50 most important topics
Science & Technology

INTERNET

Evolution of Telecommunication

- **Frequency Division Multiple Access (FDMA)-1G**
- **Time Division Multiple Access (TDMA)-2G**
- **Code Division Multiple Access (CDMA)-2.5 G**
- **WCDMA -3G**

❑LTE

❑4G

❑5G-**OFDM, MIMO**

Satellite internet

Context- According to Minister of State for Communications , Starlink got the green light only after agreeing to India's strict security norms. This means the company **must set up earth station gateways within India so that all communication stays inside the country**.

Satellite ineternet

- The advent of satellite mega-constellations such as Starlink signals a new era in space-based internet. These comprise hundreds or even thousands of satellites orbiting a few hundred kilometres above Earth.
- This "internet in the sky" offers a **plethora of applications** in military operations, disaster response, healthcare, agriculture, and transportation.
- However, this technology has a **dual-use nature,** serving both civil and military ends. This introduces complex security dynamics.

Satellite internet

Satellite internet orbits

GEO satellites

- Orbit at 35,786 km above the equator.
- Their significant drawback is **high propagation latency**. The long distance signals must travel result in delays, making GEO systems unsuitable for time-sensitive applications like video conferencing or real-time transactions.

MEO satellites

- Operate at altitudes between 2,000 km and 35,786 km. They offer a **compromise between GEO and LEO systems.**
- Their latency is lower than that of GEO satellites, but they still require a constellation for global coverage.

Satellite internet

LEO satellites

- Orbit at altitudes below 2,000 km.
- Their proximity to Earth results in **very low latency.**
- They are also smaller, often table-sized, making them cheaper and quicker to deploy.
- Their main disadvantage is their smaller coverage area.
- A **single Starlink LEO satellite's** footprint is comparable to an Indian metropolitan city.
- To achieve global coverage, LEO systems form "mega-constellations".
- These are networks of hundreds or thousands of satellites working in unison.
- **Starlink has over 7,000 satellites in orbit**, with plans for up to 42,000.

Satellite internet

Starlink speed

- Reports suggest that Indian users will get speeds between **25 Mbps and 220 Mbps.**
- Now, this might not blow away **city users who already have access to high-speed** fiber broadband.
- But for rural areas and villages that currently struggle with patchy or no internet, these speeds could be a game-changer.

Starlink Price, Release Date And Plans

- If everything goes as planned, Starlink is expected to roll out in India by **December this year.**
- The initial **setup** will likely cost around **Rs 30,000–Rs 35,000**, which covers the dish and equipment.
- **Monthly plans** are expected to fall in the **Rs 3,000–Rs 4,200 range**, varying by region and usage.

THE THREE ORBITS Satellites are deployed in three main orbits: the Geostationary Earth Orbit (GEO), the Medium Earth Orbit (MEO), and the Low Earth Orbit (LEO).

LEO
Orbital altitudes from approx **~160 to 2,000 km**

Some Starlink satellites have an altitude of **550 km**

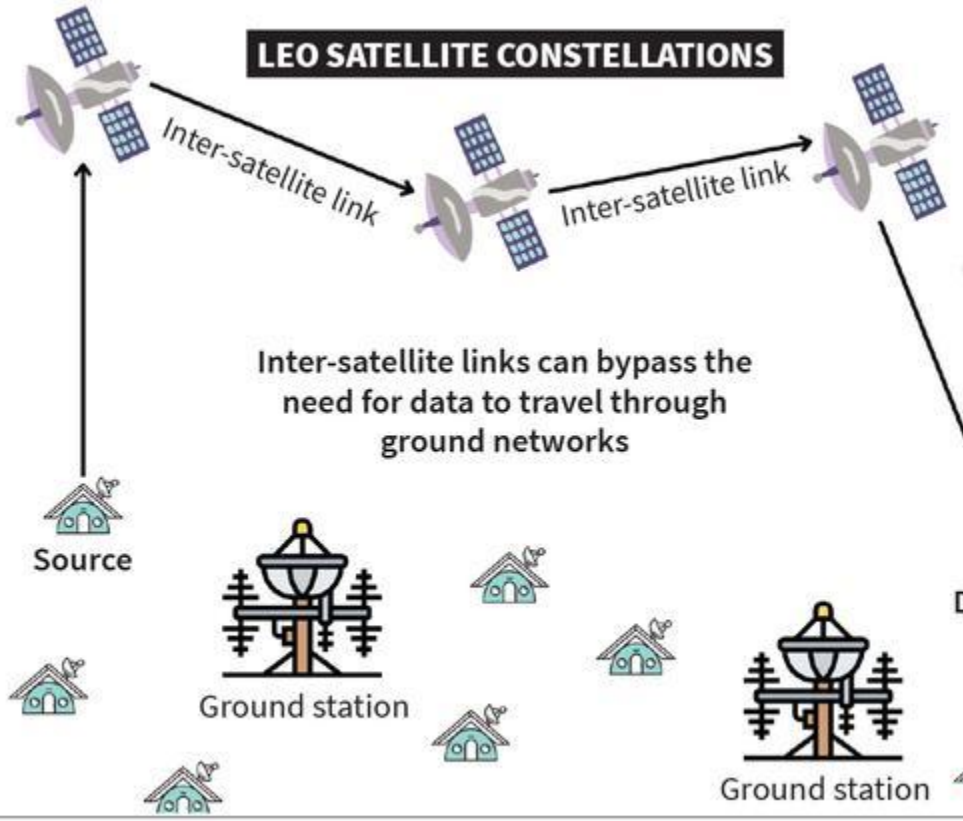
GEO
Orbital altitudes of **35,786 km**

The INSAT series and GX series are notable examples

GPS satellites are positioned at around **20,200 km**

MEO
Orbital altitudes from **2,000 km to 35,786 km**

LEO SATELLITE CONSTELLATIONS



Optical inter-satellite links allow satellites to communicate directly with each other in space. This creates a true "internet in the sky," an interconnected blanket of satellites

Inter-satellite links can bypass the need for data to travel through ground networks

Significance

- The entry of several domestic and foreign players like **Starlink (SpaceX), Eutelsat OneWeb (Bharti Airtel), Jio Space Technology (Jio-SES JV**) and **Amazon's Project Kuiper** along with established players like Nelco and Hughes Communications India shows the significant potential of the Indian Satcom market.
- This competition will ultimately benefit users though the full impact will unfold over time.

