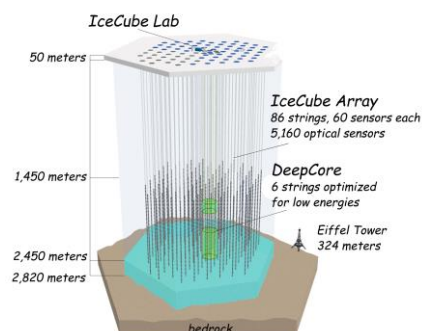
Prelims 2015:

In the context of modern scientific research, consider the following statements about '**IceCube**', a particle detector located at South Pole, which was recently in the news:

1. It is the world's largest neutrino detector, encompassing a cubic kilometre of ice.
2. It is a powerful telescope to search for dark matter.
3. It is buried deep in the ice.

Which of the statements given above is/are correct?

- (a) 1 (b) 2,3 (c) 1,3 **(d) 1, 2 and 3**



Dark energy, Dark matter

Dark Energy:

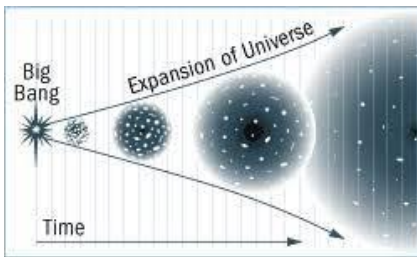
- 1) Big bang
- 2) Universe started expanding
- 3) But there is so much matter
- 4) Gravity must slow down expansion
- 5) But **speed** of expansion is **increasing**
- 6) Reason: dark energy

Dark matter:

- It is **not** in the form of **stars and planets** that we see.
- It is **not** in the form of dark clouds of **normal matter**, (matter made up of particles called baryons.)
- It is **not antimatter**, because we do not see the unique gamma rays that are produced when antimatter annihilates with matter.
- It is **not** large galaxy-sized **black hole**, because there are not many gravitational lensing events.
- It does **not** interact (**absorb, reflect, emit**) with **electromagnetic waves**.
- Existence inferred by **gravity** and maths

Universe = 68% dark energy + 27% dark matter + 5% normal matter

Dark energy is responsible for accelerated expansion of Universe



Dark matter is responsible for holding together galaxies

Cake is Milky way
Gems are Stars

Anti-matter

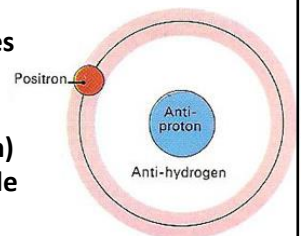
Ministry of Science & Technology

Cosmic rays propagating through Milky Way interact with matter producing excess antimatter counterpart of electron

Posted On: 30 APR 2021 6:02PM by PIB Delhi

High energy particles are generally lower in number in the cosmic universe. But the excess number of high energy particles of the antimatter counterpart of the electrons, called positrons have intrigued scientists for long. Now they have found an explanation for this mystery.

- Antimatter is made of antiparticles
- Same mass but **opposite charge**
- Proton → **antiproton**
- Electron → **antielectron (positron)**
- every basic particle has antiparticle



Baryon asymmetry:

Universe doesn't have equal amount of matter & anti-matter

How is it made?

- Big bang, cosmic rays, radioactive decays, etc
- In particle accelerators, also, but extremely less.

When matter and antimatter come into contact, they annihilate, disappearing in a flash of energy.

Positron excess:

- excess number of positrons between 10-300GeV energy found in space.
- Reason? cosmic rays in space interact with matter to produce electrons and positrons.

Prelims 2012:

A team of scientists at Brookhaven National Laboratory including those from India created the heaviest anti-matter (anti-helium nucleus). What are the implications of the creation of **anti-matter**?

1. It will make mineral prospecting and **oil exploration** easier and **cheaper**.
2. It will help probe the possibility of the existence of **stars and galaxies** made of anti-matter.
3. It will help understand the **evolution of the universe**.

Select the correct answer:

- (a) 1 only **(b) 2 and 3 only** (c) 3 only (d) 1, 2 and 3

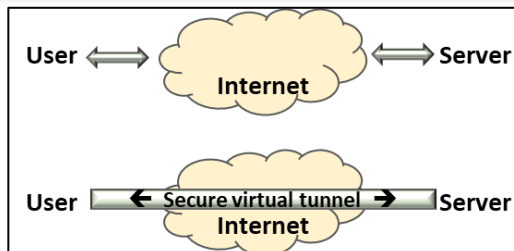
I read I forget, I see I remember

See explanation of this PDF on **YouTube** www.youtube.com/c/allinclusiveias

Virtual Private Network

What is VPN:

Virtual tunnel which securely transfers data between user and some external server.



