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IAS PRELIMS 2024

PRELIMS SAMPOORNA

SCIENCE & TECHNOLOGY

YEARLY COMPILATION

#7

THEMATIC CURRENT AFFAIRS

- Comprehensive Coverage of Last 2 Yrs. of Current Affairs
- Thematic arrangement of Topics
- Static & Current Interlinking
- PYQs & Practice MCQs to validate your learning

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1 MOCK TEST	13 APRIL	2 MOCK TEST	19 MAY
3 MOCK TEST	02 JUNE	TEST TIMING	PAPER 1: 9:30 AM to 11:30 AM PAPER 2: 01:00 PM to 03:00 PM
TEST DISCUSSION	ONLINE MODE 5:30 PM on the Day of Test		

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Preface

In the challenging and dynamic landscape of UPSC Civil Services Examination preparation, staying abreast of current affairs is indispensable. With this imperative in mind, we present "Yearly Compilation of thematic Current Affairs for Prelims." This annual compilation of Current Affairs spanning the last 1-2 years encapsulates over 800 topics, intelligently categorized into Subjects and themes to aid aspirants in their quest for success in the UPSC Preliminary Examination.

- **Comprehensive Coverage:** Encompassing the latest 1 to 2 years it offers a comprehensive overview of current affairs crucial for the Prelims Examination of 2024.
- **Thematic Arrangement:** To facilitate structured learning, our compilation adopts a thematic arrangement. Topics are intelligently categorized into subjects and themes, allowing aspirants to navigate through the vast sea of information with ease.
- **Static and current interlinking:** This comprehensive compilation incorporates recent developments and nuanced concepts. The objective is to establish a cohesive interlinking between core concepts and current affairs, thereby yielding a more desirable outcome
- **Holistic Preparation through Practice:** Beyond recent developments, this resource integrates Previous Year Questions (PYQs) and practice questions, offering a comprehensive understanding of subjects.

As aspirants gearing up for the Prelims 2024, may this compilation serve as a guiding light, illuminating the path to success.

All the Best!!

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IAS PRELIMS 2024

CURRENT AFFAIRS COMPILATION

- Comprehensive Coverage of Last 2 Yrs. of Current Affairs
- Static & Current Interlinking
- Thematic arrangement of Topics
- PYQs & Practice MCQs to validate your learning

1. POLITY
2. PROGRAMMES & POLICIES
3. ECONOMY
4. ENVIRONMENT & ECOLOGY
5. GEOGRAPHY
6. INTERNATIONAL RELATIONS
7. SCIENCE & TECHNOLOGY
8. ART & CULTURE
9. GIST OF INDIA YEAR BOOK

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Contents

CHAPTER 01

BIOTECHNOLOGY

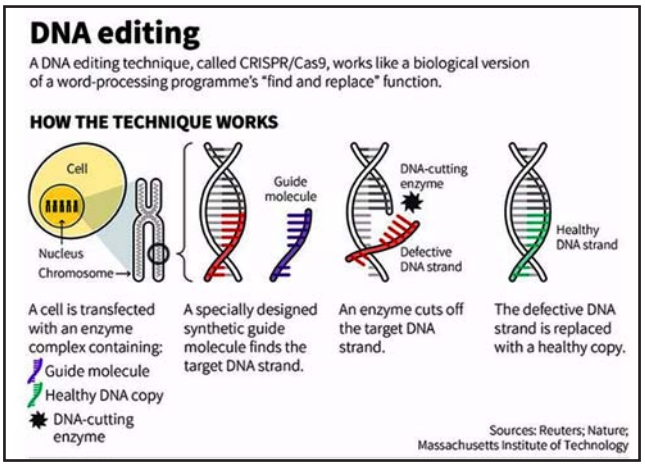
GENOME EDITING

1 GENOME EDITING AND RECENT DEVELOPMENTS

CONTEXT: Over the last few years, gene-editing technology has produced flawless results in clinical trials. India has approved a 5-year project to develop CRISPR to cure sickle cell anemia.

What is Genome Editing?

- **Genome editing (also called gene editing)** is a group of technologies that give scientists the ability to change an organism's **Deoxy-Ribonucleic Acid (DNA).**
- These technologies allow genetic material to be **added, removed, or altered** at particular locations in the **genome.**



- Advanced research has allowed scientists to develop the highly effective **Clustered Regularly Interspaced Palindromic Repeat (CRISPR)**, associated proteins-based systems.
- This system allows for **targeted intervention** at the genome sequence.
- It is currently the simplest, most versatile, and most precise method of genetic manipulation, causing a buzz in the science world.

About CRISPR technology:

- CRISPR is short for **Clustered Regularly Interspaced Short Palindromic Repeats**.
  - It is a reference to the *clustered and repetitive sequences of DNA* found in bacteria, whose natural mechanism to fight some viral diseases is replicated in this gene-editing tool.
  - "**CRISPR" (pronounced "crisper")** is shorthand for "**CRISPR-Cas9**." CRISPRs are specialized stretches of DNA, and the **protein Cas9**, where **Cas stands for "CRISPR-associated",** is an enzyme that acts like a pair of molecular scissors, capable of cutting strands of DNA.
  - CRISPR is a powerful tool for editing genomes, allowing researchers to easily alter DNA sequences and modify gene function.

CSIR's Institute of Genomics and Integrative Biology has indigenously developed a **CRISPR-based therapeutic solution for sickle cell anaemia**, which is now being readied for clinical trials.

CRISPR: Timeline of Key Events:

- **December 1987:** The CRISPR mechanism was first published.

- **March 2005**: ***Jennifer Doudna*** and Jillian Banfield started investigating CRISPR.
- **March 2011:** ***Emmanuelle Charpentier*** and Jennifer Doudna joined forces to investigate Cas9 enzyme.
- **April 2012:** First commercialization of CRISPR-Cas 9 technology.
- **January 2013**: CRISPR-Cas is used in human genome editing.
- **November 2015:** US scientists genetically modified mosquitos using CRISPR/Cas9 to prevent them from carrying malaria parasites.
- **August 2018**: First CRISPR-Cas9 clinical trial launched.
- **October 2020**: **Nobel Prize in Chemistry** awarded to **Emmanuelle Charpentier** and **Jennifer Doudna** 'for the development of a method for genome editing.

PYQ (2022)

1. Consider the following statements: DNA Barcoding can be a tool to:

1. assess the age of a plant or animal.
2. distinguish among species that look alike.
3. identify undesirable animal or plant materials in processed foods.

Which of the statements given above is/are correct?

(a) 1 only (b) 3 only

(c) 1 and 2 (d) 2 and 3

Correct Option: (d)

PYQ (2021)

2. With reference to recent developments regarding 'Recombinant vector Vaccines', consider the following statements:

1. Genetic engineering is applied in the development of these vaccines.
2. Bacteria and viruses are used as vectors.

Which of the statements given above is/are correct?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

Correct Option: (c)

2 GENOMIC SURVEILLANCE

CONTEXT: Recently, WHO' Science Council released a report "Accelerating access to genomics for global health" advocating for passing on Genomic Technologies to developing countries.

About Genomic technologies

- Genomic technologies are technologies used to manipulate and analyze genomic information.
- The field of genomics uses biochemistry, genetics and molecular biology methods to understand and use biological information in **deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).**
- This information benefits medicine and public health — especially during the COVID-19 pandemic — as well as agriculture, biological research and more.

What is genome sequencing?

- **Genome:** It is an organism's complete set of DNA, including all of its genes.
  - Each genome contains all of the information needed to build and maintain that organism. In humans, a copy of the entire genome—more than **3 billion DNA base pairs**—is contained in all cells that have a nucleus.
- **Genome sequencing:** It is figuring out the order of DNA nucleotides, or bases, in a genome—t**he order of As, Cs, Gs, and Ts** that make up an organism's DNA.

3 XENOTRANSPLANTATION

CONTEXT: Genetically modified pig heart took longer than usual to beat for human receiver in the first-ever transplant of the gene-edited pig heart to human. The human recipient lived only for 61 days after the transplant.

What is Xenotransplantation?

- Xenotransplantation involves the **transplantation of nonhuman tissues** or organs **into human recipients.**
  - In the recent heart transplant from pig to human, **gene-editing** was adopted to remove a sugar in its cells that's responsible for that hyper-fast organ rejection.
- Genome editing (also called **gene editing)** is a group of technologies that give scientists the ability to change an organism's **Deoxy-Ribonucleic Acid (DNA).**
- One of the **biggest obstacles** to transplantation is **organ rejection.**

4 GENETICALLY ENGINEERED MOSQUITOES

CONTEXT: Preliminary results of an open-air study of genetically engineered mosquitoes — with an aim to suppress a wild population of virus-carrying mosquitoes — in the United States have shown promising results.

About Genetically Modified Mosquito:

- Scientists have moved on from using **bed nets and insecticides** to kill **malaria-spreading mosquitoes**, to genetically modify the mosquitoes by inserting a gene that leads to the production of male offsprings.
- Since **only females carry the malaria-causing microorganism**, the spread of the disease is controlled in the short-term while eventually the whole population gets wiped out.
- Scientists **injected a gene from a slime mould into the mosquito** which attached itself to the **X chromosome** during sperm-making process effectively masking the sperms leading to production of male offspring.

How GM mosquitoes are produced and used to control *Ae. aegypti* mosquitoes?

- GM mosquitoes are mass-produced in a laboratory to carry two types of genes:
- A **self-limiting gene** that prevents female mosquito offspring from surviving to adulthood.
- A **fluorescent marker gene** that glows under a special red light.
- GM mosquitoes carry self-limiting and fluorescent marker genes. Released into the wild, they mate with wild mosquitoes. Offspring die before adulthood, reducing Ae. aegypti mosquito population.

5 GENETICALLY MODIFIED (GM) CROPS

CONTEXT: A notification by the food safety regulatory body of India Food Safety and Standards Authority of India (FSSAI) over genetically modified organisms (GMO) has received several objections from a pan-Indian citizen's platform.

What is GM Crop?

- A GM or transgenic crop is a plant that has a novel combination of genetic material obtained through the use of modern biotechnology.
- **For example,** a GM crop can contain a gene(s) that has been artificially inserted instead of the plant acquiring it through pollination.

How they are made?

- GM crops are made through a process known **as genetic engineering.**
- Genes of commercial interest are transferred from one organism to another.
- Two primary methods currently exist for introducing transgenes into plant genomes-:
  - The first involves a device called a '**gene gun'**.
  - The DNA to be introduced into the plant cells is coated onto tiny particles of gold or tungsten.
- The second method uses a bacterium to introduce the gene(s) of interest into the plant DNA.

6 GENETICALLY MODIFIED MUSTARD

CONTEXT: Recently, the Genetic Engineering Appraisal Committee (GEAC) under the Union Ministry of Environment, Forest and Climate Change recommended the "environmental release" of the transgenic hybrid mustard DMH-11 for seed production and ordered to conduct the field demonstration studies with respect to its effects on honey bees and other pollinating insects.

About GM-Mustard:

- DMH-11 hybrid mustard contains barnase and barstar genes from Bacillus 'amyloliquefaciens', boosting yield by 28%.
- **Barnase:** The first gene ('barnase') codes for a protein that **impairs pollen production** and renders the plant into which it is incorporated **male-sterile.**

- **DMH-11** is claimed to have shown an average **28% yield increase** over Varuna in contained field trials carried out by the **Indian Council of Agricultural Research (ICAR).**

- **Barstar:** This plant is then crossed with a fertile parental line containing, in turn, the second 'barstar' gene that blocks the action of the barnase gene.
- Bt cotton, developed by Mahyco and Monsanto, and Bt brinjal, by Mahyco with universities, aim to combat pests. Bt cotton was approved in 2002, but Bt brinjal's commercial release was blocked in 2010 despite GEAC recommendation.

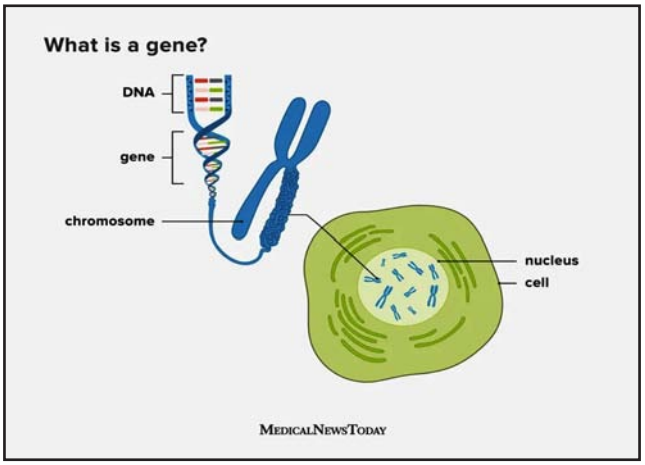
7 HUMAN PAN-GENOME MAP

CONTEXT: A new study published in the journal Nature describes a pan-genome reference map created utilising genomes from 47 anonymous individuals (19 men and 28 women), mostly from Africa but also from the Caribbean, Americas, East Asia, and Europe.

What is a genome?

The genome is our life's blueprint, consisting of genes and regions between them in our chromosomes. Each chromosome is a chain of DNA with millions of nucleotides.

- The genome is the **blueprint of life**, a collection of all the genes and regions between the genes contained in our **23 pairs of chromosomes**.



- Each chromosome is a contiguous stretch of **DNA string** composed of millions of individual **building blocks called nucleotides or bases**.
- Genome sequencing reveals the order of these nucleotides, aiding in understanding genetic diversity and disease susceptibility.
- A single genome identity card for a region could streamline identification.

What is a reference genome?

- The first reference genome in 2001 aided disease gene discovery, yet was 92% complete with gaps.
- Now, a pangenome map captures diversity among 47 individuals, enhancing understanding of human genetic variation and refining computational methods.

What is a pangenome map?

- The pangenome depicts chromosomes with nodes at shared sequences among 47 individuals and internodes showing genetic variations.
- Long-read DNA sequencing aids in creating accurate, contiguous chromosome maps, crucial for understanding genetic diversity and navigating repetitive regions.

8 MITOCHONDRIAL DONATION TREATMENT (MDT)

CONTEXT: A groundbreaking **IVF** procedure has been successfully performed in the United Kingdom, resulting in the birth of the first baby with genetic material from three persons, with the help of **mitochondrial donation treatment (MDT). What is Mitochondrial Donation Treatment (MDT)?**

Mitochondrial diseases affect 1 in 5,000 people globally and can cause severe health problems, including muscle weakness, organ failure, and neurological disorders.

- Mitochondrial donation treatment (MDT) is a medical procedure aimed at preventing **inherited diseases** caused by **mutations** in the **mitochondrial DNA (mtDNA).**
- The treatment involves **replacing the faulty mitochondria** in a woman's egg or embryo with **healthy mitochondria** from a donor.
- Inherited mutations in mtDNA can cause mitochondrial disease, which is incurable and can lead to severe health problems.

Mitochondria are the powerhouse of the cell and are responsible for producing energy. They have their own DNA, separate from the nuclear DNA that determines an individual's physical traits.

How Does MDT Work?

- Mitochondria are cell powerhouses responsible for generating energy.
- They possess their own DNA, separate from the cell nucleus, and mutations in mitochondrial DNA lead to health issues.

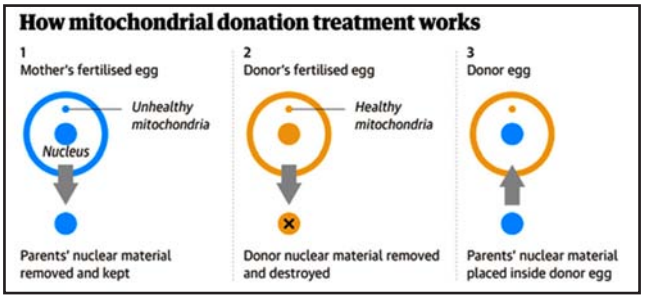
The **genetic material** from the donated egg comprises less than **1 percent** of the child's genetics

- These defects affect energy production, notably in energy-demanding tissues like brain, muscles, heart, etc.
- Mitochondrial diseases, inherited solely from the mother, impact 1 in 5,000 people.
- Impaired mitochondria cause organ dysfunction, manifesting as brain damage, organ failure, and muscle wastage.

MDT

It involves the use of **in vitro fertilization (IVF)** to create an embryo with genetic material from three people: the mother, the father, and the mitochondrial donor. The process can be done in two ways:

- **Pronuclear transfer**: transferring the nucleus of the mother's fertilized egg or embryo into the cytoplasm of a donor egg or embryo with healthy mitochondria. The resulting embryo has nuclear DNA from the mother and father and healthy mtDNA from the donor.
- **Maternal spindle transfer:** transferring the nucleus of the mother's egg into a donor egg with healthy mitochondria before fertilization. The resulting embryo has nuclear DNA from the mother and father and healthy mtDNA from the donor.