Feature	**Satellite Internet**	**Fibre Optics**
Medium	Wireless (signals travel via satellites in space)	Wired (light pulses through glass fibre cables)
Speed	Lower	Higher
Latency	Higher	Lower
Coverage	Global – works in **remote, rural, ocean, deserts**	Limited to **areas where cables are deployed**
Reliability	Affected by **weather, obstacles** (rain fade, trees, storms)	Very reliable, not affected by weather
Scalability	Needs launching more satellites; limited by orbital slots	Scalable with more fibre deployment
Energy Efficiency	Less efficient (satellite launch + operation power needed)	Highly efficient (light transmission, very low power loss)
Best Use Cases	Rural areas, mountains, islands, disaster recovery, ships, airplanes, defense, military	Cities, towns, offices, high-demand homes, data centers

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Small Modular Reactor (SMR)

- A **nuclear fission reactor** that is **smaller in size** (typically ≤ 300 MWe per unit, compared to 1000+ MWe for conventional reactors).
- Built in **modular units** → can be manufactured in factories and transported to sites for assembly.
- Designed with **advanced safety features**

Small Modular Reactor (SMR)

Key Features

- **Small Size**
  - 10–300 MWe per unit → suitable for smaller grids and remote areas.
- **Modular Construction**
  - Factory-built → lower costs, shorter construction time, scalability.
- **Advanced Safety**
  - Many designs use **passive safety systems**
- **Fuel**
  - Uses low-enriched uranium, some designs consider **thorium** or advanced fuels.
- **Flexibility**
  - Can be combined with **renewables** to stabilize grids.
  - Can provide **electricity, desalination, and hydrogen production**.

Small Modular Reactor (SMR)

Eco survey

- The Survey also links nuclear's expanded role to the development of Small Modular Reactors (SMRs), including the proposed 200 MWe Bharat Small Modular Reactor and smaller 55 MWe designs.

Perovskite Solar Cells

- The term *Perovskite* refers to a **naturally occurring mineral**: **calcium titanium oxide ($CaTiO_3$)**.
- Perovskite' is a term used to describe a group of materials that have a **distinctive crystal structure of cuboid and diamond shapes.**
- It was first discovered in the **Ural Mountains, Russia, in 1839** by German mineralogist **Gustav Rose**.
- He named it after the Russian mineralogist **Lev Perovski (1792–1856)**, who was a statesman and patron of sciences.

Perovskite Structure

- The mineral $CaTiO_3$ had a unique **crystal structure (ABX_3)**, later called the **perovskite structure**.

Why in Solar Cells?

- Scientists later discovered that **synthetic compounds with the same perovskite crystal structure** had **excellent light absorption and charge transport properties.**

Emerging Solar Technologies

Natural source

- **Surface deposits (Earth's crust):** Ural Mountains, Brazil, USA, Alps, India (titanium-rich sands).
- **Deep mantle:** Bridgmanite ($MgSiO_3$) = Earth's most abundant mineral.
- **Meteorites:** Found in shocked meteorites .
- **Planets:** Likely present in mantles of other rocky planets.

Synthetic Perovskites

- **M**ade in labs for solar cells, electronics, sensors.

	Silicon PV	Perovskite PV
Material & Structure	• Crystalline silicon wafers	• **Perovskite crystal structure (ABX_3)**.
Manufacturing & Cost	• Energy-intensive → requires **high-temperature furnaces (>1400°C)** to purify silicon. • Requires large capital investment.	• Can be produced at low temperature (100–150°C). • Lighter, cheaper
Efficiency	Commercial panels: **18–22%**. World record (lab): ~26.8%.	• Lab efficiency has jumped from **3% (2009) → 25%+ (today)**. • **Tandem (silicon + perovskite)** has crossed **30% efficiency**.
Stability & Lifespan	**25–30 years lifespan** with little degradation.	• Current stability ~1–2 years in lab tests. • **Degrades rapidly** when exposed to moisture water etc
Toxicity & Environment	• Generally non-toxic, abundant (silicon is 2nd most abundant element in Earth's crust). • Recycling challenges exist (glass, metals, old panels).	• Most efficient perovskites contain **lead (Pb)**. • Risk of **lead leakage** into soil/water during manufacturing or disposal.

DIFFERENT TYPES OF DRONES

Swarm Drones:
Multiple drones operate in coordination to overwhelm enemy defenses, DRDO and private firms are working on swarm drone technology.

Surveillance and Reconnaissance Drones (ISR Drones):
These drones are primarily used for intelligence, surveillance, and reconnaissance purposes.
India currently has:
TAPAS-BH-201 (Tactical Advanced Platform for Aerial Surveillance)
Rustom (developed by DRDO)
Heron (Israel)

Commercial/Modified Civilian Drones:
Off the shelf drones, often modified for illegal cross-border activities.

Armed/Combat Drones (UCAVs):
Unmanned combat aerial vehicles (UCAVs) are capable of launching missiles or dropping bombs.
India has:
DRDO's Ghatak (under development)
Heron TP (from Israel)

Loitering Munitions:
These drones are designed to loiter over a target area and strike when a target is identified.
India has:
Nagastra (made by Solar Industries and ZMotion)
Warmate (Polish origin)

Artificial intelligence-Types

Narrow AI (Weak AI)

- **Definition**: AI that is designed and trained to perform a **specific task** or set of tasks. It operates within a **limited context** and is **not** capable of performing tasks outside its designated functions.
- **Examples**:
  - **Siri** or **Alexa**: Virtual assistants with specific tasks like setting reminders or playing music.
  - **Google Search**: AI that helps retrieve relevant search results based on keywords.
  - **Recommendation systems**: Algorithms used by platforms like **Netflix**, **Amazon**, or **Spotify** to recommend shows, products, or songs based on user data.
- **Characteristics**:
  - Task-specific.
  - Does not have general intelligence.
  - Most of today's AI systems fall into this category.

Artificial intelligence-Types

General AI (Strong AI)

- **Definition**: AI with the ability to **understand, learn**, and **apply intelligence** across a wide range of tasks, similar to human capabilities. It is capable of reasoning, problem-solving, and decision-making in **various environments** and can **transfer knowledge** from one domain to another.
- **Examples**:
  - **Currently, there are no examples** of true General AI, as it is still an area of **research**. A **hypothetical** example would be a machine that could perform tasks like a human, from playing chess to writing a novel.
- **Characteristics**:
  - **Self-aware** and can perform a wide range of activities.
  - Ability to apply **common sense** and **reasoning** in a variety of situations.

Artificial intelligence-Types

Superintelligent AI (Superintelligence)

- **Definition**: An AI that **surpasses human intelligence** and **cognitive abilities** in every aspect, including creativity, decision-making, and emotional intelligence.
- **Examples**:
  - **Not yet realized**. This concept is still theoretical and a subject of **research**. However, it is speculated that such an AI could **evolve**, surpassing human capabilities in **all domains**.
- **Characteristics**:
  - Superintelligent AI would have **autonomy** and **self-improvement** abilities, capable of making decisions that humans may not understand or control.
  - **Possibly uncontrollable** and poses challenges in terms of safety and ethics.

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BharatGen

Context-BharatGen, a **generative AI initiative** designed to enhance public service delivery was launched by the Ministry of Science & Technology.

BharatGen

- It is the world's first **government-funded Multimodal Large Language Model project** focused on creating efficient and **inclusive AI in Indian languages.**
- Spearheaded by **IIT Bombay** under the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS), of the **Department of Science and Technology** (DST), the initiative will create generative AI systems that **can generate high-quality text and multimodal content in various Indian languages.**
- It is designed to **revolutionize public service delivery** and boost citizen engagement through developing a suite of foundational models in language, speech and computer vision
- The **four key distinguishing features of BharatGen** are the multilingual and multimodal nature of foundation models; Bhartiya data set based building, and training; **open-source platform** and development of an ecosystem of generative AI research in the country.