News:

- ❑ Govt has instructed VPN providers to save and **store user info for 5 years**
 - User name, physical addresses, e-mail ID, phone number, reason for using VPN, etc.
- ❑ But many VPN providers have a strict **no-log policy** to maintain user privacy
 - Hence, many VPN providers have stopped their services in India. e.g Express VPN, NordVPN, SurfShark

Benefits of VPN:

- ❑ **Sensitive data** can be securely transferred
 - Work-from-Home was possible mostly because of VPN use by private/public companies
 - Journalists can research against repressive regimes
- ❑ **IP address** & browse history of user **is hidden**, increasing user privacy on internet
 - Hence, third parties cannot track users by cookies or IP address.
- ❑ **User location can be changed** by switching to server in another country
 - This helps people access geographically restricted content.
 - It can allow people in China to access sites blocked by govt.
- ❑ **Kill switch** ensures that connection is always secure
 - It terminates internet connection if VPN connection is lost/interrupted.

Problem with VPN:

- ❑ Many free VPNs are **not secure**
 - They usually have third party trackers.
- ❑ **Govt regulations** may force VPN provider to **store user data**
 - This defeats the whole purpose of using VPN.
- ❑ **Misused** by criminals
 - To communicate securely or commit online crimes by remaining anonymous.

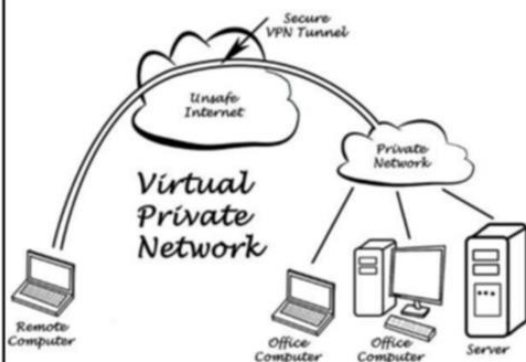
Way forward:

- ❑ Bring **Data protection law** at the earliest.
- ❑ Launch **consultative process** with all stakeholders: VPN providers, private companies, and users.

Prelims 2011:

What is "Virtual Private Network"?

- (a) It is a private computer network of an organization where the remote users can transmit encrypted information through the server of the organization.
- (b) It is a computer network across a public internet that provides users access to their organization's network while maintaining the security of the information transmitted.
- (c) It is a computer network in which users can access a shared pool of computing resources through a service provider
- (d) None of the statements (a), (b) and (c) given above is a correct description of Virtual Private Network



Net neutrality

Net neutrality:

- All Internet **traffic** should be treated **equally**.
- ISP should **not give preference** to any specific content.
- ISP should provide all traffic at **same speed under same conditions**.

Arguments in support of Net neutrality:

- ISP are not content moderators:**
 - ISP are just **intermediaries**, helping data transfer.
 - ISP **don't have power** to censor or moderate content on internet.
- ISPs may push biased/partial info to consumers**
 - **Facebook Zero** gives free internet access to access Facebook
 - People access **free** content **more**, thus see biased/partial information more often.
- To protect small businesses:**
 - Without NN, ISP may **slow down** services offered by **new** e-commerce **websites**.
 - Big players like **Amazon** and **Flipkart** may get **priority** in data transfer.
- To protect freedom of speech & expression:**
 - News channels who don't pay extra may get their websites **slowed down**.

Arguments against Net neutrality:

- Internet **bandwidth is limited**, hence **important** content must be **prioritised**.
 - **Telemedicine** data must be given preference over **YouTube** videos.
- Differential pricing** is not wrong. It is a common **marketing strategy**.
 - Consumers pay more for faster internet
 - Similarly, companies should be allowed to pay more for faster transfer of their data.
 - It will enable companies like Netflix to give **better service to customers**.

Way forward:

- ISPs must disclose their **traffic management policies**.
- Certain **emergency data** must be prioritised, e.g. tele-medicine data
- Clearly lay down **types of data** that must be **prioritised**.
- Bring law** to enforce net neutrality.