What is the legal Status of MDT?

- The **United Kingdom was the first country to legalize MDT in 2015.**
- The first baby born using MDT in the UK was in 2016.
- Since then, a few other countries, including the **United States,** have also approved the use of MDT under strict regulations.

Status in India

- In India, the MDT procedure is not currently allowed.
- However, the **Indian Council of Medical Research (ICMR)** has issued draft guidelines for MDT and is seeking public comments.

PYQ (2019)

3. With reference to the recent developments in science, which one of the following statements is not correct?

(a) Functional chromosomes can be created by joining segments of DNA taken from cells of different species.

(b) Pieces of artificial functional DNA can be created in laboratories.

(c) A piece of DNA taken out from an animal cell can be made to replicate outside a living cell in a laboratory.

(d) Cells taken out from plants and animals can be made to undergo cell division in laboratory petri dishes.

Correct Option: (a)

9 METAGENOME SEQUENCING

CONTEXT: In order to get a breakthrough in the definitive identification of SARS-CoV-2, Scientists didn't go the more time-consuming microbiology route; instead, and in a break from tradition, they were directly subjected to genome-sequencing and bioinformatic analysis, which helped the scientists quickly identify the virus. This new approach is called metagenomics.

What is Metagenomics?

- Metagenomics is a field of molecular biology and genomics
- It refers to the application of sequencing techniques to analyse the totality of the genomic material (DNA or RNA) present in a sample.
- **Metagenomics** uses **gene sequencing** to discover proteins in samples from environments across Earth, microbes living in the soil, in extreme environments like hydrothermal vents, deep in the oceans and in our guts and on the skin.

What are its major applications?

- **Microbiome Research:** Understanding the composition and functional roles of microbial communities in various environments, such as the human gut, soil, oceans, and plants. This knowledge has implications for health, agriculture, and ecology.
- **Biotechnology:** Identifying novel enzymes, pathways, and metabolic functions from environmental samples, which can be used for industrial processes, such as bioremediation, biofuel production, and the synthesis of valuable chemicals.
- **Disease Diagnosis:** Investigating the role of microbial communities in human health and disease. Metagenomic analysis can help identify potential pathogens, study the human microbiome, and understand the impact of microbial dysbiosis on various health conditions.
- **Environmental Monitoring:** Assessing the impact of pollution, climate change, and other environmental

factors on microbial ecosystems. Metagenomics can provide insights into ecosystem health and aid in conservation efforts.

- **Pharmaceutical Discovery:** Exploring natural products and bioactive compounds produced by diverse microorganisms in the environment, which may have potential applications in drug development.
- **Evolutionary Studies:** Examining the evolutionary relationships between microorganisms and tracing the evolution of specific genes or functions within microbial communities.
- **Agriculture and Food Safety**: Analyzing the microbiota of crops, livestock, and food products to improve agricultural practices, enhance crop yield, and ensure food safety.
- **Bioprospecting:** Identifying novel species and genetic elements with unique properties that can be used for various purposes, including biotechnology, medicine, and industrial processes.

PRACTICE QUESTION

1. DMH-11, a genetically modified mustard variety, incorporates genes called "barnase" and "barstar" from the soil bacterium Bacillus amyloliquefaciens. What is the primary purpose of these genes in DMH-11?

1. They enhance the mustard's flavor and aroma.
2. They make the mustard more resistant to herbicides.
3. They protect Bacillus amyloliquefaciens from competing bacteria.
4. They promote the synthesis of essential nutrients in the mustard plant.

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) Only three (d) All four

2. With reference to 'metagenome sequencing', consider the following statements:

1. It is the direct genetic analysis of genomes
2. It allows researchers to comprehensively sample all genes in all organisms present in a given complex sample.
3. It utilizes only 16S rRNA analysis.

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) Only three (d) None

3. 1. Consider the following statements regarding the '10,000 genome' project:

1. The '10,000 genome' project aimed to create a reference database of whole-genome sequences specifically from India.
2. The project was primarily focused on sequencing the genomes of individuals from diverse population groups to capture the genetic variations unique to India.

Which of the statements given above is/are correct?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

4. Consider the following statements regarding mRNA vaccines and their potential for fine-tuning:

Statement 1: mRNA vaccines work by introducing genetic instructions to the body's cells, which can occasionally lead to a harmless "slip" in the translation process, resulting in unintended proteins being produced.

Statement 2: Slip can be entirely prevented through meticulous mRNA sequence design, advanced ribosome engineering techniques, and quality control mechanisms within the cell's translational machinery.

Which one of the following is correct in respect of the above statements?

(a) Both Statement 1 and Statement 2 are correct, and Statement 2 is the correct explanation for Statement 1.

(b) Both Statement 1 and Statement 2 are correct, but Statement 2 is not the correct explanation for Statement 1.

(c) Statement 1 is incorrect, but Statement 2 is correct.

(d) Statement 1 is correct, but Statement 2 is incorrect.

5. Consider the following statements regarding the Genetic Engineering Appriasal Committee (GEAC) in India:

1. GEAC is a statutory body responsible for the appraisal of activities involving the large-scale use of hazardous microbes and recombinants in research and industrial production.
2. One of the functions of GEAC includes assessing proposals for the release of genetically engineered products and organisms into the environment, encompassing experimental field trials.

3. The Committee evaluates proposals related to the use of living modified organisms categorized as risk category III and above in the import/manufacture of recombinant pharma products or where the end-product is a modified living organism.
4. GEAC has the authority to take punitive action against individuals or bodies under the Environment (Protection) Act.
5. Approval from GEAC is mandatory before genetically modified organisms and products derived from them can be used commercially.

Select the correct statement(s):

(a) 1, 2, and 5

(b) 2, 3, and 4

(c) 1, 3, and 5

(d) 1, 2, 3, 4, and 5

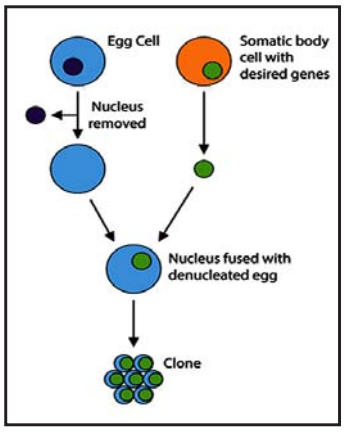
ANSWERS				
1. (b)	2. (b)	3. (c)	4. (d)	5. (d)

BIOTECHNOLOGY & CELLS

10 CLONING

CONTEXT: India's first cloned Gir cow Ganga was born at National Dairy Research Institute in Karnal, Haryana.

What is Cloning?



- **C**loning is a technique scientists use to make exact genetic copies of living things. Genes, cells, tissues, and even whole animals can all be cloned
- Types of cloning:
  - **Therapeutic:** In therapeutic cloning, the aim is to clone cells that make particular organs or types of tissue
  - **Reproductive:** In this we actually reproduce not organ but entire being (donor) from where we got genetic information

Methods:

- **Natural:** This happens naturally when one embryo spontaneously divides into two or more embryos, thus creating identical twins or, sometimes, triplets or even more
- **Artificial:** An existing embryo is mechanically divided into two or more embryos that are then allowed to develop naturally
- **Artificial and Donor:** Through use of somatic cell of Donor.

Role of somatic cells:

- Somatic cells form an organism, excluding sperm and egg cells.
- Unlike reproductive cells, somatic cells have two sets of chromosomes.
- Cloning involves transferring DNA from a somatic cell into an enucleated egg.
- The resulting embryo shares genes with the somatic cell donor and is implanted for growth.

11 CHIMERIC ANTIGEN RECEPTOR T (CAR-T) CELL THERAPY

CONTEXT: India's first indigenously developed Chimeric Antigen Receptor (CAR)-T Cell T therapy for specific types of cancer patients has shown promising results and could be the safest therapy in this category so far.

What is Chimeric Antigen Receptor (CAR)-T Cell T therapy?

About T-Cells

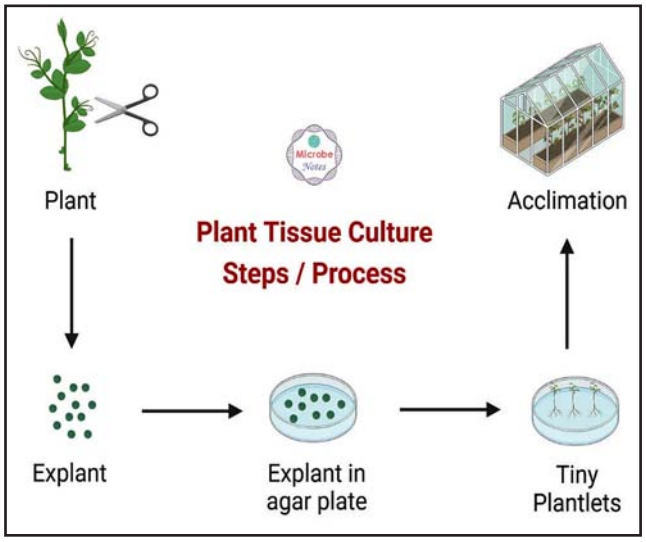
- **T-cells** are a type of white blood cell called lymphocytes. They help your immune system fight germs and protect you from disease. There are two main types.
  - **Cytotoxic T-cells** destroy infected cells.
  - **Helper T-cells** send signals that direct other immune cells to fight infection.

- CAR T cells are genetically modified in labs to bind to and kill cancer cells.
- They're tailored to target specific cancer antigens.
- Patient's T cells are extracted and equipped with a CAR receptor.
- Modified CAR T cells are multiplied in labs, then infused back into the patient.
- CAR T-cell therapy is used to treat certain blood cancers and it is being studied in the treatment of other types of cancer. Also called chimeric antigen receptor T-cell therapy.

12 TISSUE CULTURE PLANTS

CONTEXT: The Agricultural and Processed Food Products Export Development Authority (APEDA) conducted a webinar on "Export Promotion of Tissue Culture Plants such as Foliage, Live Plants, Cut Flowers, and Planting Material".

- The **Department of Biotechnology (DBT)** accredited **tissue culture** laboratories spread across India participated in the Webinar.



What is plant tissue culture?

- Plant tissue culture is the sterile cultivation of plant cells, tissues, or organs in a controlled environment using a precise nutrient medium.
- It allows for rapid propagation of mature plants, minimizing disease transmission.
- Additionally, it facilitates genetic preservation and conservation of plant species.

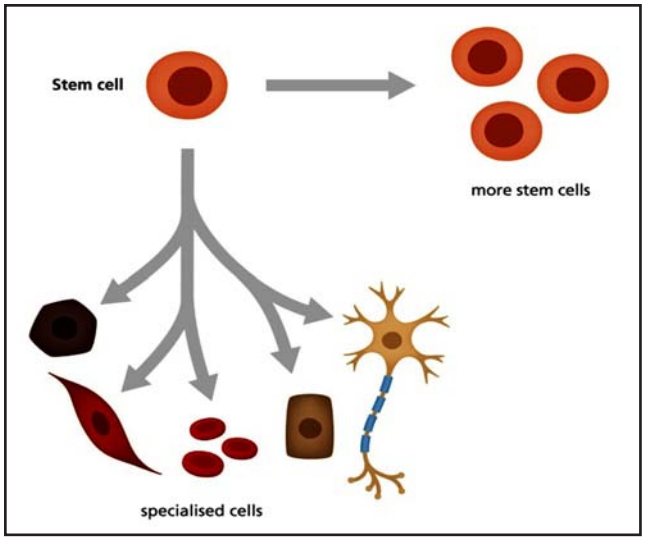
India's exports of tissue culture plants:

- In 2020-2021, India's exports of tissue culture plants stood at US USD 17.17 million, with the Netherlands accounting for around 50 per cent of the shipments.
- The top ten countries importing tissue culture plants from India are the **Netherlands, USA, Italy, Australia, Canada, Japan, Kenya, Senegal, Ethiopia and Nepal.**

13 STEM CELLS

CONTEXT: Scientists from the University of Cambridge have achieved the rare feat of creating the world's first synthetic embryo that has a brain and a beating heart.

- **Concept involved:** The embryo was created using the **stem cells** of the mouse instead of the normal process of fusing sperm and egg cells.



What are stem cells?

- Stem cells are versatile cells with the ability to develop into various specialized cell types in the body. They replenish and replace damaged or lost cells, offering potential for treating diseases in the future.
- Stem cells possess three key properties: self-renewal, unspecialized nature, and the ability to give rise to specialized cell types.

Stem cell therapy:

- Stem cell therapy, also known as regenerative medicine, promotes the repair response of diseased, dysfunctional, or injured tissue using stem cells or their derivatives.
- Stem cells may be one of the ways of generating new cells that can be transplanted into the body to replace the damaged or lost cells.

14 CELL-CULTIVATED MEAT AND ADVANTAGES

CONTEXT: Recently, two California based companies were cleared to make and sell cell cultivated chicken. As a concept, it is being hailed by stakeholders as a major step towards reducing carbon emissions associated with the food industry worldwide.

What is cell-Cultivated chicken?

- Cell-Cultivated meat is also called **as 'Cultured meat'.**
- **Process of Isolation-** It involves isolation of the cells that make up the meat (the meat that we consume), and putting them in a setting where they have all the resources they need to grow.
- **Processed with additives-** Once there are enough cultivated cells, they are collected and processed with additives to improve texture.

India's Meat Market:

- According to a research, meat production in India is estimated at 6.3 million tons annually and is **ranked 5th** in the world in terms of production volume.
- India is responsible for **3% of the total meat production in the world**.
- The nation has the **world's largest population of livestock** at about 515 million.

BIOTECHNOLOGY & GOVERNMENT INITIATIVES

15 SYNTHETIC BIOLOGY

CONTEXT: The Centre is working on a national policy on synthetic biology, an emerging science that deals with engineering life forms for a wide range of applications from making designer medicines to foods.

What is Synthetic Biology?

- Synthetic biology aims to engineer functional biological systems from DNA, proteins, and organic molecules, enabling the creation of products like ethanol, drugs, and synthetic organisms.
- These systems offer potential in various applications, such as producing renewable energy and bioremediation. The goal is to develop safer and less complex biological solutions compared to natural biological entities.

Applications

- **Redesigning organisms** so that they produce a substance, such as a medicine or fuel, or gain a new ability, such as sensing something in the environment, are common goals of synthetic biology projects.
- **Pharmaceuticals:** The synthetic manufacture of the **antimalarial drug artemisinin**, which is produced naturally in the sweet wormwood plant, a slow-growing species.
- **Biofuels:** In the area of biofuels, scientists at numerous companies are trying to create **microbes** that can **break down dense feedstocks** to produce biofuels.
- **Other Applications:**
  - **Bioremediation** to clean pollutants from our water, soil and air.
  - **Rice modified** to produce beta-carotene, a nutrient usually associated with carrots that prevents vitamin A deficiency.
  - **Yeast engineered** to produce rose oil as an eco-friendly and sustainable substitute for real roses that perfumers use to make luxury scents.

16 INDIAN BIOLOGICAL DATA CENTER

CONTEXT: The Government launched India's first national repository for life science data, the Indian Biological Data Centre (IBDC) at Faridabad, Haryana.

About:

- The 'Indian Biological Data Centre (IBDC)' is the **first national repository** for life science data in India.
- **Purpose:** deposition, storage, annotation and sharing of biological data.
- The data center is supported by the Government of India (GOI) through the **Department of Biotechnology (DBT).**
- It has a data storage capacity of about **4 petabytes** and houses the '**Brahm' High-Performance Computing (HPC) facility.**
- IBDC has started **nucleotide data submission services** via two data portals namely:
  - Indian Nucleotide Data Archive (INDA)
  - Indian Nucleotide Data Archive -Controlled Access (INDA-CA)

17 BIOTECH-PRIDE GUIDELINES

CONTEXT: Biotech-PRIDE (Promotion of Research and Innovation through Data Exchange) Guidelines was released by the Department of Biotechnology (DBT), Ministry of Science and Technology.