BharatGen

- The platform integrates text, speech, and image modalities, offering seamless AI solutions in 22 Indian languages.
- BharatGen will deliver generative AI models and their applications as a public good by prioritizing India's socio-cultural and linguistic diversity. It strives to address India’s broader needs such as social equity, cultural preservation, and linguistic diversity, while ensuring that generative AI reaches all segments of society.
- BharatGen will cater to both text and speech, ensuring coverage across India’s diverse linguistic landscape. By training on multilingual datasets, it will deeply capture the nuances of Indian languages, which are often underrepresented in global AI models.

DHRUV64

Context- Ministry of Electronics and Information Technology (MEITY) announced the launch of DHRUV64

DHRUV64

- The DHRUV64 chip is a **fully indigenous microprocessor** developed by the Centre for Development of Advanced Computing (**C-DAC**) under MEITY's Microprocessor Development Programme.
- The microprocessor is **a general-purpose 'brain' for electronics** — a 64-bit, dual-core processor that runs at 1 GHz. These specifications could mean the **processor is fast enough to run operating systems** while also being efficient enough for embedded deployment.

DHRUV64

The Digital India RISC-V (DIR-V) Program

- It is a national initiative launched in 2022 to achieve "silicon sovereignty" by building India's own ecosystem of microprocessors.

The Core Strategy

- The program moves India away from **proprietary chip designs** (like ARM or Intel) and adopts RISC-V, an **open-source "language" for chips.**
- This means **Indian engineers can design, modify, and build processors without paying expensive licensing fees** to foreign companies

DHRUV64

India is building a portfolio of RISC-V processors including:

- **SHAKTI (IIT Madras):** This is India's first indigenous industrial-grade processor. It is a family of chips designed for **everything from low-power IoT devices (like smart meters) to high-end robotic** controllers. Its primary goal is to **provide a secure, royalty-free alternative** for commercial electronics.
- **AJIT (IIT Bombay):** A medium-sized processor designed for embedded systems. It is specifically optimized for **industrial automation** and navigation systems. It was one of the first Indian chips to be fabricated entirely at the **SCL (Semi-Conductor Laboratory) in Mohali**.
- **VIKRAM (ISRO-SCL)**: Specifically engineered for **space and defense.** Unlike consumer chips, VIKRAM is "rad-hard" (radiation-hardened), meaning it can survive the harsh environment of outer space without malfunctioning. It is intended for use in ISRO's future satellite launch vehicles and spacecraft.

DHRUV64

- **THEJAS64 (C-DAC):** Part of the VEGA family, this is a powerful 64-bit multi-core processor. It is designed for **"heavy lifting" tasks** like servers, cloud computing, and high-speed data networking. It is the backbone of India's plan to build indigenous servers.
- **DHRUV64**: A specialized variant focused on **high-performance computing (HPC) and edge AI.** It is designed to process massive amounts of data locally (on the device) rather than sending it to a cloud, making it ideal for real-time surveillance or advanced telecommunications hardware.

Shrutlekh

Context-The **Digital India BHASHINI Division (DIBD)** under **MeitY** showcased **Shrutlekh**, an **AI-based speech-to-text and translation tool**, was used **live** during official sessions.

Shrutlekh

- It is an AI-powered tool developed under **India's BHASHINI (BHASHa INterface for India) platform**
- It can convert **spoken words into written text** and **translated them instantly** between languages, especially **English and Hindi**.

Key Feature

- **Auto Language Detection (ALD):** Automatically detects when a speaker switches languages.
- **Real-time transcription:** Converts speech into text instantly.
- **Live translation:** Removes the need for human interpreters in large forums.

Shrutlekh

Why is this important?

- During the **re-telecast of the Prime Minister's address** at the AI Action Summit in Paris, Shrutlekh provided **real-time multilingual translation**.
- This ensured that people from **different linguistic backgrounds** could understand the message on **responsible, inclusive, and sustainable AI**.

Shrutlekh

BHASHINI (BHASHa INterface for India)

- It is an AI-driven language translation platform launched by the Ministry of Electronics and Information Technology in August 2022 to bridge India's language divide.
- It provides real-time, **multilingual, AI-based translation** via voice, text, and converse features for 22+ languages, focusing on digital inclusion in education, health, and governance

Key Aspects of BHASHINI:

- **Core Capabilities:** The Bhashini app (available on Android/iOS) allows users to translate, **convert speech-to-text, and generate voice-to-text**, with support for 22 languages for text and 13 for conversation.

Shrutlekh

Key Products & Initiatives:

- **Bhashadaan:** A crowdsourcing initiative for collecting data to improve AI models.
- **Abhilekh:** A tool for real-time speech-to-text transcription.
- **Lekhaanuvaad:** Document translation and digitization.
- **Sahyogi:** Projects aimed at recording audio to improve language technology.

AI Washing

AI Washing is a term used to describe the act of **misleadingly labeling or marketing** a product, service, or technology as being **"AI-powered"** or utilizing **artificial intelligence** when, in reality, it might not involve AI or employ it in a very superficial way.

Why AI Washing is Problematic:

1. **Misleading Consumers**: Consumers might be drawn to products or services under the assumption that they're **cutting-edge or more effective**, when in fact, they may not offer the advanced AI capabilities they claim.
2. **Undermines Trust in AI**: Overuse of the term **"AI"** without real substance can lead to **skepticism** and **mistrust** of genuine AI technologies in the long run.
3. **Hinders Real Innovation**: By focusing on **marketing buzzwords** rather than actual advancements in technology, companies may lose sight of building truly **innovative** and useful AI applications.

AI Washing

Examples

- A company selling a **simple chatbot** claims it is "powered by AI," when it is actually just rule-based (pre-programmed responses).
- Some fintech startups say their **loan approval systems use AI** to assess risk, but behind the scenes, they only use **basic Excel-based scoring models**.

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LLM / Tool Name	Company
ChatGPT	OpenAI
DALL·E	OpenAI
Grok	xAI (Elon Musk)
Claude	Anthropic
Bard → Gemini	Google
LaMDA	Google
LLaMA	Meta (Facebook)
Midjourney	Midjourney Inc.
DeepSeek	DeepSeek (China)

Feature	Proof of Work (PoW)	Proof of Stake (PoS)
Validation Method	Competitive mining using high-powered hardware.	Staking native cryptocurrency as collateral.
Energy Use	Extremely high; comparable to entire countries.	Negligible; up to 99.95% more efficient.
Security Asset	Computational power (Hashrate).	Financial capital (Staked tokens).
Main Advantage	Battle-tested, highly secure, resistant to manipulation.	Sustainable, scalable, faster transaction finality.
Main Risk	Environmental impact and hardware centralization.	Governance centralization ('Rich-get-richer').
Top Examples	Bitcoin, Litecoin, Dogecoin.	Ethereum, Solana, Cardano.

Worldcoin

Context- Recently OpenAI formally re-introduce Worldcoin, a project of his that was eclipsed by the popularity of ChatGPT.

What is Worldcoin?

- Worldcoin is an initiative to create a **digital network in which everyone can claim some kind of stake, and join the digital economy**.
- Using a device called "**Orb,**" **Worldcoin** volunteers known as '**Orb operators'** scan a person's iris pattern to collect their biometric data and help them get a **World ID** through the World app.
- With the app, scanned participants **can collect a cryptocurrency called Worldcoin** [WLD] at regular intervals or make transactions with their World ID where possible.
- This process is called "**proof of personhood**" and makes sure that people do not sign themselves up multiple times in exchange for crypto.