Zero-rating:

- Providing **free** internet access under certain **conditions** (Airtel Zero & FB Zero were in news in 2014-16)
- Airtel Zero:** Apps would pay Airtel so that people could access those apps for free (no data charge).
- Facebook Zero:** Under Free Basics program, Reliance Communications users would get free access to FB.
 - Facebook Zero is available in some countries.
 - There, many people don't pay for internet, as they get all info from FB.
 - Hence, many people believe that Facebook is internet, and everything on it is true.
 - That is how FB shapes people's opinion, especially in developing world.

TRAI released 'Prohibition of Discriminatory Tariffs for Data Services Regulations, 2016'

- Telecom operators can't **charge** for data **based on content**.
 - Discriminatory** treatment of content is **prohibited** (i.e. can't speed up or slow down based on content)
 - Exceptions:** Telemedicine, Court orders to block certain content, Content Delivery Networks, etc.
- TRAI also recommended establishing a **multi-stakeholder body** to enforce NN by ISPs.

<https://www.financialexpress.com/industry/dot-seeks-trais-view-to-regulate-internet-calling-messaging-apps-like-whatsapp-signal/2651043/>

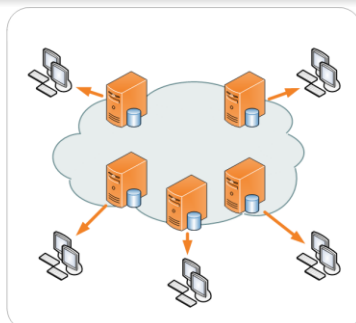
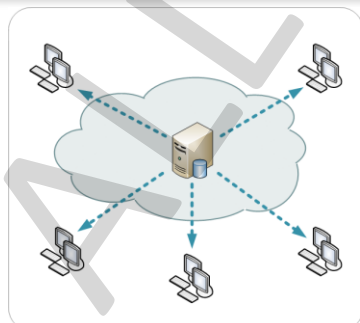
DoT seeks Trai's view to regulate internet calling, messaging apps like WhatsApp, Signal

The Department of Telecom has sought views of sector regulator Trai to prepare a framework for regulating internet calling and messaging apps like WhatsApp, Signal, Google Meet etc, a government official said on Wednesday. The Department of Telecom (DoT) has last week sent back a recommendation of the Telecom Regulatory Authority of India (Trai) on internet telephony issued in 2008, for review, and has asked the sector regulator to come up with comprehensive reference due to the change in technical environment amid the emergence of new technologies.

"The Internet Telephony recommendation of Trai was not accepted by the DoT. The Department has now sought comprehensive reference from Trai for internet telephony and over-the-top players," the official, who did not wish to be named, told PTI. **Telecom operators have been asking the government to apply the principle of "same service same rules" for the industry.** They have frequently asked that internet calling and messaging apps should pay the same level of **licence fee**, comply with regulation of **legal interception, quality of service** etc, as applicable on telecom operators and internet service providers (ISPs).

In 2008, Trai had recommended that ISPs shall be allowed to provide internet telephony including calls on normal telephone networks but they will have to pay interconnection charges, install lawful interception equipment as per the requirement of security agencies etc.

The issue was raised by telecom operators in 2016-17 as well, when the issue of net neutrality was being discussed by the regulator and the government. However, the government did not impose any restriction on call and messaging service being provided by apps. The **regulator**, however, **eased the cost burden on telecom operators by removing interconnect usage charges** to bring their calling cost at par with that of calling apps. **IUC is a charge that is paid by a telco to another operator when its customers make voice calls to subscribers of the rival network.** However, calling and messaging apps never had to pay any such charge.



Content Delivery Network (CDN):

Geographically distributed servers to speed up delivery of web content by bringing it closer to users.

Non-Fungible Token

- ❑ NFT is a unit of data that **certifies a digital asset** to be unique.
- ❑ It **uses blockchain** technology to certify authenticity of a digital file.
- ❑ The digital file may contain painting, photo, music, video, etc.

Benefits:

- ❑ **Authenticity:**
 - It helps in confirming authenticity of **digital files**
- ❑ **Monetisation:**
 - It helps artists to monetise their creations, thus boosting **creator economy**.


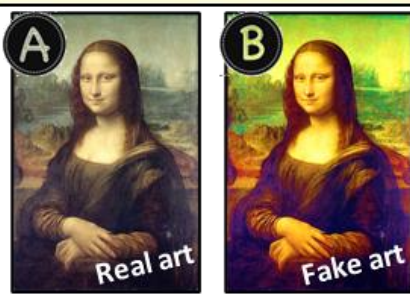
Concerns:

- ❑ **Environmental costs:**
 - Huge amount of **electricity** is consumed due to use of **blockchain** technology
- ❑ **Legal vacuum:**
 - **Tax implications** are not clear if payment is made by **cryptocurrency**.
- ❑ **Money laundering:**
 - Useless digital files could be sold for high amounts, to help in **layering for money laundering**.