Key-highlights of the guidelines

- Providing a well-defined framework and guiding principle to facilitate and enable sharing and exchange of **biological knowledge, information and data.**
- **Implementing agency:** They will be implemented through the **Indian Biological Data Centre (IBDC)** at Regional Centre for Biotechnology supported by the **Department of Biotechnology.**
- Other existing datasets/ data centres will be bridged to this IBDC which will be **called Bio-Grid.**

Bio-Grid

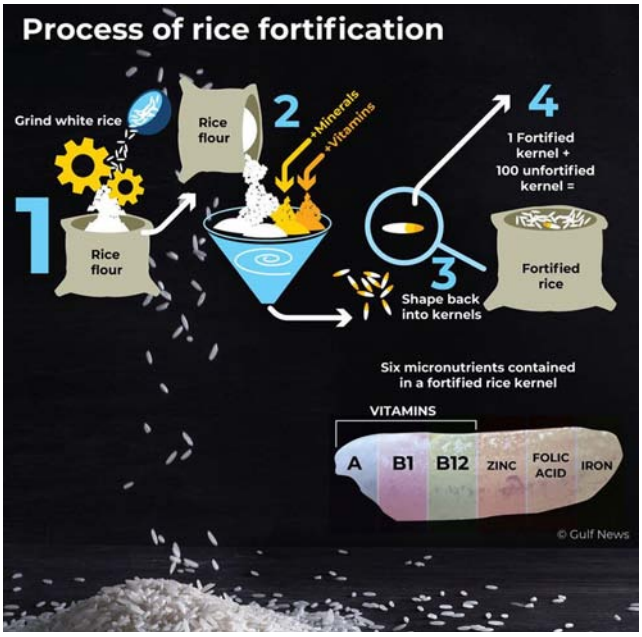
- This Bio-Grid will be a **National Repository for biological knowledge**, information and data.
- It is going to be responsible for enabling its exchange, developing measures for safety, standards and quality for datasets and establishing detailed modalities for accessing data.

IMPORTANT TECHNIQUES

18 RICE FORTIFICATION AND USES

CONTEXT: The Cabinet Committee on Economic Affairs accorded its approval for supply of fortified rice throughout the Targeted Public Distribution System (TPDS).

What is rice fortification?



- The Food Safety and Standards Authority of India **(FSSAI)** defines: "**deliberately increasing the content of essential micronutrients in a food so as to improve the nutritional quality of food and to provide public health benefits with minimal risk to health**".
- The fortified rice kernels are blended with regular rice to produce fortified rice.
- Various technologies are available to add **micronutrients to regular rice**, such as coating, dusting, and 'extrusion'.
  - The '**Extrusion**' involves the **production of fortified rice kernels (FRKs)** from a mixture using an 'extruder' machine.
  - It is considered to be the best technology for India.
- **10 g of FRK must be blended with 1 kg of regular rice.**
- Fortified rice will be **packed in jute bags with the logo ('+F') and the line "Fortified with Iron, Folic Acid, and Vitamin B12".**
- **Important technologies**: **coating, dusting, and 'extrusion'.**
  - The **'Extrusion'** involves the production of **fortified rice kernels (FRKs)** from a mixture using an '**extruder' machine.** It is considered to be the best technology for India.

Standards for fortification (Ministry of Consumer Affairs, Food and Public Distribution)

- 10 g of FRK must be blended with 1 kg of regular rice.
- According to FSSAI norms, 1 kg of fortified rice will contain the following:
  - **Iron** (28 mg-42.5 mg)
  - **Folic acid** (75-125 microgram)
  - **Vitamin B-12** (0.75-1.25 microgram)
- Rice may also be fortified with zinc (10 mg-15 mg), vitamin A (500-750 microgram RE), vitamin B-1 (1 mg-1.5 mg), vitamin B-2 (1.25 mg-1.75 mg), vitamin B-3 (12.5 mg-20 mg) and vitamin B-6 (1.5 mg-2.5 mg) per kg

19 ADDITIVE MANUFACTURING

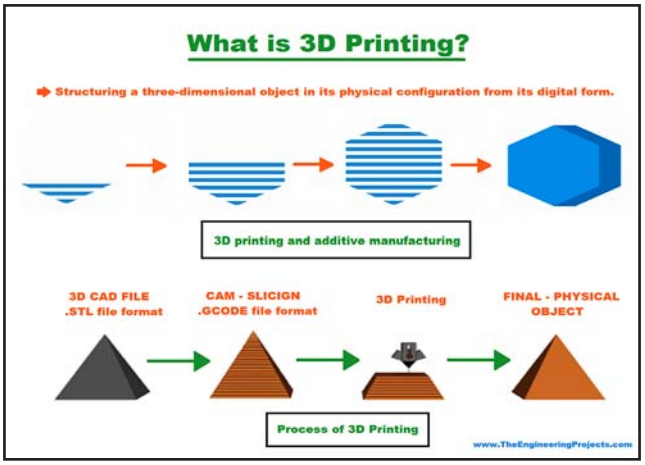
CONTEXT: The Ministry of Electronics and Information Technology (MeitY) aims to increase India's share in global additive manufacturing to 5 per cent within the next three years.

Additive manufacturing technology or **3D printing** is a type of technology that uses successive layers of material to create 3D objects.

About 3D Printing:

- 3D printing, also known as additive manufacturing, creates objects layer by layer using materials like plastic or metal, based on computer-aided designs.
- Software guides the 3D printer, which uses CAD or 3D scanners for precise measurements.
- It finds applications in diverse sectors such as defense, automotive, and medical equipment design.
- 3D printing or additive manufacturing uses **computer-aided designing** to make prototypes or working models of objects by laying down successive layers of materials such as plastic, resin, thermoplastic, metal, fiber or ceramic.

Types of 3D Printing:



- **Binder Jetting:** This method works similarly to your run-of-the-mill office printer except it prints three-dimensional objects.
- **Directed Energy Deposition (DED):** It utilizes welding principles to create three-dimensional objects.
- **Material Extrusion:** The material feeds into the printer from a coil. The tip of the nozzle heats and melts the material. The liquid material is then placed layer by layer on the build platform, where it can cool and solidify, forming the object.
- **Powder Bed Fusion (PBF):** It starts with a large bed of powdered material, typically plastic, metal, sand, or ceramic powders mixed with sand. The powder is selectively fused together using a laser or electron beam. Once a layer of material is fused, the working area moves down, and the new layer is built on top using the same process.
- **Sheet Lamination:** Sheet lamination, otherwise known as **ultrasonic additive manufacturing (UAM)** or laminated object manufacturing (LOM) is an additive manufacturing process that stacks thin sheets of material and bonds them together through ultrasonic welding, bonding, or brazing.
- **Vat Polymerization:** Vat polymerization is similar to powder bed fusion, except instead of a bed of powder, it uses a vat of photopolymer resin, which is hardened in layers by an ultraviolet laser.
- **Material Jetting:** Similar to binder jetting, material jetting layers material to construct an object. However, instead of layering adhesive on a bed of powder, material jetting melts wax-like materials and precisely deposits droplets onto the build platform.

20 CARBON DATING

CONTEXT: The District Court in Varanasi allowed a petition seeking Carbon Dating of the structure inside the Gyanvapi mosque that the Hindu side has claimed is a 'Shivling'.

Carbon dating

- It determines the age of organic material by analyzing the decay of a radioactive isotope of carbon called C-14. Living things absorb carbon-14 from the atmosphere, maintaining a certain ratio with stable carbon-12.
- When they die, carbon-14 begins to decay at a known rate.
- By measuring the change in the carbon-12 to carbon-14 ratio, scientists estimate the approximate age of the organism or its remains.

21 CARBON DATING METHOD: ISSUES & SOLUTION

CONTEXT: A new study shows a way to use calcium-41 the same way carbon-14 has been used in carbon-dating, but with several advantages.

What is Radiometric dating?

- Radiometric dating, like carbon-14 dating, estimates the age of organic materials by measuring the decay of radioactive isotopes.
- While alive, organisms absorb and lose carbon-14 atoms.
- After death, carbon-14 decay begins. By comparing the carbon-14 levels in remains with expected amounts, scientists estimate the time of death.

CHAPTER 02

NANO-TECHNOLOGY

APPLICATION OF NANOTECHNOLOGY

1 NANOTECHNOLOGY

CONTEXT: Nanotechnology, generally regarded as technologies at the atomic and molecular scales of size less than 100nm (1nm corresponding to a billionth of a metre), is a fast-growing area with the potential to impact many areas of activity.

What is nanotechnology?

- Nanotechnology focuses on designing and using structures at the nanoscale, around 100 nanometres or less.
- Examples include graphene discovery, using nanotech for vaccine delivery, nanomedicine for disease treatment like cancer, and aiding clean energy tech development.

Types of Nanomaterials

- Inorganic nanoparticles are non-toxic, stable, and often used in biomedicine.
- Carbon nanoparticles are low in toxicity, electrically conductive, and useful in sensing.
- Organic nanoparticles are biocompatible and include liposomes and dendrimers.
- Composite nanoparticles offer diverse properties like strength and conductivity by combining materials like carbon nanotubes and quantum dots.

2 CORDY GOLD NANOPARTICLES (COR-AUNPS)

CONTEXT: Recently, a collaborative experiment by scientists from four Indian institutions has earned an international patent from Germany for developing Cordy Gold Nanoparticles (Cor-AuNPs), which can make drug delivery in the human body faster and surer.

About Cordy Gold Nanoparticles (Cor-AuNPs):

- These nanoparticles, derived from the synthesis of the extracts of Cordyceps militaris and gold salts, could make drug delivery in the **human body faster and safer.**
- Cordyceps militaris is a high value **parasitic fungus. Gold salts are ionic chemical** compounds of gold generally used in medicine.
- Wild **Cordyceps mushrooms are found in the eastern Himalayan belt.**

Biosynthesised nanogold particles indicate a new application of **nanoparticles in the development of therapeutic drugs** which can be delivered as ointments, tablets, capsules, and in other forms.

3 QUANTUM DOTS

CONTEXT: Alexei I. Ekimov, Louis E. Brus, and Moungi G. Bawendi have been awarded the 2023 Nobel Prize for chemistry "for the discovery and synthesis of quantum dots".

What are Quantum Dots?

- Quantum dots are ultra-small particles made of semiconducting material, exhibiting unique optical and electronic properties.
- They emit colorful light when exposed to UV light and are used in solar cells for their ability to absorb various wavelengths, potentially increasing efficiency.
- Their **small size** allows them to absorb light of different wavelengths, including those in the ultraviolet and infrared spectrum, which are typically not absorbed by traditional solar cells.
  - This means that quantum dot-based solar cells can potentially harness more of the sun's energy, leading to higher efficiency.
- Quantum dots can be synthesized in a solution, which makes them easier and cheaper to produce than traditional solar cells. This could significantly reduce the cost of solar energy, making it more accessible to a wider range of consumers and businesses.

4 VIKARSH NANO TECHNOLOGY

CONTEXT: The technology to stop carbon emissions from iron production developed by Pune-based Vikarsh Nano Technology was honoured at 'Elecrama 2023'.

About

- Vikarsh Nano Technology has developed a Counter Current Reactor and the green steel technology aimed at completely stop carbon emissions from iron production.

5 NANOMATERIALS

CONTEXT: Advancements in nanotechnology have led to the development of nanomaterials that are used across day-to-day applications, from fabrics, cosmetics, and sportswear, to camera displays and eyewear.

What are nanomaterials?

- Nanomaterials are materials with structures and properties significantly different from those of bulk materials due to their small size.
- With the help of nanotech, material properties can be tweaked to make them durable and stronger, have better electrical & thermal conductivity, and so on.
- Typically, in the clothing sector, fabrics can be made wrinkle-free and resistant to micro-bacterial growth.
- Nanomaterials are also an important component of **lithium-ion batteries.**

6 ENVIRONMENTAL REMEDIATION

CONTEXT: Nanotechnology, because of unique properties of nanomaterials, offers a wide range of applications in environment, agriculture, food and energy sectors.

About

- Nanostructured materials such as **nanocomposites, functionalized nanomaterials, metal organic frameworks, nanocatalysts, carbonaceous materials, nano zeolites, nano silica, nano lubricants and nano coatings** etc. have enormous possibilities in sequestration and reduction of greenhouse gases, biofuel production, wastewater treatment and environmental remediation using a sustainable approach.

Applications

Environmental remediation applications include:

- **Water purification**: Durable graphene-based water filtration membranes to remove environmental contaminants such as heavy metals from industrial wastewater with self-cleaning capabilities and long lives.
- Nanoparticles for cleaning industrial wastewater pollutants in groundwater.
- Thin-film nanoporous MoS2 membranes for energy-efficient desalination.
- A potassium manganese oxide nanowire-based nanofabric "paper towel" for oil spillage clean-up applications.
- Nanotechnology-enabled sensors for environmental pollution monitoring and air quality sensing.

7 INDIA'S FIRST NANO DAP PLANT IN GUJARAT

CONTEXT: The government recently inaugurated the Country's first Nano DAP plant by IFFCO near Kalol in Gandhinagar.

About

- The Nano liquid dap plant in Kalol has been set up by IFFCO at the cost of 300 crore rupees. The plant has been developed in tune with the Aatmnirbhar Bharat vision of Prime Minister Narendra Modi.
- The plant will lead to a significant reduction in imports of DAP and also will bring down the logistics and warehousing costs.
- The plant will produce 5 crore bottles of Nano dap liquid equivalent to 25 tons of DAP.

IFFCO Nano DAP

- IFFCO Nano DAP is a potent nitrogen and phosphorus source for crops, addressing deficiencies in standing crops.
- With 8.0% N and 16.0% P2O5, its nano formulation, with particles less than 100nm, ensures easy absorption by seeds and plants.
- Functionalized with bio-polymers, it enhances spreadability and assimilation, leading to improved seed vigor, chlorophyll levels, and crop yield without environmental harm.

Application of nanotechnology in Agriculture

- Postharvest management
- Poultry production, animal breeding, animal health.
- Plant disease diagnostics.
- Nanodevices for the plants' genetic engineering.
- Nanosensors' application in crop protection to identify the diseases and residues of the agrochemicals.
- The nanoformulations of the agrochemicals to apply fertilizers and pesticides to improve crops.

8 NANO UREA

CONTEXT: Nano-urea, a product developed by the Indian Farmers and Fertiliser Cooperative (IFFCO) and heavily advertised by government as panacea to reduce farmer dependence on packaged urea is yet to be fully tested despite having been fast tracked for commercial application.

NanoUrea:

- Nano Urea is a game-changing agricultural input using nanotechnology to deliver nitrogen to plants.
- It's a sustainable option, reducing traditional urea use by 50%. With 4% nanoscale nitrogen particles, it's highly efficient, boosting crop health and yield.

Benefits of Nano urea:

- Benefits include balanced soil nutrition, reduced pollution, and an 8% crop yield increase, making it a cost-effective and eco-friendly choice for farmers.
- One bottle can replace a 45kg urea sack.
- It will **encourage balanced soil nutrition** by cutting off the excessive use of traditional urea and making plants healthier, stronger, and safeguarding them from the effect of lodging.
- Nano urea is a great alternative to traditional urea.
- It can **cut down urea requirement by a whopping 50%.**
- A 500 ml bottle of nano urea features **40,000 ppm (parts per million) of Nitrogen**.
- This will **cut down logistics and warehousing cost**
- Nano urea promises to **decrease pollution of soil, water, and air,** at the same time, address the issue of global warming.

9 WINGED MICROCHIP

CONTEXT: Northwestern University engineers have created the smallest-ever human-made flying structure in the form of a winged microchip, drawing inspiration from the film "Ant-Man."

About

- The "microflier" is approximately the size of a grain of sand and far smaller than an ordinary ant.

- It **doesn't have a motor or an engine**, instead catching flight with the wind and a propeller, much like a helicopter.
- The microflier structures are designed to accommodate miniature technology such as sensors, power supplies, wireless communication antennae, and memory data.

10 NANOROBOTICS

CONTEXT: Nanorobotics is an interdisciplinary field that has the potential to revolutionize a wide range of industries.

What is Nanorobotics?

- Nanorobotics refers to the emerging field of science and technology that deals with the design, development and control of robots at the nanoscale.
- The nanoscale includes the size range of **1 to 100 nanometers**, where one nanometer (nm) is equal to one billionth of a meter.
- Since nanorobots are robots built to operate at the nanoscale, they could perform tasks that are beyond the capabilities of conventional macro-scale robots.
- Nanorobots would have unique properties and capabilities that allow them to control and manipulate materials at the nanoscale, which would make them highly valuable for a wide range of applications and industries.

Applications of Nanorobotics

- Improved Medical Treatments
- Environmental Cleanup
- Enhanced Manufacturing
- Increased Scientific Knowledge
- Advancements in Materials Science
- Space Exploration

11 NANOTECHNOLOGY IN HEALTHCARE

CONTEXT: Nanotechnology, once known to be the stuff of science fiction, has become a prominent concept in healthcare.

Application of nanotechnology in the field of healthcare diagnostics.