Immunity

- Immunity can be defined as the **body's ability to guard itself against disease-causing organisms**. In other words, it is the ability to resist an infection by the action of particular antibodies.

Types of Immunity

The two major types of immunity are:

1. Innate Immunity or Non-specific Immunity.
2. Acquired Immunity or Adaptive Immunity.

Immunity

Innate Immunity (Non-specific Immunity)

- First line of defense, present from birth, *non-specific* (does not target one pathogen, but fights all).
- **Characteristics:**
  - Immediate action (minutes to hours).
  - No memory (same response every time).
  - Found in all living organisms.
- **Components:**
  - **Physical barriers** → skin, mucous membranes.
  - **Physiological barriers** → stomach acid, saliva enzymes, fever.
  - **Cellular defenses** → macrophages, neutrophils, natural killer (NK) cells.

Immunity

Acquired Immunity (Adaptive / Specific Immunity)

- Immunity developed *after exposure* to a specific pathogen (via infection or vaccination).
- **Characteristics:**
  - Slower response (days).
  - Highly specific to the antigen.
  - Has **memory** → stronger & faster response on re-infection.

Immunity

Acquired Immunity Types

1. Active Immunity

- The **body's own immune system produces antibodies** and memory cells after exposure.
- **Natural Active Immunity**
  - Occurs when a person is **exposed to the disease-causing organism**.
  - Example: Recovering from measles, chickenpox, or COVID-19 infection.
  - Provides long-lasting immunity (memory cells formed).
- **Artificial Active Immunity**
  - Induced by **vaccination.**
  - Example: Polio vaccine, Hepatitis B vaccine, COVID vaccines.
  - Antigens in the vaccine trigger immune response without causing disease.

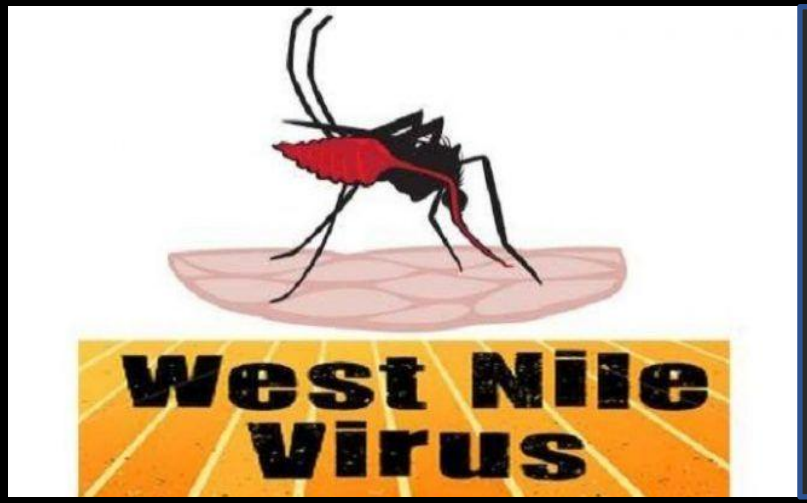
Immunity

2. Passive Immunity

- **Ready-made antibodies** are given; body does not produce them.
- **Natural Passive Immunity**
  - Antibodies transferred from **mother to child.**
  - Provides short-term protection (few months).
- **Artificial Passive Immunity**
  - Injection of **pre-formed antibodies** (antiserum or monoclonal antibodies).
  - Example: Rabies antiserum, Tetanus antitoxin, COVID monoclonal antibody therapy.
  - Provides immediate but short-lived protection.

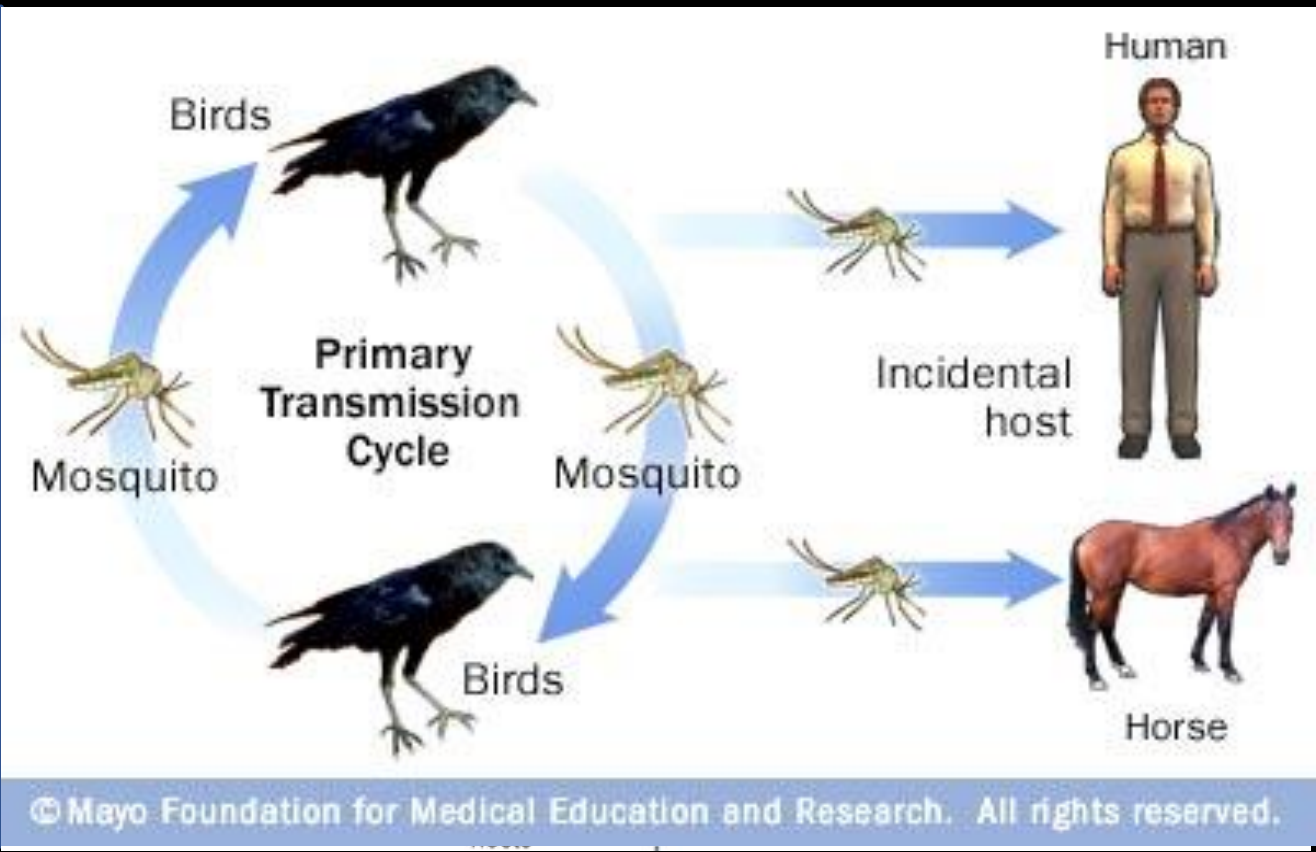
West Nile Virus (WNV)

- Recently, a **47-year-old man in Thrissur, Kerala died due to West Nile Virus (WNV).**
- This has caused the Kerala health department to be on alert.