Its an emerging technology and needs close monitoring.

Though NFT market exploded to \$25 billion in 2021, some experts believe that NFTs are a bubble that might burst soon.

Non-Fungible Token

Concept of fungibility (replaceability)	
Money	Art
	
<p>There are many real notes. All are replaceable.</p>	<p>There is only one real. Fakes are many and readily available.</p>

Problem: how to differentiate between real and fake.

Solution: give a certificate of authenticity to the real one.

Problem: someone can create fake certificates.

Solution: use blockchain technology to certify authenticity.

NFT: unit of data that certifies a digital asset to be unique.

Fungible:

→ replaceable by another identical item

Non-fungible:

→ not replaceable by another identical item

Non-fungible token:

→ proof that the digital product is original

Data Centre

Data Centre:

- ❑ Dedicated building for storing, processing and distributing large amounts of data.
- ❑ Location selection criteria:
 - 24x7 **power** supply for uninterrupted operations
 - **Fibre** connectivity to transfer large amounts of data
 - Availability of skilled IT **manpower**
 - Cool **climate** to reduce power for cooling servers (many new data centres are in extremely cold places like Scandinavian countries)



Why India needs more Data centres:

- ❑ **To comply with govt directives:**
 - RBI's data localisation norms makes it mandatory to store **payment data** within India.
- ❑ **Rising internet penetration:**
 - There are **70 crore** active internet users in India
 - This figure may rise to 90 crores by 2025 (Report by Internet and Mobile Association of India)
- ❑ **Growing digital economy:**
 - India is witnessing explosion of data due to smartphones, e-commerce, content creator economy, etc.
- ❑ **Emerging technologies:**
 - Cloud Computing, Internet of Things, etc will increase data requirements many-fold.

Challenges:

- ❑ India lacks data protection **law:**
 - Overseas investors may hesitate to invest in absence of clear data protection laws
- ❑ Lack of supporting **infra:**
 - Reliable power is still not available in most parts of India
- ❑ **Environmental** concerns:
 - Huge amount of electricity is consumed by Data centres.
 - Coal is used to generate most of electricity in India, this increasing emissions.
- ❑ **Import** dependence of **hardware** poses security threat:
 - India imports most of its electronic hardware from China
 - Hardware may have backdoors to leak critical data to China

MeitY's Draft Data Centre Policy 2020

- ❑ Provide **infra status** to Data Centres at par with road, rail, power
 - It will help in availing long term credit at easier terms
- ❑ Formulate Data Centre **Incentivization** Scheme
 - Tax incentives for companies can boost investment
- ❑ Demarcate **specific zones** with good supporting infra for Data centres
 - It will help companies in finding optimum location
- ❑ Set up four Data Centre **Economic Zones** as a Central Sector Scheme
 - Favourable ecosystem will be created as in case of Special Economic Zones
- ❑ Captive **power** generation units
 - Encourage dedicated power unit in Data Centre Economic Zones
- ❑ Declare Data centres as **Essential** Service under ESMA 1968
 - This will ensure continuity of services even during calamity/crisis.
 - Essential Services Maintenance Act, 1968 (ESMA)

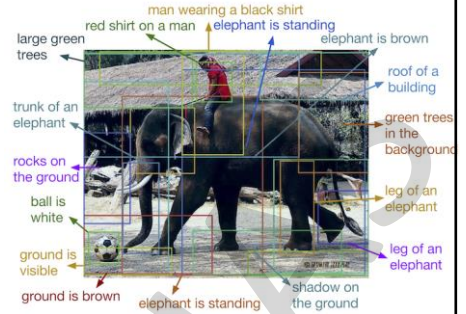
Computer Vision

Computer vision:

- ❑ It is a branch of AI that enables computers to derive meaningful information from photos and videos.
- ❑ It helps to automate tasks done by humans.