- Nanotechnology enhances healthcare diagnostics by improving sensitivity to detect low biomarker concentrations, enabling early disease detection before symptoms arise.
- It enables portable, rapid testing at point-of-care, especially in remote areas, and facilitates non-invasive techniques for patient comfort.
- Nanoparticles act as contrast agents in medical imaging, enhancing sensitivity and accuracy.
- Nanoscale materials and structures have high surface area-to-volume ratios, which

Application

- Gold nanoparticle-based probes detect targeted gene therapies.
- Gold nanoparticles treat cancer and other diseases.
- Improved diagnostic and imaging tools.
- Advanced nanopore materials allow high-throughput single-molecule detection and gene sequencing.
- Nanocapsules deliver drugs for improved cancer treatment with fewer side effects.
- Regenerative medicine, including neural and bone tissue engineering.
- Graphene nanoribbons aid spinal injury treatment and regeneration.
- mRNA carriers in vaccines and needle-free vaccine delivery.
- Drug carriers and smart pills monitor and treat specific diseases with tailored functions.
- **Fluorescent nanoclusters:** They have been developed to target leukemic cells in the blood so that a tiny bit of blood is adequate to detect leukemic cells in the blood samples.

12 NANOMICELLES: USING NANOPARTICLES FOR CANCER TREATMENT'

CONTEXT: With the advance in nanotechnology, researchers across the globe have been exploring how to use nanoparticles for efficient drug delivery. Now researchers have created a nanomicelle that can be used to deliver a drug named docetaxel, which is commonly used to treat various cancers including breast, colon and lung cancer.

About

- Nanomicelles, like nanoshells and nanovesicles, are tiny structures used in targeted therapy. They resemble globes with a hydrophilic outer shell and a hydrophobic interior.
- Their dual property makes them ideal carriers for drugs. Less than 100nm in size, they remain stable at room temperature.

- Injected intravenously, they can penetrate solid tumors with leaky blood vessels, aiding drug delivery.

Advantages

- Nanomicelles offer many advantages, including
  - small size (10–50 nm)
  - structural stability
  - less toxicity
  - ability to entrap large amounts of hydrophobic drugs/contrast agent and solubilize in water
  - conjugation with target ligand and stimuli-sensitive regions

13 NANOTECH TATTOO AS HEALTH MONITORING DEVICE

CONTEXT: Researchers in South Korea have developed an electronic tattoo ink made of liquid metal and carbon nanotubes that functions as a bio-electrode.

About:

- The device could be used to send readout of the wearer's vital signs if connected to biosensors, including for instance an electrocardiogram.
- Alongside heart rates it could be used to read glucose or lactate levels for people with diabetes or sepsis.
- The monitors could in theory be located anywhere, including in patients' homes.

The Electronic Tattoo:

- The electronic tattoo ink is made of liquid metal and carbon nanotubes that can deliver vital body information.
- The ink is non-invasive and made from particles based on gallium, a soft, silvery metal also used in semiconductors or in thermometers.
- Platinum-decorated carbon nanotubes help conduct electricity while providing durability.
- When it is applied to the skin, even with rubbing the tattoo doesn't come off, this is not possible with just liquid metal.

14 NANOTECHNOLOGY IN ELECTRONICS

CONTEXT: Nanotechnology in Electronic Devices has the potential to change a wide range of electronic goods.

Application

- **Nano-RAM:** It is a non-volatile RAM (Random Access Memory) based on carbon nanotubes deposited on a chip-like substrate. Its small size permits very high-density memories.
- **Nano optomechanical SRAM (Static RAM):** This shows faster read/write time as compared to a MEMS memory. Also, the processes take place without interference which further reduces time when compared to a traditional electrical enabled SRAM.
- **Printed Electronics:** Nanotechnology finds application in printed electronics for RFID, smart cards, and smart packaging. It also serves the purpose of realistic video games and flexible displays for e-books.
- **Magnetic RAM:** It is enabled by nanometer-scale magnetic tunnel junctions. Also, it can keep even encrypted data following a system shutdown or crash. This enables resume play functionality.

PRACTICE QUESTION

1. Consider the following statements regarding 'Dark Pattern':

1. Dark patterns are manipulative design tactics used in digital interfaces to guide users into making decisions that benefit the organization.
2. False urgency, basket sneaking, confirm shaming are examples of dark patterns.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

2. Consider the following statements regarding 'nanoparticles' present in environment:

1. They are ubiquitous in the atmosphere.
2. Higher concentrations of nanoparticles decreases solar radiation, causing a warm effect on climate.
3. Long exposures to high concentrations of nanoparticles brings a number of adverse health effects such as lung problems, and cardiovascular disease.
4. There are currently no air quality regulations in any part of the world to control exposure to nanoparticles.

How many of the statements given above are correct?

(a) Only one

(b) Only two

(c) Only three

(d) All four

3. With reference to the Nanophotonic electron accelerator (NEA), recently seen in news, consider the following statements:

1. It is a cutting-edge device that consists of a miniature microchip.
2. It relies on more than 9,000 magnets to create a magnetic field for particle acceleration.
3. Electrons accelerated by the NEA have substantially less energy than electrons accelerated by major colliders such as the Large Hadron Collider (LHC).

How many of the statements given above are correct?

(a) Only one

(b) Only two

(c) All three

(d) None

4. What isotope is primarily used in carbon dating methods?

(a) Carbon-12

(b) Carbon-13

(c) Carbon-14

(d) Carbon-16

ANSWERS				
1. (c)	2. (c)	3. (b)	4. (c)	

CHAPTER 03

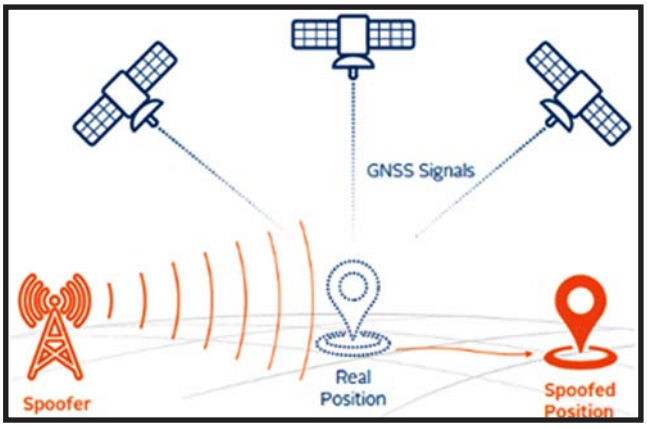
IT & TELECOMMUNICATION

1 GLOBAL POSITIONING SYSTEM (GPS) SPOOFING

CONTEXT: A committee has been established by the Directorate General of Civil Aviation (DGCA) to keep an eye on GNSS (Global Navigation Satellite System) spoofing in Indian airspace.

What is GPS spoofing?

- An attempt to alter the initial location of a GPS-enabled device is known as **GPS spoofing.**
- GPS spoofing sends **false data** to a receiver to divert traffic, goods, or people with falsified information.



- **How is it done?** GPS spoofing involves a radio transmitter near a target that interferes with the actual GPS signals being transmitted.
  - GPS signals are often weak and transmitted through satellites.
  - A stronger radio transmitter can be used to override the weaker signal and send illegitimate coordinates and information to the receiver.
  - GPS spoofing can then send people off course or say that someone is somewhere that they are not.

GPS System

- GPS is one of the global navigation satellite systems (GNSS) used in the world.
- Along with delivering location information, it is also used to keep accurate time.
- These functions can also be disrupted through spoofing or jamming.

Not the same as GPS jamming

- Spoofing is completely different from jamming and much more dangerous.
- As the name suggests, jamming is when the GPS signals are interfered with.
- While planes and other aircraft frequently deal with jamming, spoofing like the recent instances in Iran is reportedly unheard of.
- Compared to GPS jamming, spoofing is more difficult to detect.

Harms of GPS spoofing

- Misdirecting cargo shipments to alternate locations to steal the shipments
- Hijacking a boat for piracy purposes
- Interfering with GPS at airports
- Misdirecting cars
- Disrupting the universal time source
- Disrupting services through mobile apps and websites

2 COUNTRY'S INDIGENOUS MOBILE OPERATING SYSTEM BHAROS

CONTEXT: The Ministry for Communications, Electronics and Information Technology tested 'BharOS', the recently-unveiled indigenous operating system developed by the Indian Institute of Technology, Madras (IIT).

What is BharOS?

- BharOS is India's first homegrown mobile operating system.
- It is Linux kernel-based operating system that is designed to be secure and powerful.
- **Developed by:** The BharOS was developed by JandK Operations Private Limited (JandKops), which has been incubated by IIT Madras Pravartak Technologies Foundation, a Section 8 (Not for Profit) Company established by IIT Madras.

Important Features:

Key features of the new made-in-India OS:

- **No default apps:** BharOS does not include any bloatware or default apps, giving users more storage space. Without any default apps, users are also not forced to use any app they may not trust.
- **NOTA updates:** BharOS offers "Native over the Air" (NOTA) updates, similar to Android, which means the software updates, will be automatically downloaded and installed on the device.
- **Access to PASS:** The new OS will also provide access to **Private App Store Services (PASS),** which offer trusted apps from specific organisations.

A PASS provides access to a curated list of apps that have been thoroughly vetted and have met certain security and privacy standards of organisations. This means users can be confident that the apps they are installing are safe to use and have been checked for any potential security vulnerabilities or privacy concerns

COMPARISON OF BHAROS & ANDROID

SIMILARITY	DIFFERENCE
Technically, BharOS is very similar to Android because they share the same basics. Because BharOS uses **AOSP or Android Open Source Project**, the functionalities and the methodologies both OS use are essentially the same.	BharOS is free from Google Services and Apps. Google has used its preinstalled apps and services to collect data, sometimes without explicitly asking a user. Similarly, other apps from Google's PlayStore share data with third-party services. BharOS does not come with any

3 LIDAR TECHNOLOGY

CONTEXT: Ministry of Environment, Forest, and Climate Change released the Detailed Project Reports (DPRs) of LiDAR-based survey of forest areas in ten states namely Assam, Bihar, Chhatisgarh, Goa, Jharkhand, Madhya Pradesh, Maharashtra, Manipur, Nagaland, and Tripura.

What is Lidar technology?

- Lidar — **Light Detection and Ranging** — is a **remote sensing method** used to **examine the surface of the Earth.**
- It uses light in the form of a **pulsed laser** to measure **ranges (variable distances)** to the Earth.
- These light pulses—combined with other data recorded by the **airborne system** — generate precise, **three-dimensional information** about the shape of the Earth and its surface characteristics.
- Lidar systems allow scientists and mapping professionals to examine both natural and manmade environments with accuracy, precision, and flexibility.

Applications of LiDAR:

- Land Surveying
- Power Line Inspection for Maintenance
- Forestry and Farming survey
- Mining Application
- Transportation Expansion

4 OVER-THE-TOP (OTT) SERVICE PROVIDERS

CONTEXT: Public service broadcaster, Prasar Bharati has inked a Memorandum of Understanding (MoU) with YuppTV, an over-the-top (OTT) platform, which will act as gateway for Doordarshan viewers across the globe.

OTT

- OTT, or "over-the-top," refers to streaming content directly to customers over the internet.
- This includes video-on-demand, audio streaming, and messaging services, bypassing traditional distribution channels.
- DD India, Prasar Bharati's international channel, serves as India's global window, reaching over 190 countries and connecting with the Indian diaspora.
- With DD India now available on Yupp TV's OTT platform in several countries, it amplifies India's perspective on international developments.

5 KESSLER SYNDROME

CONTEXT: Kessler syndrome and space debris are posing threat for the humans.

About:

- The Kessler Syndrome is a phenomenon in which the amount of junk in orbit around Earth reaches a point where it just creates more and more space debris, causing big problems for satellites, astronauts and mission planners.
- Simply put, it is a theoretical scenario in which Earth's orbit is overpopulated with objects and debris, preventing the use of satellites in certain sections of Earth's orbit.
- **Donald J Kessler**, a NASA scientist gave the term.

6 HYPERLOOP SYSTEM

CONTEXT: NITI Aayog is working to finalising a report on technological and commercial feasibility for adoption of Hyperloop Technology in India.

What is hyper loop system?

- The Hyperloop is a proposed form of high-speed ground transportation currently under development. It can be designed for passenger and freight transport, with speed capabilities expected to surpass all existing forms of transport.
- Hyperloop is capable of connecting different city centers in quite the same way a metro rail system connects major stops within a city.

How does it work?

- **Composition:** The hyperloop system consists of a **network of tubes**, connecting mobility hubs, with pods traveling at **ultra-high speeds** in a vacuum.
- **Benefits:**
  - The low-pressure environment ensures **energy-efficient operation** thanks to low **aerodynamic drag.**
  - **Contactless magnetic levitation** and propulsion systems enable a comfortable and silent passenger experience.
  - Hyperloop combines the key benefits of **speed and flexibility, comfort and safety as well as sustainability.**

7 VIRTUAL PRIVATE NETWORK (VPN)

CONTEXT: Virtual private network (VPN) service providers are up in arms against a new directive of The Indian Computer Emergency Response Team or Cert-In that mandates they must maintain all customer data for five years.

What Is A VPN?

- A VPN, or Virtual Private Network, creates a secure private network from a public internet connection.
- It hides your IP address, encrypts your data, and masks your online activities, protecting you from hackers and cybercriminals, especially on public Wi-Fi networks.
- By rerouting your connection through its servers worldwide, a VPN makes it nearly impossible for third parties to track your online activities and steal your data.

8 PARAM PORUL

CONTEXT: PARAM PORUL, a state-of-the art Supercomputer at NIT Tiruchirappalli under National Supercomputing Mission (NSM) was inaugurated.

Key-highlights

- PARAM PORUL supercomputing facility is established under **Phase 2 of the NSM**.
- Majority of the components have been manufactured and assembled within the country, along with an indigenous software stack developed by C-DAC, in line with the Make in India initiative.

What are the Features of PARAM PORUL?

Supercomputer

- A supercomputer is a computer with a high level of performance compared to a general-purpose computer.

- **FLOPs (Floating point operations per second)** measure the supercomputer's performance, which is very high compared to the speed of general-purpose computers

- **PARAM PORUL system** is equipped with a mix of **CPU (Central Processing Unit) nodes, GPU (Graphics Processing Unit) nodes, High Memory nodes, High throughput storage and high-performance InfiniBand interconnect** to cater the computing needs of various scientific and engineering applications.
- This system is based on **Direct Contact Liquid Cooling technology** to obtain a high-power usage effectiveness and thereby reducing the operational cost.
- Multiple applications from various scientific domains such as **Weather and Climate, Bioinformatics, Computational Chemistry, Molecular Dynamics, Material Sciences, Computational Fluid Dynamics** etc. have been installed on the system for the benefit of researchers.

National Supercomputing Mission (NSM)

- The National Supercomputing Mission (NSM) is being steered jointly **by Ministry of Electronics & Information Technology (MeiTY)** and the **Department of Science and Technology (DST).**
- It is being implemented by **Centre for Development of Advanced Computing (C-DAC)** and **Indian Institute of Science (IISc),** Bangalore.

9 PARAM GANGA

CONTEXT: Recently, a Made in India Petascale Supercomputer "PARAM Ganga" has been installed at IIT Roorkee.

About "PARAM Ganga":

The new system, designed and commissioned by the Centre for Development of Advanced Computing (C-DAC) under the auspices of the NSM, will offer 1.66 (presumably peak) petaflops.

- **Urban Modelling**: Science Based Decision Support Framework to Address Urban Environment Issues (Meteorology, Hydrology, Air Quality).
- Flood Early Warning and Prediction System for River Basins of India.
- HPC Software Suite for Seismic Imaging to aid Oil and Gas Exploration.
- **MPPLAB:** Telecom Network Optimization.

India's fastest Supercomputers:

- As of June 2021 there are 3 systems based in India on the TOP500 supercomputer list.

RANK	SITE	NAME
89	Centre for Development of Advanced Computing	PARAM Siddhi-AI
107	Indian Institute of Tropical Meteorology	Pratyush (Cray XC40)
187	National Centre for Medium Range Weather Forecasting	Mihir (Cray XC40)

10 PARAM ANANTA

CONTEXT: PARAM ANANTA Supercomputer was commissioned in 2022 at IIT Gandhinagar.

About:

- PARAM ANANTA supercomputing facility is established under **Phase 2 of the National Supercomputing Mission (NSM)** - a joint initiative of Ministry of Electronics and Information Technology (MeitY) and Department of Science and Technology (DST).
- It is an 838 **TeraFlops Supercomputing Facility** and is based on **Direct Contact Liquid Cooling technology**.
- Under NSM, till date 15 supercomputers have been installed across the nation with aggregate compute capacity of 24 petaflops.
- All these supercomputers have been manufactured in India and operating on indigenously developed software stack developed **by Centre for Development in Advanced Computing (C-DAC).**

11 TRUE RANDOM NUMBER GENERATOR (TRNG)

CONTEXT: A team at the Department of Electrical Communication Engineering (ECE), Indian Institute of Science (IISc) has developed a true random number generator (TRNG).