- first isolated in a woman in the West Nile district of Uganda in 1937.
- Mosquito
- Contact with infected animal
- through organ transplant, blood transfusions and breast milk

- fever, headache, tiredness, and body aches, nausea, vomiting
- Severe-neurological,Paralysis,death
- Vector-mosquito (genus-culex)
- Reservoir host-Birds
- Dead end host-Human,horses
- Kerala (Previous-West bengal)
- No specific treatment



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The West Nile virus

- It is a single-stranded **RNA virus** that causes a mosquito-borne disease known as West Nile fever. The infection spreads amongst humans from infected bites of Culex mosquitoes
- These mosquitoes get the virus from **infected birds since birds are the natural host for this virus**. So, in addition to human beings, horses and other mammals can also get infected

Treatment

- Unfortunately, **no specific treatment is available**. And, since it is mostly asymptomatic; many people do not even realise they have been infected. However, if severe, then one may require hospitalisation and supportive care.

Transmission

- Human infection is most often the result of bites from infected mosquitoes. Mosquitoes become infected when they **feed on infected birds, which circulate the virus in their blood for a few days.** The virus eventually gets into the mosquito's salivary glands. During later blood meals (when mosquitoes bite), the virus may be injected into humans and animals, where it can multiply and possibly cause illness.
- The virus may also be transmitted **through contact with other infected animals, their blood, or other tissues.**
- **A very small proportion of human infections** have occurred through **organ transplant, blood transfusions and breast milk.** There is **one reported case of transplacental (mother-to-child) WNV transmission.**
- To date, **no human-to-human transmission of WNV through casual contact** has been documented, and no transmission of WNV to health care workers has been reported when standard infection control precautions have been put in place

How is it different from malaria?

- The similarities are that they are **both mosquito-borne diseases and sometimes, both can be potentially life-threatening.**
- However, **malaria** is caused by a parasite called **plasmodium**, and the **West Nile virus** is a single-stranded **RNA virus** that causes West Nile fever.
- Also, while the **female Anopheles mosquito transmits malaria to humans**, **Culex mosquitoes transmit the West Nile virus.**
- Additionally, malaria presents symptoms like fever with chills and, an immediately throbbing **headache** with chances of complications being high. But the **symptoms of West Nile virus do not always immediately become evident.**
- Treatment wise, **malaria has a specific line of treatment and can be cured**. There is **no specific treatment for West Nile virus** because it is a viral disease. As reported, many people do not even realise they have been infected.

Organ Transplantation

Organ transplantation is a **medical procedure in which a failing or damaged organ is replaced** with a healthy organ from a **donor**.

Types of Transplants

- **Autograft (Autologous):** Donor and recipient are the **same person**. Example: Skin graft, coronary bypass using patient's saphenous vein.
- **Isograft (Syngeneic):** Between **genetically identical** individuals (monozygotic twins).Minimal rejection.
- **Allograft (Allogeneic):** Between **two humans** of the same species but **genetically different**.Most solid-organ transplants: kidney, liver, heart.
- **Xenograft (Xenotransplant):** Between **different species**.Example: Genetically modified pig kidney/heart to human (experimental/clinical trials).

Organ Transplantation

Challenges

1. Immune Rejection

- The human immune system quickly recognizes animal organs as foreign → causes **hyperacute rejection**.
- Overcome partly by **genetic modification** of donor animals.

2. Transmission of Diseases

- Concern over **zoonotic infections**.

3. Ethical and Religious Concerns

- Ethical questions about animal rights and genetic modification.
- Religious sensitivities in certain communities.

Organ Transplantation

Xenotransplantation

In the early 1900s, doctors attempted to replace failing human organs with organs from animals such as pigs, goats, lambs or monkeys. All of these xenotransplants failed.

Organ Transplantation

Practical cases

1. In 1963, Dr Thomas Starzl transplanted **kidneys from baboons** into six human recipients in Denver, US. The patients survived between 19–98 days.
2. On January 7, 2022, Dr Bartley Griffith and his team at the University of Maryland Medical Center performed the first successful **orthotopic heart xenotransplantation** from a genetically modified pig into a 57-year-old man

Organ Transplantation

3.World's first pig liver transplant keeps man alive for 171 days in China (2025)

- Doctors in China have reported a major milestone in organ transplantation after a 71-year-old man lived 171 days following the world's first published pig liver transplant.
- It involved transplanting a genetically modified liver from an 11-month-old pig. The patient initially survived 38 days with the pig organ in place before it was removed when his own liver functioned sufficiently.

Organ Transplantation

Modern Advancements

- **3D Bioprinting:** uses stem cells to print organ structures.
- **Xenotransplantation:** genetically modified animal organs for human use.
- **Stem Cell Therapy:** regenerating damaged tissues.
- **Artificial Organs:** mechanical hearts, dialysis, etc.

Zika virus

Context- Recently Karnataka health department has issued an alert after **mosquito samples in Talakayalabetta village in Chikkaballapura** were found to be infected with **Zika virus**

- Last year, a five-year-old girl from Karnataka was confirmed to be infected with the Zika virus.

Zika virus

- Zika virus is a mosquito-borne virus **first identified in Uganda in 1947** in a Rhesus macaque monkey followed by evidence of infection and disease in humans in other African countries in the 1950s.

Transmission

- Zika virus is primarily transmitted by infected mosquitoes of the ***Aedes* (*Stegomyia*) genus, mainly *Aedes aegypti*,** in tropical and subtropical regions.
- *Aedes* mosquitoes usually **bite during the day.** These mosquitoes also transmit dengue, chikungunya and urban yellow fever.
- Zika virus is **also transmitted from mother to fetus during pregnancy**, as well as through **sexual contact, transfusion of blood** and blood products, and possibly through organ transplantation.

Zika virus

Symptoms

- Mild including **rash, fever, conjunctivitis, muscle and joint pain**, malaise and headache, and usually last for 2–7 days. These symptoms are common to other arboviral and non-arboviral diseases; thus, the diagnosis of Zika virus infection requires laboratory confirmation.

Complications

- Zika virus **infection during pregnancy is a cause of microcephaly** and other congenital malformations in the infant, including limb contractures, high muscle tone, eye abnormalities and hearing loss. These clinical features are collectively referred to as **congenital Zika syndrome.**
- Zika infection in pregnancy can also cause complications such as fetal loss, stillbirth and preterm birth.
- Zika virus infection can also cause **Guillain-Barré syndrome**, neuropathy and myelitis, particularly in adults and older children.

Zika virus

Treatment

- There is **no specific treatment available for Zika virus** infection or disease.
- People with symptoms such as rash, fever or joint pain should get **plenty of rest, drink fluids, and treat symptoms with antipyretics and/or analgesics**.
- Nonsteroidal anti-inflammatory drugs should be avoided until dengue virus infections are ruled out because of bleeding risk. If symptoms worsen, patients should seek medical care and advice.
- Pregnant women living in areas with Zika transmission or who develop symptoms of Zika virus infection should seek medical attention for laboratory testing, information, counselling and other clinical care.