Applications:

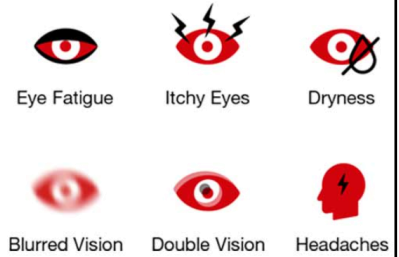
- ❑ **Autonomous cars:**
 - **Identifying the road**, other vehicles, trees, road signs, etc.
- ❑ **Medicine:**
 - **diagnosing** disease/tumour from x-ray or CT scan images
- ❑ **Security:**
 - **Facial recognition** can help identify/track suspects
 - **Motion detection** by camera can alert in case of any intrusion
 - **Border surveillance** especially in difficult terrain or extreme weather conditions
- ❑ **Manufacturing:**
 - **Defect identification** can help automate **quality control** process
- ❑ **E-commerce:**
 - **Google lens** uses pic of any object to find it on e-commerce website for purchase
- ❑ **Exposing fake news:**
 - **Reverse image search** tech helps locate real source of images and thus expose fake news



Note: "Computer Vision" is NOT related to "Computer Vision Syndrome"

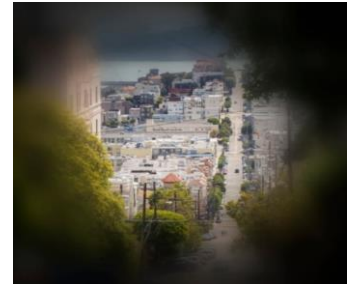
Computer vision syndrome (aka Digital Eye Strain)

- ❑ eye related problems that result from prolonged use of digital devices
- ❑ Research shows that 50%-90% of people who use computers have at least some symptoms.
- ❑ Even young kids are spending considerable time on mobile / tablet / laptops.



What can be done:

- ❑ Reduce glare/**brightness** of screen, use anti-glare filter
- ❑ Use **blue cut** filter or glasses to reduce blue light
- ❑ Do not use digital screens in **room with dim lights**
- ❑ Use **20-20-20** break Rule i.e. every 20 minutes focus on **20 feet away** object for 20 seconds.



Open Source Software

Open Source Software:

- They allow source code to be edited and reused
- They do not have copyright constraints
- eg Linux, Android, Firefox, WordPress, MySQL

Benefits:

- Source code can be **customized** to suit local requirements
- More **innovation** through wider collaboration
- Source code is **free** from any royalty.
- Less **costs** and no vendor lock-in

Issues:

- Lack of user-friendly **interface** affects productivity and adoption
- Security** threat is higher as source code is openly available
- Lack of warranty which is provided by vendor in case of proprietary software / CSS

Role in govt:

- National Policy on IT 2012**
 - It states adopting open source technologies as one of its objectives
- Policy on Open Source Software 2014**
 - Govt shall prefer OSS in comparison to Closed Source Software
- Examples**
 - Digilocker, CoWin, Aarogya Setu have been built using OSS

Web 3.0

Web 3.0

- ❑ It is the name given to the next generation of **Internet architecture**.
- ❑ It will use technologies like **blockchain** to create a decentralised Internet.
- ❑ It will **decentralise the internet**, away from control of tech giants like Google, FB, Amazon.

Prelims 2022:

- Web 3.0 technology enables people to **control their own data**.
- In Web 3.0 world, there can be **blockchain** based social networks.
- Web 3.0 is operated by users **collectively** rather than a corporation.

Benefits of Web 3.0

- ❑ **End control by Big Tech:**
 - FB / Twitter will not be able to delete any posts.
 - As users will be able to directly interact without intermediaries
- ❑ **Users will gain control over their data:**
 - This will help reduce data mining done by companies

Issues:

- ❑ **Difficult to regulate** due to decentralised nature
 - This will increase instances of cybercrime, hate speech, misinformation, fake news.
- ❑ **Environmental impact:**
 - Blockchain is electricity intensive technology.
- ❑ **Scalability issues:**
 - If every info is held in blockchain, it will make data storage and data transfer unsustainable.

India: opportunity & threats

- ❑ Opportunity:
 - Large number of web **developers**
 - New opportunity for tech **entrepreneurs**
- ❑ Challenges:
 - Low digital **literacy**; unsafe web browsing practices
 - Faster **brain drain** as best talent may move abroad for better packages

Way forward:

- Regulatory **sandbox** to encourage innovation while protecting public interest.
- Regularly updated **curriculum** in universities and professional courses.
- **Incentives** to tech industry to set up research bases in India.