About the Technology:

- A **true random number generator (TRNG),** also known as a ***hardware random number generator*** **(HRNG),** uses

an **external unpredictable physical variable** such as **radioactive decay of isotopes** or airwave static to generate random numbers.

- Similarly, subatomic particles are also ideal variables of an unpredictable system since they exhibit truly and completely random behavior, also known as *pure randomness*.
- This can improve data encryption and provide improved security for sensitive digital data such as credit card details, passwords and other personal information.

Random numbers

- Random numbers are a core component of the internet, computing and any application that involves data security and integrity.
- The numbers, to put it simplistically, create a cryptographic lock – the less predictable (more random) these numbers are, the more secure the encryption becomes.

12 FIBERISATION

CONTEXT: The government launched a new 5G RoW application 'form' on GatiShakti Sanchar Portal to enable faster 5G roll-out in India.

What is required for 5G roll-out?

- 5G roll-out requires 'fiberisation', however, currently, **only 35% of the mobile towers are fiberized.**
- The process of connecting radio towers with each other via optical fibre cables is called **fiberisation**.
- It helps provide full utilisation of network capacity, and carry large amounts of data once 5G services are rolled out.

GatiSakti Sanchar Portal

- **GatiSakti Sanchar Portal** was launched for the development of infrastructure services in an integrated manner.
- The IT systems of all States/UTs and major infrastructure central ministries such as Railway, Highways have been integrated with the portal to make India ready for 5G launch.

13 CRYPTOJACKING

CONTEXT: Cryptojacking attacks on computer systems have gone up by 30% to 66.7 million in the first half of 2022 compared to the first half of last year, according to a report.

What is Cryptojacking?

- Cryptojacking is a cyber-attack wherein a computing device is hijacked and controlled by the attacker, and its resources are used to illicitly mine cryptocurrency.
- In most cases, the malicious programme is installed when the user clicks on an unsafe link, or visits an infected website — and unknowingly provides access to their Internet-connected device.
- **Why crypto jacking is done?** Cryptojackers co-opt devices, servers, and cloud infrastructure, and use their resources for mining. The use of 'stolen' or cryptojacked resources slashes the cost involved in mining.

14 PROOF-OF-STAKE TECHNOLOGY

CONTEXT: Proof of stake is a consensus mechanism used to verify new cryptocurrency transactions. Since blockchains lack any centralized governing authorities, proof of stake is a method to guarantee that data saved on the network is valid.

What Is Proof-of-Stake (PoS)?

- Proof-of-Stake (PoS) is a cryptocurrency consensus mechanism that validates transactions and creates new blocks in a blockchain.
- It was created as an alternative to Proof-of-Work (PoW), requiring validators to hold and stake tokens instead of solving cryptographic puzzles.
- PoS reduces computational work, as validators are randomly selected to validate blocks.
- It aims to make attacks less advantageous and offers a more secure and efficient blockchain validation process.

15 QUANTUM INTERNET

CONTEXT: While much progressive is not what India has done in the field of quantum tech yet, it is better late than never. India's willingness to be at par with other technologically advanced countries can be seen via the announcement of the National Mission for Quantum Technologies and Applications (NM-QTA).

About Quantum Technology:

- Quantum Technology, rooted in Quantum mechanics, aims to harness quantum properties for technological advancements. Its first phase yielded breakthroughs like lasers.

- Currently, a new phase focuses on quantum computing. China leads in R&D, achieving milestones like quantum satellites and computers.
- In India, quantum technology R&D is limited, with fewer researchers and industry focus. This highlights the disparity in quantum technology development between the two countries.

16 QUANTUM NETWORK

CONTEXT: IBM's Quantum Network aims to advance quantum computing skills and research in India.

About:

- Quantum computing is a **rapidly-emerging technology** that harnesses the laws of quantum mechanics to solve problems too complex for classical computers.
- Quantum networks form an important **element of quantum computing and quantum communication systems.**
- Quantum networks facilitate the transmission of information in the form of quantum bits, also called qubits, between physically separated quantum processors.
- A quantum processor is a small quantum computer being able to perform quantum logic gates on a certain number of qubits.
- Quantum networks work in a similar way to classical networks.
- The main difference is that quantum networking, like quantum computing, is better at solving certain problems, such as modelling quantum systems.

17 QUANTUM ENTANGLEMENT

CONTEXT: The term Quantum Entanglement is seen in the news recently in relation to the Nobel prize awards 2022.

About:

- Quantum entanglement is a key resource in quantum technology, and its quantification is a vital task in the current noisy intermediate-scale quantum (NISQ) era.
- This paper combines hybrid quantum-classical computation and quasi-probability decomposition to propose two variational quantum algorithms, called **variational entanglement detection (VED) and variational logarithmic negativity estimation (VLNE),** for detecting and quantifying entanglement on near-term quantum devices, respectively.
- VED makes use of the positive map criterion and works as follows. Firstly, it decomposes a positive map into a combination of quantum operations implementable on near-term quantum devices.
- It then variationally estimates the minimal eigenvalue of the final state, obtained by executing these implementable operations on the target state and averaging the output states.

Quantum entanglement, the most **non-classical manifestation** of **quantum mechanics**, has been identified as invaluable resource enabling a tremendous number of tasks ranging from **quantum information processing, quantum cryptography, quantum algorithms, quantum communication**, to measurement-based quantum computing.

18 GLOBAL LIGHTHOUSE NETWORK (GLN)

CONTEXT: Hindustan Unilever Limited (HUL) has joined the Lighthouse Network with its Dapada facility, which produces home care products such as Surf Excel, Rin, and Vim.

- The first FMCG production facility in India to receive this designation.

Key-highlights

- HUL's Dapada unit became the 1st FMCG factory in India to be recognised as an 'Advanced 4th Industrial Revolution Lighthouse'.
- **Fourth Industrial Revolution:** The fourth industrial revolution is conceptualized as an upgrade on the third revolution and is marked by a fusion of technologies straddling the physical, digital and biological worlds.

Centre of Fourth Industrial Revolution (C4IR):

- Recently, the **World Economic Forum (WEF)** chose Hyderabad, Telangana for establishing its **Center for the Fourth Industrial Revolution (C4IR).**
- C4IR Telangana is the **18th centre** to join the World Economic Forum's Fourth Industrial Revolution (C4IR) Network, which is **spread in four continents.**
- It will be an **autonomous non-profit organization** that will focus on healthcare and life sciences**.**
  - The **Centre for the Fourth Industrial Revolution in India (C4IR)** was established in October 2018 to focus on the role of emerging technologies across different sectors and to plug the challenges that will emanate from Fourth Industrial Revolution.

What is Global Lighthouse Network?

- **Launched in:** 2018
- It is a community of manufacturing sites recognised by the **World Economic Forum (WEF)** for applying advanced technologies, innovations, and sustainable practices to modernise business operations.
- The Network includes sites that have implemented **end-to-end digitisation** across the value chain, pushing the boundaries of technological advancement.
- These revolutionary technologies result in reduced manufacturing **cost, greater agility, and speed.**

Interesting Fact:

- **Tata steel Kalinganagar TSK** is the **first Indian manufacturing plant** to be included in the WEF's Lighthouse Network.
- They serve as beacons to guide others to overcome challenges in upgrading systems and **applying cutting-edge technologies such as artificial intelligence, big data analytics and 3D printing.**

19 YOTTA D1

CONTEXT: North India's first hyperscale data centre 'Yotta D1' has been recently inaugurated in Greater Noida.

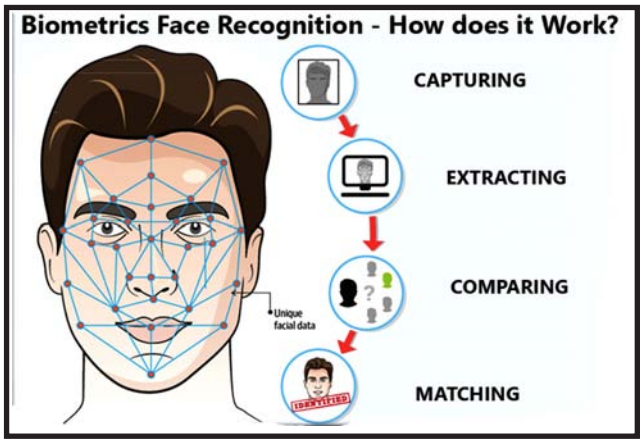
About YOTTA D1:

- Yotta D1 is **North India's first hyperscale data centre.**
- **Located in:** Greater Noida, UP
- **Built by**: Yotta Infrastructure, part of Hiranandani Group
- The data centre is spread across 20 acres and will offer a total capacity of 30,000 racks, 4 dedicated fiber paths and an IT power capacity of 160 MW.
- **Purpose:** It will cater to the full spectrum of digital transformation needs with an elaborate portfolio of solutions that include data center colocation services, network and connectivity, internet peering, IT security and smart cybersecurity and a host of application modernisation and cloud-enabled services.
- **Significance:** This data centre will increase the data storage capacity of the country, which until now stood at 2% only despite the fact that 1.5 billion mobile phones and **650 million internet users** in the world are from India using 20 percent of data.

20 FACIAL RECOGNITION TECHNOLOGY

CONTEXT: Right to Information (RTI) responses, reveals that the Delhi Police treats matches of above 80% similarity generated by its facial recognition technology (FRT) system as positive results.

What is facial recognition technology (FRT) system?



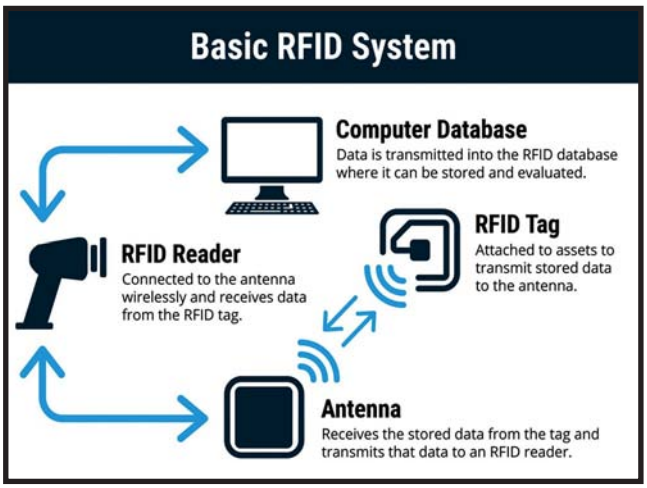
- Facial recognition is an **algorithm-based technology** that creates a digital map of the face by identifying and mapping an individual's facial features, which it then matches against the database to which it has access.
- It is a **biometric technology** that uses distinctive features of the face to identify and distinguish an individual.
- It has evolved in many ways- from looking at the 3D contours of a face to recognizing skin patterns.

21 RADIO FREQUENCY IDENTIFICATION (RFID)

CONTEXT: Baggage tags equipped with radio-frequency identification (RFID) will soon be available at Delhi's Indira Gandhi International Airport, marking a first of its kind for the country.

About the Technology:

- Radio Frequency Identification (RFID) is a technology that uses radio waves to passively identify a tagged object.
- It is used in several commercial and industrial applications, from tracking items along a supply chain to keeping track of items checked out of a library.



- Radio Frequency Identification (RFID) is a type of passive wireless technology that allows for tracking or matching of an item or individual.
- The three components of an RFID system are:
  - Transponder,
  - receiver, and
  - transmitter
- The system has two basic parts: **tags and readers.**
- The reader gives off radio waves and gets signals back from the RFID tag, while the tag uses radio waves to communicate its identity and other information.

22 DOXXING

CONTEXT: Twitter has suspended the account of several journalists in the United States, and according to its owner Elon Musk, this was in continuation of the social media platform's new anti-doxxing policy.

What is Doxxing?

- Doxxing is basically the **revealing of someone's intimate information**, where **harassment** is the intent.
- It is a popular and controversial tactic used against those with opposing political views and sometimes even celebrities and influencers have been doxxed with real-life consequences.
- In many cases, harassers have used this private information to send **SWAT teams** or armed police to the homes of many of the victims.
- This private information includes one's address, phone number, financial information, etc.
- But some have argued that journalistic reports — especially on those running popular but anonymous accounts on social media — are **examples of doxxing** as well, which is not the case.

The policy goes on to describe revealing what information would be considered doxxing. This includes:

- Identity documents, including government-issued IDs and social security or other national identity numbers;
- Contact information, including non-public personal phone numbers or email addresses;
- Financial account information, including bank account and credit card details;
- Other private information, including biometric data or medical records;
- Media of private individuals without the permission of the person(s) depicted.

23 VARIABLE REFRESH RATES (VRR)

CONTEXT: Google is said to be testing support for variable refresh rates (VRR) in the Chrome OS 101 Dev Channel, according to a report by About Chromebooks. The feature could improve gaming experience on Chromebooks.

About:

- Refresh rate is the number of times a display is capable of refreshing in a second.
- It is measured in **hertz (Hz).** So, a 30 Hz or a 60 Hz display can refresh 30 or 60 times per second, respectively. The higher the refresh rate, the better the quality of viewing experience.
- Displays with over 120 Hz can deliver a smoother and more comfortable viewing experience. This is necessary while playing video games or watching videos.
- VRR supports a wide range of refresh rates, allowing its refresh rate to change in real-time based on the **frames-per-second (FPS) rate** coming from a source device such as a gaming console.
- VRR is also termed as dynamic refresh rate or adaptive refresh rate by different device makers.
- VRR is designed to eliminate syncing issues that arise when the refresh rate of a display does not match with the FPS of the content from a source device. Issues such as screen-tearing, judder (wobbling effect) and lag are common when refresh rate and FPS are not synchronised.

24 5G VERTICAL ENGAGEMENT AND PARTNERSHIP PROGRAM (VEPP)

CONTEXT: The Department of Telecommunications (DoT) invites Expression of Interest (EoI) for "5G Vertical Engagement and Partnership Program (VEPP)"initiative to build strong collaboration partnerships across 5G Use-case ecosystem stakeholders with velocity and with an exclusive emphasis to address User/Vertical Industry needs.

About:

- **5G Vertical Engagement and Partnership Program** is being offered to Industry verticals which have potential as testing cum breeding grounds for **innovative 5G use cases**, through an Expression of Interest (EoI) to enable close collaboration between User vertical sand 5G Tech stakeholders (Service providers, Solution providers & partner OEMs), which can trigger a multiplier effect to try & fine tune 5G digital solutions in respective economic verticals.

25 L-ROOT SERVER

CONTEXT: Rajasthan has become the first state in the country to get the L-root server.

About:

- A root name server is a name server for the root zone of the Domain Name System (DNS) of the Internet.
- Root servers, or DNS root servers, are name servers that are responsible for the functionality of the DNS as well as the entire Internet.

- With seamless internet connectivity, this server will assist the State government in providing its **flagship digital services (e-Mitra, Jan Aadhaar Yojana, Jan Kalyan portal, Jan Soochna portal) and enforcing e-governance.**
- This new facility will be strengthening the internet infrastructure of the state and will also help in improving the resilience and security of all internet-based operations.
- With this newly installed root server, for the domain name system, the state will no longer be reliant on any root server.
- Now if any problem occurs in internet connectivity due to any natural calamity or technical glitch in the whole of India or even Asia, the state of Rajasthan will be able to access the internet without any interruption.

Currently, there are **three J-root servers** deployed in **Mumbai, New Delhi, and Gorakhpur** and two L-root servers deployed in *Kolkata and Mumbai*. The L-root server installed in Rajasthan is the first one that has been deployed at the State level.

26 ARTIFICIAL INTELLIGENCE (AI) CHIPS

CONTEXT: Intel launched new Artificial Intelligence (AI) chips to provide customers with deep learning compute choices for training and inferencing in data centres.

What are AI Chips?

- AI chips are built with specific architecture and have integrated **AI** acceleration to support deep learning-based applications.
- AI chips help turn data into information and then into knowledge.

Types of AI chips:

There are different types of AI chips such as:

- Application-specific integrated circuits (ASICs),
- Field-programmable gate arrays (FPGAs),
- Central processing units (CPUs) and
- GPUs

- The Worldwide AI chip industry accounted for $8.02 billion in 2020 and is expected to reach $194.9 billion by 2030, growing at a compound annual growth rate (CAGR) of 37.4% from 2021 to 2030.
- The increasing adoption of AI chips is one of the major factors driving the growth of the market.