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Nipah virus

Context-Recently two suspected cases of Nipah virus were detected at the Virus Research and Diagnostic Laboratory at AIIMS Kalyani in West Bengal

About Nipah virus

- Nipah virus (NiV) is a **zoonotic virus** (it is transmitted from animals to humans) and can also be transmitted through contaminated food or directly between people.
- Nipah is a viral infection that **mainly affects animals** such as **bats, pigs, dogs, and horses,** but can **jump to humans** who come in contact with infected animals and cause serious illness.
- Nipah virus was first recognized in 1999 during an outbreak among pig farmers in, **Malaysia.**
- Kerala has had a number of Nipah outbreaks since 2018.
- **Fruit bats** of the family *Pteropodidae* – particularly species belonging to the *Pteropus* genus – are the **natural hosts for Nipah virus**. There is no apparent disease in fruit bats.

Nipah virus

- Nipah usually presents as **fever and swelling of the brain**.
- In infected people, it causes a range of illnesses from asymptomatic (subclinical) infection to **acute respiratory illness and fatal encephalitis**. The virus can also cause severe disease in animals such as pig
- In 2018, 17 of 18 infected persons had died. One death was reported in 2021, and two in 2023. With the death of the 14-year-old, the total number of deaths due to Nipah in Kerala since 2018 has gone up to 21.
- During the later outbreaks in Bangladesh and India, Nipah virus spread **directly from human-to-human through close contact with people's secretions and excretions.**

Nipah virus

Treatment

- There are currently **no drugs or vaccines specific for Nipah virus** infection although WHO has identified Nipah as a priority disease for the WHO Research and Development Blueprint.

Hepatitis A

Context- As India debates the inclusion of the typhoid conjugate vaccine in its **Universal Immunisation Programme**, it is time to ask whether Hepatitis A — a growing cause of acute liver failure — deserves even greater priority.

Epidemiological Shift: Why Hepatitis A Is Rising

Old pattern (before improvement in sanitation):

- Most Indians infected in early childhood.
- Illness mild; lifelong immunity developed.

New pattern (due to better hygiene & sanitation):

- **Fewer children exposed early** cause reduced natural immunity.
- Increasing cases among **adolescents and young adults** (where disease is more severe).
- Recent outbreaks in **Kerala, Maharashtra, Uttar Pradesh, Delhi** show worsening trends.

Hepatitis A

- Multiple hospitals reports clusters of **acute liver failure** and **deaths** due to severe Hepatitis A
- There is **no specific antiviral treatment exists**, only supportive care.

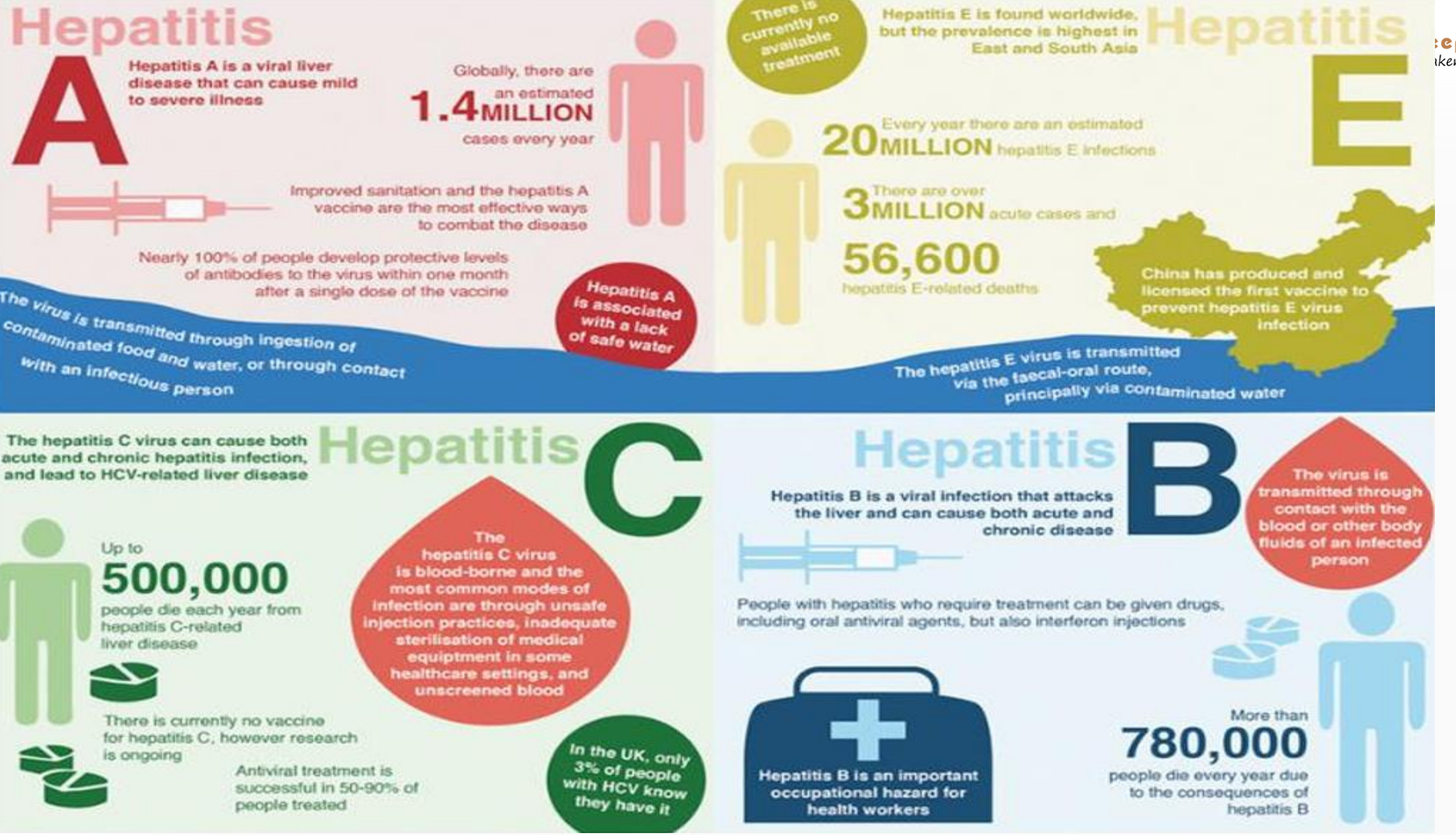
Declining Seroprevalence: The Immunity Gap

- Protective antibodies have **fallen from >90% to <60%** in many urban regions over two decades.
- This creates a **large pool of susceptible individuals**, especially older children and youth.
- Hepatitis A is **no longer a benign childhood illness**; it is becoming a **significant public health concern**.

Hepatitis A

Hepatitis

- It refers to **inflammation of the liver**, usually caused by viral infections, but also by alcohol, drugs, autoimmune disorders, and metabolic diseases.
  The major concern in public health is **viral hepatitis** (A, B, C, D, E).