Metaverse / VR / AR

Benefits/Applications of Metaverse/VR/AR

- ❑ **Healthcare:**
 - VR can help in **training** of doctors/nurses through animations
 - AR can help in **telemedicine** and robotic **surgery**
 - Immerse patient in **virtual world** to treat for **depression** or phobia
- ❑ **Education:**
 - EdTech companies are using **animations** to make learning fun for students
- ❑ **Defense:**
 - Simulation of various **combat** situations e.g. pilot training
 - **Helmet-mounted** display can increase **situational awareness** of soldiers
- ❑ **E-commerce:**
 - Customers can visualise how **furniture** will look in their room, or how **specs** will look on their face
- ❑ **Tourism:**
 - Guided tour of **Archaeological** sites can give info to tourists about monuments history.
- ❑ **Recreation:**
 - Virtual Reality Headset with certain **games** as in Microsoft Xbox-360
- ❑ **Miscellaneous:**
 - **Urban** planning, **Disaster** Management, **Building** architecture, etc.

Metaverse:

- ❑ Metaverse is a life like **digital space**.
- ❑ People will have **virtual representations** of themselves.
- ❑ They can buy land, go shopping, study, work, interact with others, etc.
- ❑ Tech industry believes that Metaverse will be the **successor to internet**.

Why there's an increased interest in Metaverse?

- ❑ **Web 3.0** will decentralise the internet, away from control of tech giants like Google, FB, Amazon.
- ❑ **Creator economy** is booming and creators can benefit by selling their creations on metaverse.
- ❑ **New technologies** like NFTs allows proof of ownership of digital assets like paintings.
- ❑ **Cryptocurrencies** are truly global and allows digital transactions irrespective of physical location of users.

Concerns associated with Metaverse?

- ❑ **It will lower socialisation:**
 - People will prefer virtual interactions while ignoring their real world needs.
- ❑ **Security concern:**
 - Cybercrimes could take on new forms in these new virtual worlds.
- ❑ **Lack of regulation:**
 - Social media platforms like FB promote hate content to increase user engagement.
 - Such behaviour in Metaverse will only increase social division in real world.
- ❑ **Environmental impact:**
 - Lot of electricity is used in technologies like AI systems, AR/VR, Crypto currency, NFT etc.

Way forward:

- ❑ Regulate after consulting all stakeholders
- ❑ Coordinate with other countries
- ❑ Bring data protection law
- ❑ Update IT laws as per evolving technologies
- ❑ Train police to tackle tech related crimes

Metaverses have huge **potential to revolutionise** healthcare, education, etc.
But as long as they are run purely for profit motive, the benefits would likely be lesser.

Note: Creator economy is a software-facilitated economy that allows creators to earn revenue from their creations, through YouTube, TikTok, Instagram, Facebook, etc)

Metaverse

91. In the context of digital technologies for entertainment, consider the following statements :

- ✗ 1. In Augmented Reality (AR), a simulated environment is created and the physical world is completely shut out.
- ✗ 2. In Virtual Reality (VR), images generated from a computer are projected onto real-life objects or surroundings.
- ✓ 3. AR allows individuals to be present in the world and improves the experience using the camera of smart-phone or PC.
- ✓ 4. VR closes the world, and transposes an individual, providing complete immersion experience.

Which of the statements given above is/are correct?

- (a) 1 and 2 only
- (b) 3 and 4
- (c) 1, 2 and 3
- (d) 4 only

Prelims 2019



- ❖ **Metaverse**: a virtual universe (in future) (like an advanced version of Second life)
- ❖ **Related techs**: Augmented reality, Virtual reality
- ❖ **Not to be confused** **Multiverse** (hypothetical group of multiple universes)

Virtual reality:

Everything is fake (virtual), like a video game.



Fake (virtual) environment of roads and buildings



Fake (virtual) environment of garden, plants, Pokemons

Real environment

of roads and buildings augmented by images of green lines and speedometer

Real environment

of road and Trees augmented by images of Pokemon

Augmented reality:

Fake images are overlaid on real things



NAFRS

National Automated Facial Recognition System:

- initiative of **NCRB**
- use database to identify people on CCTV videos, etc
- example of use of AI for surveillance, dead bodies, etc.

National Crime Records Bureau:

- 1986; **MHA**; initiatives like CCTNS 2009, ICJS 2019, etc

Crimes and criminal Tracking Network System:

- national **database** of crimes and criminals
- **connects** databases, police stations, etc.

Inter-operable Criminal Justice System (ICJS)

- integrating CCTNS with e-Courts, e-prisons, etc.

Biometrics

Physiological

- face
- fingerprint
- hand
- iris
- DNA

Behavioral

- keystroke
- signature
- voice

I read I forget, I see I remember

See explanation of this PDF on **YouTube** www.youtube.com/c/allinclusiveias