Applications:

- **Computer vision:** Some of these chips **support in-vehicle computers** to run state-of-the-art AI applications more efficiently.
- **Robotics:** AI chips are also powering applications of **computational imaging in wearable electronics, drones, and robots**.
- **Natural language processing (NLP):**
  - The use of AI chips for NLP applications has increased due to the rise in demand for chatbots and online channels such as Messenger, Slack, and others.
  - They use NLP to analyse user messages and conversational logic.

- **Used for network security** across a wide variety of sectors, including automotive, IT, healthcare, and retail.
- AI processors with on-chip hardware acceleration are designed to help customers **achieve business insights at scale** across banking, finance, trading, insurance applications and customer interactions.

27 METAVERSE

CONTEXT: The telecom regular TRAI has red-flagged concerns around Metaverse, raising critical issues such as privacy, safety, and security which require greater deliberation.

What is Metaverse?

- The metaverse is the emerging **3-D-enabled digital space** that uses virtual reality, augmented reality, and other advanced internet and semiconductor technology to allow people to have lifelike personal and business experiences online.
- At its most basic, the metaverse will have three features:
  - a sense of immersion
  - real-time interactivity
  - user agency
- And ultimately, the full vision of the metaverse will include the following:
  - platforms and devices that work seamlessly with each other
  - the possibility for thousands of people to interact simultaneously
  - use cases well beyond gaming

28 NEAR FIELD COMMUNICATION (NFC)

CONTEXT: Google Pay launched a new feature in India, 'Tap to pay for UPI', in collaboration with Pine Labs.

- The feature makes use of **Near Field Communication (NFC) technology**.

What Is Near-Field Communication?

- Near-field communication (NFC) is **a short-range wireless technology** that makes smartphone, tablet, wearables, payment cards, and other devices even smarter.
- NFC is the ultimate in connectivity.
- With NFC, one can transfer information between devices quickly and easily with a single touch, whether **paying bills, exchanging business cards, downloading coupons, or sharing a research paper.**
- NFC technology can operate in one of three primary modes: reader/writer, peer-to-peer, or card emulation.

29 QR CODES

CONTEXT: A surge in UPI-related scams, including QR code scams, has emerged.

What is a QR code?

- QR Code (**Quick Response Code)** is a technique of storing information or data so that computers can understand it easily and also can be scanned by utilising QR code scanners to fetch the data.
- These QR codes are widely used for UPT payment methods.
- So, technically QR code is a **monochromatic matrix** with embedded data that is used in manufacturing industries in order to label the products.
- Nowadays QR codes are being used for payments in UPI-based apps, some chatting apps like **WhatsApp, and in the play store.**

30 D2M TECHNOLOGY

CONTEXT: The Department of Telecommunications (DoT) and India's public service broadcaster Prasar Bharati are exploring the feasibility of a technology that allows broadcasting video and other forms of multimedia content directly to mobile phones, without needing an active internet connection.

Direct-to-Mobile (D2M) broadcasting:

- The technology is based on the **convergence of broadband and broadcast**, using which mobile phones can receive terrestrial digital TV.
- It would be similar to how people listen to FM radio on their phones, where a receiver within the phone can tap into radio frequencies.
- Using **D2M**, multimedia content can also be beamed to phones directly.

31 CRYSXPP

CONTEXT: Recently, Researchers from IIT Kharagpur in collaboration with the Indo-Korea Science and Technology Center (IKST) have developed a method called CrysXPP to predict the properties of crystalline materials through machine learning.

About:

- **CrysXPP:** It is a machine learning system that enables rapid prediction of various material properties with high precision.
- **Machine learning:** is a type of artificial intelligence (AI) that allows software applications to become more accurate at predicting outcomes without being explicitly programmed to do so.
  - Machine learning algorithms use historical data as input to predict new output values.

Applications:

- Recommendation engines are a common use case for machine learning.
- Other popular uses include fraud detection, spam filtering, malware threat detection, business process automation (BPA) and Predictive maintenance.

32 HERMIT

CONTEXT: The most recent sophisticated malware to make headlines is "Hermit," and it's thought to have targeted Android and iPhone devices in Italy and Kazakhstan.

- The Lookout, a Cybersecurity company based in San Francisco, was the first to discover Hermit's deployment.
- The spyware was created by an **Italian vendor** named **RCS Lab.**

What is a Hermit and how does it affect?

- Hermit is **spyware** similar to **NSO Group's Pegasus.**
- Once installed, it has the ability to **make unauthorized calls, record audio on the device, and perform a variety of other unauthorized tasks.**
- The spyware is capable of **stealing** contacts, calendar events, bookmarks and searches from saved account emails.
- Additionally, it has the ability to snap photographs of the device, steal data such as information about the **kernel, model, manufacturer, OS, security patch, phone number, etc.**
- On a hijacked phone, it may also download and install **APK files**, which are the **programme software files for Android.**
- The spyware can also read notifications, upload files from the device, and take screenshots of the display.

33 VYOMMITRA

CONTEXT: Before orbiting astronauts on India's first manned mission to space in December 2021, the Indian Space Research Organisation will send 'Vyom Mitra', a 'lady robot' in the unmanned Gaganyaan spacecraft.

About:

- Vyom Mitra is **half-humanoid** and her body stops at the torso and has no legs.

Significant features:

- Capable of switching panel operations, performing **Environment Control and Life Support Systems (ECLSS) functions**, conversations with the astronauts, recognising them and solving their queries.
- can detect and give out warnings if the environment changes within the cabin.
- The humanoid has been developed by the **ISRO Inertial Systems Unit**, Thiruvananthapuram.

34 VERY LARGE-SCALE INTEGRATION (VLSI)

CONTEXT: With the rise of development in the IT sector and technology, VLSI devices came into existence. The microprocessor, memory chip, integrated circuit, etc., are some examples of Very Large Scale Integration.

What Does Very Large-Scale Integration (VLSI) Mean?

- Very large-scale integration (VLSI) is **the process of integrating or embedding hundreds of thousands of transistors on a single silicon semiconductor microchip.**
- VLSI technology was conceived in the late 1970s when advanced level computer processor microchips were under development.
- VLSI is a successor to **large-scale integration (LSI), medium-scale integration (MSI) and small-scale integration (SSI) technologies.**

35 GOOGLE'S 1,000 LANGUAGE AI MODEL

CONTEXT: The tech giant Google is currently developing an AI model that supports 1,000 most spoken languages of the world.

How AI Model works?

- AI language models aims to minimise the dependence on human labour for fields such as translation, customer service or computation.
- They automate manual processes and generate new insights based on the existing data.
- The deep learning processes of these AI models are used for instantly decoding foreign languages by making use of massive volumes of user data and content on their servers.

Google's 1,000 language AI Model is said to be the "largest language coverage" among existing speech models.

36 CHATGPT, THE LATEST NATURAL LANGUAGE PROCESSING TOOL

CONTEXT: The ChatGPT an artificial intelligence tool developed by OpenAI has created a buzz among computer scientists and programmers due to its creative capabilities.z

About ChatGPT:

- ChatGPT is a ***'conversational' AI*** and will answer queries just like a human would.
  - It can answer follow-up questions.
  - It can also "admit its mistakes
  - It can challenge incorrect premises and reject inappropriate requests.
  - It is being seen as a replacement for much of the daily mundane writing, from an email to even college-style essays.
  - **Developed by:** OpenAI, a research, and development firm, was founded as a nonprofit in 2015.
  - **Language Used:** It has used the **GPT 3.5 series of language learning models (LLM)**.
- GPT stands for **Generative Pre-trained Transformer 3.**
- It relies on **deep learning techniques** to produce human-like text based on inputs.'

Other language models:

- ***BERT (Bidirectional Encoder Representations from Transformers)*** from Google.
- **Language Model for Dialogue Applications (LaMDA)** from Google

37 GENERATIVE PRE-TRAINED TRANSFORMER 3 (GPT-3)

CONTEXT: When GPT-3 was first launched in 2020, it brought enhancements it brought over GPT-2, AI language models like ChatGPT and Dall-E continue to impress people with their abilities, and both are based on OpenAI's GPT-3.x family of large language models.

About GPT-3 model:

- GPT-3, or the **third-generation Generative Pre-trained Transformer**, is a **neural network machine** learning model trained using internet data to generate any type of text.
- Developed by **OpenAI,** it requires a small amount of input text to generate large volumes of relevant and sophisticated machine-generated text.
- **GPT-3's deep learning neural network** is a model with over 175 billion machine learning parameters.
- To put things into scale, the largest trained language model before GPT-3 was **Microsoft's Turing Natural Language Generation (NLG) model**, which had 10 billion parameters.

As of early 2021, GPT-3 is the largest neural network ever produced. As a result, GPT-3 is better than any prior model for producing text that is convincing enough to seem like a human could have written it.

38 GPT-4 VS CHATGPT

CONTEXT: GPT-4 is a large multimodal model created by OpenAI and announced in March 2023.

What is GPT-4?

- GPT-4 is "multimodal" created by OpenAI, which means it can generate content from both image and text prompts.

- Multimodal models can encompass more than just text and also accepts **images as input**.
- Meanwhile, **GPT-3 and GPT-3.5** only operated in one modality, text, meaning users could only ask questions by typing them out.
- GPT-4 is also capable of handling over **25,000 words of text**, opening up a greater number of use cases that now also include long-form content creation, document search and analysis, and extended conversations.

39 LaMDA

CONTEXT: A senior engineer at Google claimed that the company's artificial intelligence-based chatbot Language Model for Dialogue Applications (LaMDA) had become "sentient".

What is LaMDA?

- LaMDA is short for '**Language Model for Dialogue Applications**', Google's modern conversational agent enabled with a neural network capable of deep learning.
- Google first announced LaMDA at its flagship developer conference I/O in 2021 as its generative language model for dialogue applications which can ensure that the Assistant would be able to converse on any topic.
- In simple terms, LaMDA can have a discussion based on a user's inputs.
- In 2022 Google announced LaMDA 2.0 which further builds on LaMDA 1.0
- The new model can possibly take an idea and generate "imaginative and relevant descriptions", stay on a particular topic even if a user strays off-topic, and can suggest a list of things needed for a specified activity.
- Language Models for Dialog Applications is a machine-learning language model created by Google as a chatbot that is supposed to mimic humans in conversation.
- Like BERT, GPT-3 and other language models, LaMDA is built on Transformer, a **neural network architecture** that Google invented and open-sourced in 2017.
- This architecture produces a model that can be trained to read many words while paying attention to how those words relate to one another and then predicts what words it will think will come next.
- But what makes LaMDA different is that it was trained on dialogue, unlike most models.
- LaMDA is designed to be able to engage in free-flowing conversations about a virtually endless number of topics.

What is a neural network?

- A neural network is an AI tech that attempts to mimic the web of neurons in the brain to learn and behave like humans.

40 CPaaS

CONTEXT: Companies are increasingly adopting communication platform-as-a-service (CPaaS), as more organizations are using cloud-based solutions for their communication needs.

What is Communication Platform as a Service (cPaaS) Platforms?

- Communication Platform as a Service (cPaaS) platforms, also known as cloud communication platforms, offer tools for mobile developers to link their apps to phone features like SMS, voice, and verification through APIs.
- Developers use these tools to enhance their apps with features like text notifications, in-app chatting, and voice calls. cPaaS allows for customization, enabling developers to implement advanced functions like multi-factor authentication.
- These platforms are associated with VoIP software, enabling seamless phone calls over IP networks. They host APIs for integration and provide documentation for developers.
- To qualify for inclusion in the Communication Platforms as a Service (cPaaS) category, a product must:
  - Host APIs allowing developers to integrate communication functionalities in their apps
  - Provide documentation around API interactions and extensibility

PRACTICE QUESTION

1. Regarding GPS spoofing, consider the following statements:

1. It includes alteration of the initial location of a GPS-enabled device.
2. GPS spoofing involves a radio transmitter near a target that interferes with the actual GPS signals being transmitted.
3. It is similar to GPS Jamming.

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) All three (d) None

2. With reference to Quantum dots (QDs), consider the following statements:

1. They are artificial nanostructures.

2. They have the ability to transport electrons and emit light of various colors when exposed to UV light.
3. These semiconducting particles are one-thousandth the width of a human hair.

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) All three (d) None

3. Regarding the National Automated Fingerprints Identification System (NAFIS), consider the following statements:

1. It is a country-wide searchable database of crime- and criminal-related fingerprints.
2. It functions as a central information repository by consolidating fingerprint data from all states and Union Territories.
3. It assigns 16-digit National Fingerprint Number (NFN) to different sets of crimes.
4. It is managed by the NCRB.

Which of the statements given above is/are correct?

(a) Only one (b) Only two

(c) Only three (d) All four

4. Consider the following statements regarding the National Quantum Mission (NQM):

1. The National Quantum Mission (NQM) received approval from the Union Cabinet on 19th April 2023, with an allocated budget of Rs. 6003.65 Crore for a duration of eight years.
2. The Mission Governing Board (MGB) emphasized the importance of importing quantum systems to accelerate the NQM's progress.
3. A "Call for Pre-proposals" was approved by the MGB, inviting proposals for the establishment of four technology hubs under NQM.

How many of the above statements are correct?

(a) Only one

(b) Only two

(c) All three

(d) None

ANSWERS				
1. (b)	**2. (c)**	**3. (c)**	**4. (b)**	

CHAPTER 04

SPACE TECHNOLOGY

SPACE

IMPORTANT SPACE PHENOMENON	
Asteroid	A broad and diverse group of rocks in space that were little studied by astronomers until the mid-twentieth century. A major 'belt' of asteroids exists between Mars and Jupiter, and divides the solar system into the terrestrial group of planets and the gaseous giants.
Black Hole	A large, massive star that has run out of fuel and collapsed in on itself. The remnant core or sphere is so densely packed that light and other objects cannot escape its gravitational pull.
Comet	These "dirty snowballs" were once believed to be harbingers of doom or fortune. Unlocking their secrets helped scientists of the renaissance era to hone and prove their mathematical models.
Dark Matter	Scientists believe that small (and possibly exotic) particles account for motions of stars and galaxies that cannot otherwise be explained. Dark matter, to this point, has eluded detection and cannot be seen with technologies that known particles and matter can.
Exoplanet	Planets located in solar systems and orbiting stars other than our own. There have been a substantial number of exoplanets discovered in the past few years by astronomers, utilizing improved detection methods and telescopes.
Nebula	Sometimes referred to as molecular clouds, these enormous regions of space consisting of dust, hydrogen, helium, and other gasses. Thousands of protostars may form from certain types of nebulae.
Pulsar	Extremely dense neutron stars that rotate extremely fast.
Quasar	Quasars are super-luminous objects located at the center of galaxies. Current scientific theories state that quasars are powered by massive black holes at the center of young galaxies.
Solar Wind	Solar wind is a phenomenon that occurs when the heat from the Sun's corona excites protons, electrons and other particles to a state where they escape the Sun's gravitational pull.
Supernova	Massive and powerful implosions and explosions that are the climactic finale of certain types of stars. Some stars are so massive that their implosions cause their own atoms to collapse.

1 25 YEARS OF THE INTERNATIONAL SPACE STATION

CONTEXT: On the occasion of 25 years of launch of International Space Station (ISS) there is recall to recognize its efforts to facilitate science and symbolizes international collaboration, peace, and diplomacy.

India is aiming to build a **Bharatiya Antariksha Station (Indian Space Station)** by 2035.

When did the International Space Station launch?

- The International Space Station is a large spacecraft in orbit around Earth. It serves as a home where crews of astronauts and cosmonauts live.
- The space station is made of parts that were assembled in space by astronauts.
  - The first part of the International Space Station (ISS), called '**Zarya**', was launched by Russia on November 20, 1998. It provided **fuel, power, and a docking zone** for other spacecraft.
  - A month later, on December 4, 1998, the **United States** launched the **Unity Node 1 module.**
  - Together with Zarya, they formed the **beginning of the ISS**, which, through 42 assembly flights, evolved into a fully functional **space laboratory.**

Details about International Space station (ISS):

- The ISS features essential amenities like six sleeping quarters, two bathrooms, a gym, and a stunning 360-degree view bay window.
- Its dimensions measure 109 meters (357 feet) end-to-end, nearly the length of a football field, and twice the length of an Olympic swimming pool.
- Despite its size, it's 12 meters shorter than SpaceX's Starship.
- Travelling at a speed of 8 kilometers (5 miles) per second, it orbits Earth every 90 minutes.
- With a solar array wingspan of 109 meters, it surpasses the Airbus A380's wingspan.
- Intricately wired, it boasts approximately 13 kilometers of electrical wiring.