Hepatitis A
Hepatitis A is a viral liver disease that can cause mild to severe illness
Globally, there are an estimated 1.4 MILLION cases every year
Improved sanitation and the hepatitis A vaccine are the most effective ways to combat the disease
Nearly 100% of people develop protective levels of antibodies to the virus within one month after a single dose of the vaccine
Hepatitis A is associated with a lack of safe water
The virus is transmitted through ingestion of contaminated food and water, or through contact with an infectious person
There is currently no available treatment
Hepatitis E is found worldwide, but the prevalence is highest in East and South Asia
Hepatitis E
Every year there are an estimated 20 MILLION hepatitis E infections
There are over 3 MILLION acute cases and 56,600 hepatitis E-related deaths
China has produced and licensed the first vaccine to prevent hepatitis E virus infection
The hepatitis E virus is transmitted via the faecal-oral route, principally via contaminated water
The hepatitis C virus can cause both acute and chronic hepatitis infection, and lead to HCV-related liver disease
Hepatitis C
Up to 500,000 people die each year from hepatitis C-related liver disease
The hepatitis C virus is blood-borne and the most common modes of infection are through unsafe injection practices, inadequate sterilisation of medical equipment in some healthcare settings, and unscreened blood
There is currently no vaccine for hepatitis C, however research is ongoing
Antiviral treatment is successful in 50-90% of people treated
In the UK, only 3% of people with HCV know they have it
Hepatitis B
Hepatitis B is a viral infection that attacks the liver and can cause both acute and chronic disease
The virus is transmitted through contact with the blood or other body fluids of an infected person
People with hepatitis who require treatment can be given drugs, including oral antiviral agents, but also interferon injections
Hepatitis B is an important occupational hazard for health workers
More than 780,000 people die every year due to the consequences of hepatitis B

Hepatitis A

Way forward

- India could begin by introducing **Hepatitis A vaccination in States that have experienced repeated outbreaks** or show declining antibody prevalence.
- The vaccine can be **co-administered with existing boosters such as DPT or MR**, using the same infrastructure.
- **Periodic serosurveys can track population immunity** and guide expansion. This phased approach aligns with the UIP's proven model of gradual, evidence-based rollout.

Obesity

Context-Recently WHO issues guidelines for GLP-1 weight loss drugs to combat obesity which is classified as chronic disease.

Guidelines

- New guidance recognises that obesity is a chronic disease that can be treated with comprehensive and lifelong care.
- The guidelines refer to obesity as "a chronic disease requiring lifetime care." comprehensive treatment for obesity should include screening, early diagnosis and management of obesity-related complications
- GLP-1 therapies can help millions overcome obesity and reduce its associated harms
- At present, there are 12 GLP-1 therapies approved for the treatment of obesity or Type-2 diabetes.
- WHO has supported long-term use of these medicines in adults, except pregnant women, the recommendation is not strong owing to the lack of data on long-term use of the medicines.

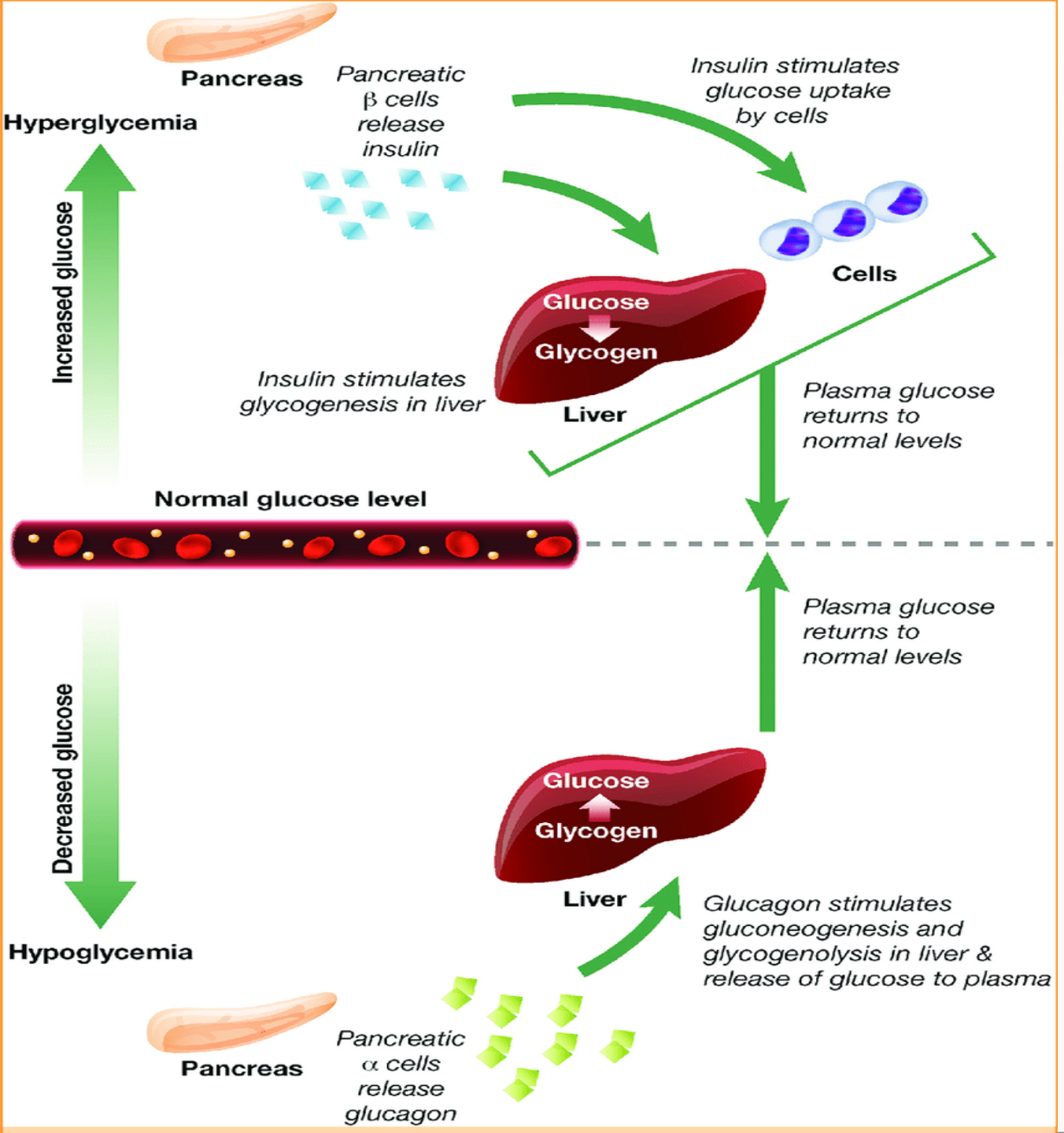
Obesity

GLP-1 (glucagon-like peptide-1)

- GLP-1 receptor agonists are a class of medications that mimic a natural hormone to regulate blood sugar, reduce appetite, and slow digestion, leading to significant weight loss (10-15%) and improved cardiovascular health in patients with type 2 diabetes or obesity. Common examples include semaglutide and tirzepatide

Mechanism of Action:

- They stimulate **insulin release when blood sugar** is high, **reduce glucagon secretion**, and promote satiety (fullness) by acting on the brain.
- Primary Uses: They are FDA-approved for managing Type 2 diabetes and chronic weight management.
- Weight Loss Efficacy: Studies indicate they can lead to substantial weight reduction, particularly when paired with lifestyle changes.