2 INDIA'S EVOLVING SPACE ECONOMY

CONTEXT: Space is becoming an important component of the India's economy with Space Start-ups attracting private investment amounting to more than Rs. 1, 000 crore.

Recent developments in India's Space Sector

- **Defence Space Agency:** India has recently set up its Defence Space Agency (DSA) supported by the **Defence Space Research Organisation (DSRO)** that has the mandate to create weapons to "degrade, disrupt, destroy or deceive an adversary's space capability".
- **Defence Space Mission:** The Mission was recently launched at the **Defence Expo 2022,** Gandhinagar.
- **Expanding Satellite Manufacturing Capabilities**: India's satellite-manufacturing opportunity will reach USD 3.2 billion by the year 2025 (in 2020 it was USD 2.1 billion)
- **SAMVAD Program**: To encourage and nurture space research among young minds, ISRO launched its Student Outreach Program called SAMVAD at its Bengaluru facility.

Indian Space Policy, 2023:

- The Indian Space Policy 2023 delineates roles in the space sector.
- **Focus:** It emphasizes R&D to keep India at the forefront.
- **ISRO:** ISRO to focus on applied research, tech dev, and human spaceflight.
- **Scope:** Applicable to all space activities in or from Indian Territory.
- Includes exclusive economic zone.

3 GEOMAGNETIC STORM

CONTEXT: Space-monitoring agencies have predicted that a strong geomagnetic storm is likely to hit the earth. There have already been 11 X-class flares since January — more than the last five years put together.

About Geomagnetic storm

- A geomagnetic storm is a disturbance in the **earth's magnetosphere**, which is the area around the planet controlled by its magnetic field.

- The **earth's magnetosphere** protects its inhabitants from most of the particles emitted by the sun.
- When a **coronal mass ejection (CME)** or a high-speed stream reaches the earth, it strikes the planet's magnetosphere.

The largest solar storm recorded so far occurred in 1859 and is known as the **Carrington Event**.

- If the incoming solar magnetic field is directed southwards, it interacts strongly with the earth's own magnetic field that is opposite in direction, causing disturbances.
- The changes produced in the earth's magnetic field as a result of this interaction allow solar wind particles to stream down the magnetic field lines and hit the atmosphere near the poles.
- **Solar winds** deeply impact the shape of the earth's magnetosphere, and variations in solar winds cause **geomagnetic storms** on earth.
- At the surface of the earth, a geomagnetic storm can result in a rapid decline in the earth's magnetic field strength. This decrease can last for around 6 to 12 hours and gradually recovers over several days.

IMPORTANT SPACE EVENTS	
Coronal Mass Ejection (CME)	◉ A coronal mass ejection is a **large expulsion of plasma and magnetic field from the sun's corona.** ◉ Plasma is the highly ionised gas present on the sun, while corona is the outermost part of the sun's atmosphere. ◉ The corona is structured by strong magnetic fields. If these fields are closed, the solar atmosphere can release sudden, violent bubbles of gas and magnetic fields which constitute the CME. ◉ One large CME is capable of containing a billion tonnes of matter. ◉ CMEs can travel at varying speeds – as slow as 250 km per second to as high as 3,000 km per second.
Solar Storm	◉ Solar storms are magnetic plasma ejected at great speed from the solar surface. ◉ They occur during the release of magnetic energy associated with sunspots ('dark' regions on the Sun that are cooler than the surrounding photosphere), and can last for a few minutes or hours. ◉ Solar storms can hit operations of space-dependent services like **global positioning systems (GPS), radio, and satellite communications.**
Sunspots	◉ Sunspots are dark areas on the solar surface and contain strong, shifting magnetic fields. ◆ These are formed when areas on the surface of the sun cool slightly – from around 6,000 °C to about 4,200 °C — due to strong magnetic fields that emerge through the solar surface. ◆ Sunspots appear as dark spots against the otherwise bright sun.

4 SPACE TOURISM

CONTEXT: Blue Origin has successfully launched Jeff Bezos and three other civilians into space on the first crewed flight of the New Shepard spacecraft.

Karman Line

The Kármán line is a boundary 62 miles (100 kilometers) above mean sea level that borders Earth's atmosphere and the beginning of space.

About New Shepard:

- New Shepard is a **fully reusable suborbital launch vehicle** developed by **Blue Origin** for **space tourism.**
- The vehicle is named after **Alan Shepard, the first American astronaut in space** in 1961.
- The vehicle is capable of vertical take-off and vertical landing, and can carry a crew.
- The **rocket system** has been designed to take astronauts and research payloads past the **Karman line.**
- New Shephard also allows space tourists to experience **microgravity** by taking them 100 km above the Earth.

Microgravity is the condition in which people or objects appear to be weightless.

5 EXO-MOONS

CONTEXT: In a significant development, scientists have developed a method to trace exomoons that remain elusive so far. Till now, scientists have discovered nearly five thousand exoplanets with the help of ground-based and space telescopes including CoRoT, Spitzer, Kepler, and Hubble space telescopes.

About Exomoons:

- Exomoons are considered to be those **natural satellites** that revolve around **exoplanets.**
- The exo part in front of exoplanet and exomoon refers to an **astrophysical object that is around another star (extrasolar).**
- **Exoring:** If an exoplanet had a ring system like **Saturn** then it could be classed as an exoring.
- **Difficult to trace:**
  - Exomoon around any of the planets continues to remain untraceable.
  - The signals of exo-moons are too weak, because of their small sizes.

6 EXOPLANETS

CONTEXT: Scientists discovered six new worlds. With six exoplanets — HD 36384 b, TOI-198 b, TOI-2095 b, TOI-2095 c, TOI-4860 b, and MWC 758 c — scientists tipped the scales and surpassed 5,500 exoplanets found. To be exact, there are now 5,502 known exoplanets.

What are Exoplanets?

- An exoplanet is any planet beyond our solar system, i.e., planets that orbit around stars other than the sun.
- Most orbit other stars, but free-floating exoplanets, called rogue planets, orbit the galactic center and are untethered to any star.
- Nearly five thousand exoplanets have been discovered outside our solar system.

7 GRAVITATIONAL WAVE

CONTEXT: Scientists detected low-frequency gravitational waves echoing throughout the universe for the first time.

What are gravitational waves?

- These waves are created when huge objects in the universe move around and collide in space.
- They stretch and compress space-time as they travel through space,

8 GEOMAGNETIC STORM

CONTEXT: Elon Musk's Starlink has lost dozens of satellites that were caught in a geomagnetic storm a day after they were launched.

About

- The satellites were designed to burn up on re-entry into the Earth's atmosphere, and did not create debris in space.
- However, the loss of 40 satellites — most of a launch batch — in a single solar event has been described as "unheard of" and "huge".

What is Starlink?

- Starlink is a **SpaceX project** to build a broadband network with a cluster of orbiting spacecraft that could eventually number thousands.
- The Starlink network is **one of several ongoing efforts** to start beaming data signals from space.

What is a Geomagnetic storm?

- Geomagnetic storms are disruptions in Earth's magnetosphere caused by solar wind energy.
- Solar storms originate from solar winds released from sunspots.
- They cause fluctuations in Earth's magnetosphere due to changes in currents, plasmas, and fields.
- Solar storms occur when the Sun emits bursts of energy like solar flares and coronal mass ejections.
- These events send electric charges and magnetic fields towards Earth at high speeds.

Magnetosphere

- Earth is surrounded by a system of magnetic fields, called the magnetosphere.
- It shields Earth from harmful solar and cosmic particle radiation.

TYPES OF SOLAR STORMS	
Solar Flares	⊙ A solar flare is a sudden flash of increased brightness on the Sun, usually observed near its surface and in proximity to a sunspot group.
Coronal Mass Ejection	⊙ A coronal mass ejection (CME) is a significant release of plasma and accompanying magnetic field from the solar corona. They often follow solar flares and are normally present during a solar prominence eruption.
Geomagnetic Storm	⊙ A geomagnetic storm is a temporary disturbance of the Earth's magnetosphere caused by a solar wind shock that interacts with the Earth's magnetic field.
Solar Particle Events	⊙ A solar particle event or solar proton event (SPE), or prompt proton event, occurs when particles (mostly protons) emitted by the Sun become accelerated either close to the Sun during a flare or in interplanetary space by coronal mass ejection shocks.

9 MOON – WOBBLE

CONTEXT: The moon wobble is a standard fluctuation in the moon's orbit, documented in 1728 for the first time.

⊙ This moon wobbles required more than 18.6 years to complete and orbits cyclically. The moon wobble influences the moon's gravitational pull and indirectly affects the flow and ebb of tides on the earth.

About

⊙ Moon wobble, observed since the 1700s, denotes fluctuations in the moon's orbit due to changes in its elliptical orbit and resulting gravitational pull on Earth.

⊙ High tides on Earth are induced by the moon's gravity, causing two high tides within 24 hours on most coasts.

⊙ The moon's orbit, inclined about 5 degrees to Earth's orbital plane, and completes a nodal cycle every 18.6 years.

⊙ Chandler wobble refers to movements in Earth's orbit.

10 HIGH ABUNDANCE OF LITHIUM IN STARS

CONTEXT: Recently, Scientists have found a clue to the mystery behind the high abundance of Lithium in some evolved stars.

Key Points:

⊙ Research focused on lithium in red giants, finding only about 1% of sun-like red giants had lithium-enriched surfaces.

⊙ Methodology involved surveying 500,000 stars (GALAH survey) with known physical and chemical properties, including lithium levels.

⊙ Findings: Lithium-rich stars confirmed to burn helium in their core, likely due to violent helium-core flash.

⊙ Proposed mechanism: Collision between stable helium isotopes leads to stable lithium isotope.

⊙ Survey highlighted rare occurrence of lithium-rich giants among sun-like low-mass stars.

About Lithium:

⊙ Lithium is a **trace element on Earth**, and a key **component of rechargeable batteries.**

⊙ It is a **chemical element** with the symbol Li.

⊙ It is a **soft, silvery-white metal.**

⊙ Under standard conditions, it is the **lightest metal and the lightest solid element.**

⊙ It is **highly reactive and flammable**, and must be stored in mineral oil.

⊙ Lithium has become the **new 'white gold'** as the demand for high performing **rechargeable batteries** is rising.

⊙ Rising global lithium demand and surging prices have drawn increased interest in the so-called **'lithium triangle' that spans parts of Argentina, Bolivia and Chile.**

11 LASER COMMUNICATIONS RELAY DEMONSTRATION (LCRD)

CONTEXT: NASA has launched its new Laser Communications Relay Demonstration (LCRD).

About LCRD:

⊙ It is the agency's first-ever laser communications system.

⊙ The LCRD will help the agency test **optical communication in space**.

- LCRD is a technology demonstration that will pave the way for future optical communications missions.
- The LCRD payload is hosted on board the US Department of Defense's **Space Test Program Satellite 6 (STPSat-6).**
- It will be in a **geosynchronous orbit**, over 35,000km above Earth.

Laser VS radio:

- Laser communications and radio waves use different wavelengths of light.
- Laser uses infrared light and has a shorter wavelength than radio waves. This will help the transmission of more data in a short time.

12 ASTEROID TERRESTRIAL-IMPACT LAST ALERT SYSTEM (ATLAS)

CONTEXT: The NASA-funded Asteroid Terrestrial-impact Last Alert System (ATLAS) has become first survey capable of searching entire dark sky for near-Earth objects (NEOs), every 24 hours.

About:

- ATLAS is an advanced asteroid detection system operated by the University of Hawai'i for NASA's Planetary Defence Coordination Office.
- Recently expanded to the southern hemisphere with two new observatories in Chile and South Africa, now totaling four telescopes.
- Developed under a 2013 grant from NASA's Near-Earth Objects Observations Program.
- Capable of scanning the entire dark sky every 24 hours, aiding NASA's continuous effort to find, track, and monitor Near-Earth Objects (NEOs).

13 EJECTA HALO

CONTEXT: Recently, when the Vikram lander of Chandrayaan-3 touched down on the Moon's surface, it resulted in a lunar phenomenon called 'ejecta halo.'

What is ejecta halo?

- Ejecta halo is an irregular, bright patch surrounding the lander.
- Scientists from Indian Space Research Organisation estimate that about 2.06 tonnes of **lunar epi regolith** were ejected and displaced over an area of **4 m²** around the landing site.
- **Significance:**
- This discovery sheds light on the behaviour of lunar materials during such events.
- It opens up new avenues for research and understanding lunar geology.

What is Regolith?

- It is a blanket of **unconsolidated, loose, heterogeneous** superficial deposits covering solid rock.
- Epiregolith is lunar rocks and soil, or **regolith, or Moon dust.**

PRACTICE QUESTION

1. Which of the following statements is correct regarding 'UHZ1', recently seen in news?

(a) It is a galaxy located within the Abell 2744 cluster, approximately 3.5 billion light-years from Earth.

(b) It is the oldest galaxy ever detected, formed just 470 million years after the big bang.

(c) It is a distant quasar emitting powerful gamma-ray bursts.

(d) It is a terrestrial exoplanet with potential habitable conditions.

2. Regarding metaverse, consider the following statements:

1. It can be any 3D virtual space powered by technology.
2. It includes only fully immersive 3D experiences.
3. It is a spatial computing platform built on blockchain that acts as an alternative to or a replica of the real world.

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) All three (d) None

3. What is the primary objective of NASA's Psyche mission, which aims to explore the asteroid 16 Psyche?

(a) To investigate the potential for asteroid mining for valuable metals

(b) To study primordial asteroids near Jupiter

(c) To search for signs of extra-terrestrial life on the asteroid

(d) To conduct a flyby of the exposed core of a demolished planet

4. Consider the following pairs

Planets	Moons
1. Saturn	1. Titan
2. Jupiter	2. Mimas
3. Uranus	3. Titania

How many of the given pairs are correctly matched?

(a) Only one

(b) Only two

(c) All three

(d) None

5. Consider the following pairs:

Mission	Payload
1. Aditya L1	Visible Emission Line Coronagraph (VELC)
2. Chandryayaan-2	Solar X-Ray monitor (XSM)
3. AstroSat	Large Area X-Ray proportional counter
4. Mangalyaan	Lyman Alpha Photometer (LAP)

How many of the given pairs is/ are correctly matched?

(a) Only one (b) Only two

(c) Only three (d) All four

ANSWERS				
1. (b)	2. (b)	3. (a)	4. (b)	5. (d)

TECHNOLOGY

14 INDIA'S FIRST PRIVATELY DEVELOPED ROCKET "VIKRAM-S"

CONTEXT: India's first privately developed rocket "Vikram-S" has been launched.

Details:

- The maiden mission of **Skyroot Aerospace**, **'Prarambh',** will be launched from ISRO's launchpad at Sriharikota.
- Collaborative support of ISRO and IN-SPACe (Indian National Space Promotion and Authorisation Centre) has made this mission ready in a short span of time.

Skyroot Aerospace Private Limited is an Indian private aerospace manufacturer and commercial launch service provider headquartered in Hyderabad.

Vikram-S rocket:

- It is a single-stage sub-orbital launch vehicle.
- It will be carrying three customer payloads and help test and validate the majority of the technologies in the Vikram series of space launch vehicles.
- **Skyroot's launch vehicles are named 'Vikram'** as a tribute to the founder of the Indian space programme and renowned scientist **Vikram Sarabhai.**
- **New Space India Limited (NSIL):** Announced in Budget 2019, it aims to **use research and development carried out by ISRO** over the years for commercial purposes through Indian industry partners.
- **IN-SPACe-It** facilitates private companies' access to Indian space infrastructure, ensuring a level playing field.
- Serves as a single-point interface between ISRO and entities interested in space-related activities.
- Indian Space Association (ISpA) aims to represent the collective voice of the Indian space industry, comprising leading domestic and global corporations with advanced space and satellite technologies.

15 ROHINI RH¬200 SOUNDING ROCKET

CONTEXT: In a few weeks' time, the Indian Space Research Organisation (ISRO) hopes to achieve a remarkable feat — the 200th successful launch of the Rohini RH-200 sounding rocket in a row.

About Sounding Rocket

- Sounding rockets are one or two-stage solid propellant rockets used for probing the upper atmospheric regions and for space research.
  - Sounding in the rocket context is equivalent to **"taking a measurement".**
- The rockets are used to launch instruments from 48

to 145 km above the surface of the Earth, the altitude generally between weather balloons and satellites.

- The maximum altitude for balloons is about 40 km and the minimum for satellites is approximately 121 km.
- They also serve as easily affordable platforms to test or prove prototypes of new components or subsystems intended for use in launch vehicles and satellites.