Obesity

Recent news

- Lancet medical journal's Diabetes & Endocrinology Commission proposed a **new definition and method for diagnosing obesity**

Reason

- **BMI alone is an inadequate measure**

How has obesity been measured thus far?

BMI- Body mass (weight) in kilograms by the square of their height measured in metres

BMI < 18.5 – Underweight
BMI 18.5 - 24.9 – Normal
BMI 25 - 29.9 – Overweight
BMI > 30 - Obese

Obesity

How has obesity been measured thus far?

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India

- In India, L**ean people with a BMI of less than 30 have abdominal fat** that can affect the functioning of various organs.
- It is seen that Indians would get **diabetes, hypertension, heart diseases and other consequences of obesity even at lower BMI**
- Indeed, the BMI cut-offs for obesity **were adjusted for Indians in 2009**. Those falling in the 23 to 24.9 range were deemed overweight, while a **BMI of more than 25 was deemed to indicate obesity**.

Rabies - a notifiable disease

Context-Recently Delhi government decided to declare human rabies a notifiable **disease under the Epidemic Diseases Act,1897**

Notifiable disease

Any disease that is required as per the law **to be reported to the public health authorities** is called a notifiable disease. The purpose of notification is

- To facilitate a prompt investigation,
- Assessment of risk to human health
- To respond to cases of infectious disease and contamination.

The government has declared many diseases as notified diseases like cholera, dengue, tuberculosis however, the notifiable diseases list **varies across states. Recently added ones like snakebite in 2024.**

Rabies - a notifiable disease

Rabies

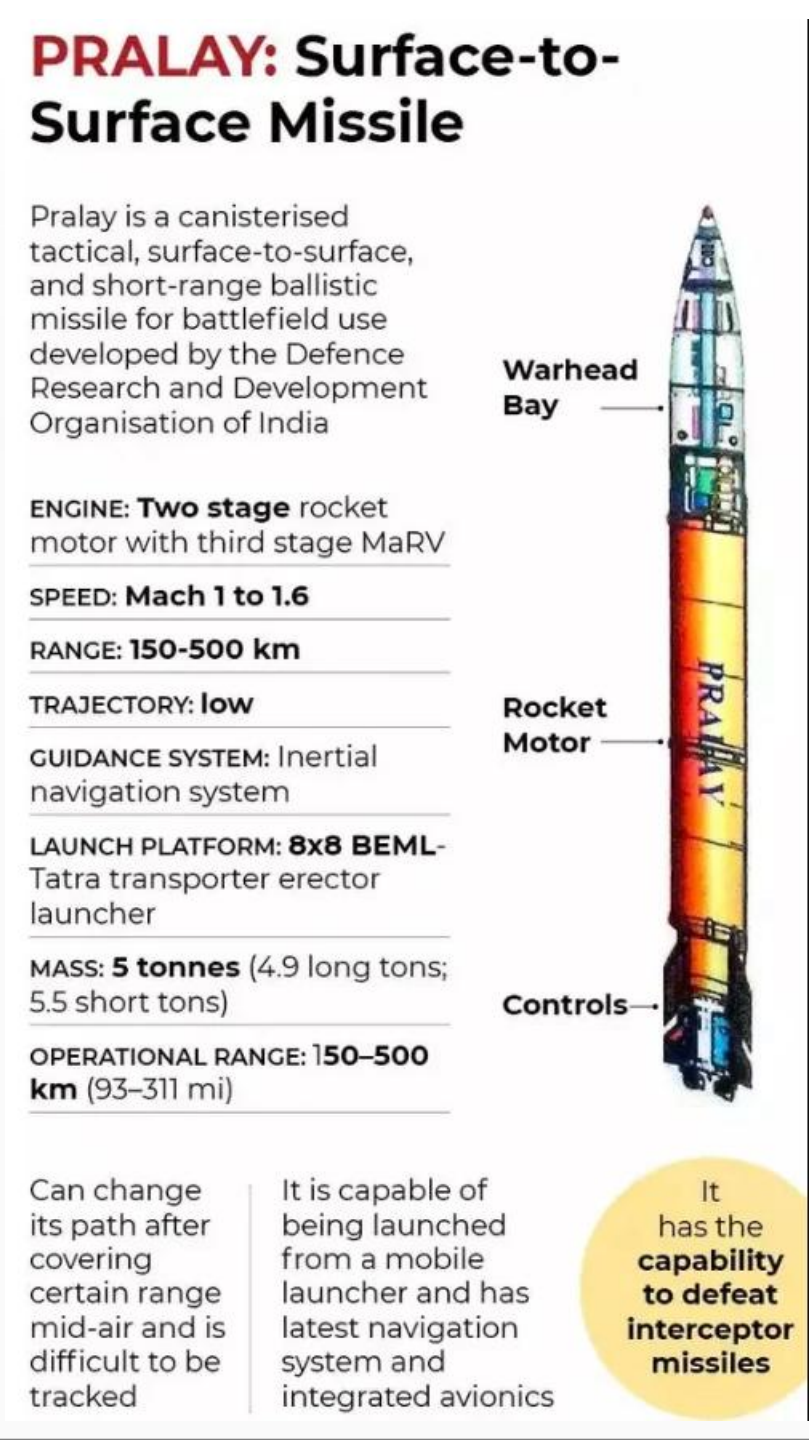
- Rabies is a vaccine-preventable, **zoonotic, viral disease affecting** the central nervous system.
- In up to **99% of the human rabies cases, dogs are responsible for virus transmission**. Children between the age of 5 and 14 years are frequent victims.
- Rabies infects **mammals, including dogs, cats, livestock and wildlife**.
- Rabies spreads to people and animals **via saliva, usually through bites, scratches, or direct contact with mucosa** (e.g. eyes, mouth, or open wounds).
- **In the Americas**, where dog-mediated rabies is mostly controlled, **hematophagous (blood-feeding) bats** are now the primary source of human rabies. Bat-mediated rabies is also an emerging public health threat in Australia and parts of western Europe.
- Currently there are **no WHO-approved diagnostic tools** for detecting rabies infection before the onset of clinical disease.

Pralay missiles

Context-The Defence Research & Development Organisation (DRDO) carried out a salvo launch of two indigenous Pralay missiles from the same launcher

Pralay Missile

- Pralay is a solid propellant, quasi-ballistic missile equipped with state-of-the-art guidance and navigation systems to ensure high precision.
- It is a surface-to-surface, short-range ballistic missile with a strike range of about 150 km to 500 km.
- It can carry multiple types of warheads against various targets.



Pralay missiles

Quasi ballistic missile

- A quasi-ballistic missile is a short-range, surface-to-surface weapon that follows a **low-altitude, unpredictable trajectory**, combining the **high speed of a ballistic missile** with the **maneuvering capabilities of a cruise missile.**
- Unlike traditional ballistic missiles that follow a predictable, parabolic arc, these missiles fly at a lower, "depressed" trajectory and can maneuver during both mid-course and terminal phases, making them difficult to intercept.