About Rohini RH-200

- Rohini RH-200: A two-stage rocket reaching 70 km altitude carrying scientific payloads.
- Both stages powered by solid motors, denoted by "200" referring to rocket diameter.
- Variants include RH-300 Mk-II and RH-560 Mk-III.
- Initially used PVC-based propellant; transitioned to HTPB (hydroxyl-terminated Polybutadiene)-based propellant in Sept. 2020.
- HTPB propellant offers higher energy, improved mechanical properties, and reduced defects.

16 ONE WEB COMMUNICATION CONSTELLATION

CONTEXT: Indian Space Research Organisation's heaviest rocket, GSLV Mk-III, launched 36 satellites of the 'OneWeb communication' constellation. With this the GSLV Mk-III will enter the global commercial launch service market.

Facts:

India currently has **three operational** launch vehicles – the **PSLV, GSLV, and GSLV Mk III**. The space agency has also developed a small satellite launch vehicle, whose first development flight was partially successful.

About

- This is the first time that India's heaviest rocket is being used for a commercial launch.
- Also, this will the first time a rocket other than India's workhorse – **Polar Satellite Launch Vehicle (PSLV)** – is being used to carry out commercial launch.
- Till now, the PSLV has conducted at least **eight commercial-only launches**.

Geostationary Orbit of earth: (Orbit of Communication Satellites)

- A **geostationary orbit** is also referred to as a **geosynchronous equatorial orbit** (**GEO**).
- It is a circular geosynchronous orbit 35,786 km (22,236 mi) in altitude above Earth's equator (42,164 km (26,199 mi) in radius from Earth's centre) and following the direction of Earth's rotation.

The GSLV Mk-III rocket:

- GSLV Mk-III: ISRO's medium-lift launch vehicle with three stages.
- Stages include two S200 solid strap-on motors, one liquid core stage, and a high-thrust cryogenic upper stage.
- First successful experimental flight was in December 2014.
- Designed primarily for launching communication satellites into geostationary orbit and identified for crewed missions.
- Also used in science missions like Chandrayaan-2.
- Boasts higher payload capacity than GSLV Mk II.
- Improvements underway to enhance reliability and safety for human missions.

17 SPACE BRICKS

CONTEXT: Researchers from the Indian Space Research Organisation (ISRO) and the Indian Institute of Science (IISc) have developed a way to make bricks (space bricks) from Martian soil with the help of bacteria and urea.

A team from the Indian Institute of Science (IISc) and Isro has developed a scalable technique to make **"space bricks"** using **Martian Simulant Soil (MSS).**

About Space Bricks

- Team utilized Sporosarcina pasteurii bacterium in Martian Simulant Soil (MSS) to harden it.
- Under ideal conditions, MSS transforms into a brick within 15-20 days.
- Guar gum, a natural polymer, was added to enhance brick strength, similar to lunar simulant soil bricks.
- Guar gum extracted from guar beans is known for its thickening and stabilizing properties.
- These "space bricks" can aid in building structures for potential human settlement on Mars.

Utilisation of Bacteria (bio-mineralisation)

- Bacteria are very **versatile organisms** and certain species are capable of **bio-mineralisation** — a process by which living organisms produce minerals to harden or stiffen existing tissues — which was exploited to make these bricks.

18 SATELLITE INTERNET

CONTEXT: JioSpaceFiber is a satellite-based broadband service announced by Reliance Jio at the Indian Mobile Congress.

What is Satellite Internet?

- Satellite internet works by using **radio waves** to communicate with satellites orbiting the Earth.
- Data is sent and retrieved through a communication network that starts with person's device and travels through the modem and satellite dish, out to a satellite in space.
- It then gets back to Earth to ground stations known as **network operations centres (NOC).**
- And then, data travels back through this network—out to space and then back to your satellite dish on Earth—to deliver data on your device.
- It typically communicates with the satellites either in geostationary orbit or **Lower Earth Orbit.**

- Unlike standard broadband that uses cables or fiber to deliver high-speed internet, JioSpaceFiber uses communication satellites to provide internet access.
- JioSpaceFiber is different in comparison to both JioAirFiber and Jio Fibre.

Types of Satellites

- Satellites orbiting the Earth fall into one of three categories: **Geostationary Earth Orbit (GEO), Medium Earth Orbit (MEO), and Low Earth Orbit (LEO)**

Geostationary Earth Orbit (GEO) satellites	They orbit at 35,786 km above the surface of the earth. They match the Earth's rotation as they travel, remaining above the same point on the ground. Due to their size and altitude, only three GEO satellites are required to cover the entire surface of the earth.
Medium Earth Orbit (MEO) satellites	They occupy the space between 5,000 and 12,000 km above earth. Their lower altitude enables lower latency compared to GEO satellites but necessitates more spacecraft – between eight and 20 – for complete coverage.
Low Earth Orbit (LEO) satellites	They operate between 850 and 2000 km1. While LEO satellites deliver the lowest latency of the three orbits, LEO networks require an exponentially higher number of satellites for full coverage, and atmospheric drag reduces satellite lifespan.

19 INTERNATIONAL LIQUID-MIRROR TELESCOPE (ILMT)

CONTEXT: India has commissioned a unique liquid-mirror telescope atop a mountain in the Himalayan range in Uttarakhand to keep a watch on the overhead sky to identify transient or variable objects such space debris, asteroids, supernovae and gravitational lenses.

About:

- The first liquid mirror telescope in India and largest in Asia.
- Employs a 4-meter-diameter rotating mirror made of liquid mercury to collect and focus light.
- Developed by scientists from India, Belgium, and Canada.
- Located at an altitude of 2450 meters at the Devasthal Observatory campus of ARIES.
- **Significance:** Enables surveying the sky to observe galaxies and astronomical sources by observing the strip of sky passing overhead.

20 LUX-ZEPLIN (LZ) DARK MATTER DETECTOR

CONTEXT: The LUX-ZEPLIN (LZ) Dark Matter Detector recently passed the check-out phase of the operation and generated first results.

About:

- **LUX-ZEPLIN** is the world's most sensitive **WIMP dark matter detector**.
- **Location:** The detector has been installed deep down the Black Hills in **South Dakota** in Sanford Underground Research Facility (SURF), United States.
- The LUX-ZEPLIN detector is designed to capture **weakly interacting massive particles (WIMPs)** believed to be the constituents of dark matter.

21 INFLATABLE AERODYNAMIC DECELERATOR (IAD)

CONTEXT: The Indian Space Research Organisation (ISRO) just declared that it has successfully demonstrated the new technology with Inflatable Aerodynamic Decelerator (IAD).

What is IAD?

- **IAD:** Technique for atmospheric entry payload.
- Components: Inflatable envelope and inflatant (air or helium).
- Function: Inflates like a balloon during entry, decelerating the lander.
- Purpose: Increases drag upon atmospheric entry on planets like Earth, Mars, or Moon.
- **ISRO's IAD:** Developed at Vikram Sarabhai Space Centre.
- **Features:** Includes ejectable spin rocket, made of Kevlar fabric and coated with polychloroprene for strength and heat resistance.
- Inflation System: Developed by Liquid Propulsion Systems Centre, uses compressed nitrogen.
- Effectiveness: Successfully decreases payload velocity during test flights, maintaining trajectory.

22 MARS OXYGEN IN-SITU RESOURCE UTILIZATION EXPERIMENT (MOXIE)

CONTEXT: Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE) has produced the 1st instance of the utilisation of resources in a planet's atmosphere to meet human needs.

About MOXIE:

- **Led by:** Massachusetts Institute of Technology (MIT)
- The **Mars Oxygen In-Situ Resource Utilization Experiment, or MOXIE**, was launched as part of **NASA's Perseverance rover mission**.
- The **Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE)** is a small instrument on the **Perseverance rover** that's designed to transform carbon dioxide, which comprises some 96% of the atmosphere on Mars, into breathable oxygen.
- It has been successfully making oxygen from the planet's carbon-dioxide-rich atmosphere since it landed there in February 2021.
  - Inside Moxie, Martian air is first filtered in and pressurised.
  - It is then sent through the Solid OXide Electrolyzer (SOXE), which electrochemically splits the carbon dioxide-rich air into oxygen ions and carbon monoxide.
  - The oxygen ions are isolated and recombined to form breathable, molecular oxygen (O2).

23 WEBB DETECTS KEY CARBON MOLECULE

CONTEXT: The $CH3^+$ molecule has been detected in space for the first time by the James Webb Space Telescope (JWST).

What has been found?

- Known as **methyl cation** ($CH3^+$), the molecule was detected in a young star system, with a protoplanetary disk, known as **d203-506,** which is located about 1,350 light-years away in the Orion Nebula.
- The findings, published in the ***journal Nature***, showed that although the star in **d203-506** is a **small red dwarf**, the system is bombarded by strong **ultraviolet (UV) light** from nearby hot, young, massive stars.

What is carbocation CH3+?

- **Methyl cation ($CH3^+$):** Simple organic molecule with one carbon and three hydrogen atoms.
- **Reactivity:** Forms complex molecules by reacting with other compounds.
- **Structure:** Positively charged carbon atom (C+) with three hydrogen atoms (H).
- Belongs to alkyl cation family.
- **Unique Property:** Reacts inefficiently with hydrogen but readily reacts with other molecules, initiating growth of complex carbon-based molecules.

Webb Telescope

The world's premier space science observatory, Webb Telescope is an international programme led by NASA with its partners, **ESA (European Space Agency)** and the **Canadian Space Agency.**

24 DEEP FAKE

CONTEXT: The incidents of deep fake videos is on rise.

What are Deep Fakes?

- **Deepfakes constitute fake content** — often in the form of videos but also other media formats such as pictures or audio — created using powerful artificial intelligence tools.
- Simply, it is an amalgamation of the words "**deep learning**" and "**fake**" and it means fabricated videos generated from existing face-swapping techniques and technology.
- They are called deepfakes because they use **deep learning technology**, a branch of machine learning that applies neural net simulation to massive data sets, to create fake content.
- It employs a branch of artificial intelligence where if a computer is fed enough data, it can generate fakes which behave much like a real person.
- The **origin of the word** "**deepfake**" can be traced back to 2017 when a Reddit user, with the username "deepfakes", posted explicit videos of celebrities.

PRACTICE QUESTION

1. Regarding Deepfakes, consider the following statements:

1. Deepfakes are videos that have been reworked by video editing software.
2. A generative adversarial network (GAN) trains two neural networks to compete against each other to generate more authentic new data from a given training dataset.

Which of the statements given above is/are correct?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

2. Which of the following is the correct production process for 'white hydrogen'?

(a) It is made from methane gas.

(b) It is produced using renewable energy to split water.

(c) It is naturally produced in the Earth's crust.

(d) It is produced from biomass

3. Why has the use of INSAT 3D satellite maps been prominent in North India?

(a) Monitoring wildlife migration patterns

(b) Predicting earthquake-prone regions

(c) Assessing heavy fog conditions

(d) Observing urban development trends

ANSWERS				
1. (b)	2. (c)	3. (c)		

SATELLITES/MISSION/INITIATIVES

25 CHANDRAYAAN-3

CONTEXT: Chandrayaan-3's lunar South Pole landing elevated India's global standing.

About the mission:

- The Chandrayaan-3 mission is a follow-up of **Chandrayaan-2** of July 2019, which aimed to land a rover on the **lunar South Pole.**
- **Chandrayaan-3 consists of-**
  - **Indigenous Lander module (LM):** Capability to soft land at a specified lunar site and deploy the Rover
  - **Rover:** Capability to carry out **in-situ chemical analysis** of the lunar surface during the course of its mobility. The Lander and the Rover have scientific payloads to carry out experiments on the lunar surface.
  - **Propulsion module (PM):** The propulsion module has the **Spectro-polarimetry of Habitable Planet Earth (SHAPE)** payload to study the spectral and Polari metric measurements of Earth from the lunar orbit.
- **Objectives of the mission**
  - better understanding the Moon's composition
  - demonstrating a safe and soft landing on the lunar surface
  - demonstrating the rover's roving capabilities on the moon
  - performing in-situ scientific observations

- **Components:**
  - The mission's **Chandra Surface Thermophysical Experiment (ChaSTE)** will measure the thermal conductivity and temperature
  - The **Instrument for Lunar Seismic Activity (ILSA)** will measure the seismicity around the landing site.
  - The **Langmuir Probe (LP)** will estimate the plasma density and its variations.
  - A **passive Laser Retroreflector Array** from NASA is accommodated on the mission for **lunar laser ranging studies.**

Chandrayaan-3's LVM-3

- LVM-3 or Launch Vehicle Mark-III, is a **three-stage medium-lift launch vehicle** developed by ISRO and earlier known as the **GSLV Mark III.**
- It is the **most powerful rocket** in the space agency.
- **Lift-off mass:** 640 tonnes.
- **Payload capacity**:
  - upto 8,000 kilograms to a **low-Earth orbit.**
  - Upto 4,000 kilograms of payload to a **geostationary transfer orbit**
- Its **cryogenic upper stage** is powered by **CE-20** (**India's largest cryogenics engine**).
- The **core stage** is powered by two **L110 liquid-stage Vikas rockets.**

26 ADITYA-L1

CONTEXT: The Indian Space Research Organization (ISRO), successfully launched its first solar mission 'Aditya-L1' to study the Sun.

About

- **Aditya L1** is a solar mission by the Indian Space Research Organization (ISRO).
- It is the first Indian mission dedicated to studying the Sun.
- The mission, expected to operate for at least five years.
- **Position:** Aditya L1 will be placed in a **large halo orbit** around the Sun-Earth **Lagrange Point L1**.
- Aditya-l1 distance from the Sun will be about 148.5 million kilometres (925,000 miles).

Lagrange Point L1

- This is a point in space that is located about 1.5 million kilometres from Earth. The L1 point is a stable location where the gravitational forces of the Sun and Earth balance each other out.

- **Layers:** The Aditya-L1 spacecraft payloads (instruments) will study the **photosphere, chromosphere, and the outermost layers of the Sun (the corona).**

INSTRUMENTS	
Aditya-L1 is carrying the following seven instruments	
Visible Emission Line Coronagraph (VELC)	to study the solar corona and dynamics of Coronal Mass Ejections
Solar Ultra-violet Imaging Telescope (SUIT)	for imaging the Solar Photosphere and Chromosphere in near Ultra-violet (UV). It also measures the solar irradiance variations in near UV
Solar Low Energy X-ray Spectrometer (SoLEXS)	to study the X-ray flares from the Sun over a wide X-ray energy range
High Energy L1 Orbiting X-ray Spectrometer (HEL1OS)	to study the X-ray flares from the Sun over a wide X-ray energy range
Aditya Solar Wind Particle EXperiment (ASPEX) **Plasma Analyser Package for Aditya (PAPA)**	to study the solar wind and energetic ions, as well as their energy distribution
Advanced Tri-axial High-Resolution Digital Magnetometers	to measure interplanetary magnetic fields at the L1 point

27 ISRO TESTED REUSABLE LAUNCH VEHICLE

CONTEXT: ISRO successfully carried out the landing experiment of the Reusable Launch Vehicle-Technology Demonstration (RLV-TD) programme at the Aeronautical Test Range in Chitradurga, Karnataka.

About Reusable Launch Vehicle-Technology Demonstration (RLV-TD):

- The configuration of RLV-TD is similar to that of an aircraft and **combines the complexity** of both **launch vehicles and aircraft**.
- The winged RLV-TD has been configured to **act as a flying test bed to evaluate various technologies**, namely, hypersonic flight, autonomous landing and powered cruise flight.
- **Components**:
- RLV-TD consists of a fuselage (body), a **nose cap, double delta wings and twin vertical tails.**
- It also features symmetrically placed active control surfaces called **Elevons and Rudder**.
- This technology demonstrator was boosted to **Mach no: 5** by a conventional solid booster (HS9) designed for low burn rate.

Objectives of RLV-TD:

- Hypersonic aero thermodynamic characterisation of wing body
- Evaluation of autonomous Navigation, Guidance and Control (NGC) schemes
- Integrated flight management
- Thermal Protection System Evaluation

Aeronautical Test Range (ATR) Facility:

- **Aeronautical Test Range (ATR)** is out-door testing and evaluation facility set up by DRDO exclusively for unmanned and manned aircraft.
- The ATR is under the command of the Aeronautical Development Establishment (ADE).
- ATR is located at Varavoo Kaval in Challakere Taluk of Chitradurga district
- ATR, Chitradurga has a Range Control Centre (RCC) with **air traffic display system**. It is equipped with a mission **video distribution and display system**. It has a **Radar Centre** which houses primary and secondary surveillance radars.

28 SSLV-D2

CONTEXT: The Indian Space Research Organisation (ISRO) launched the second edition of the Small Satellite Launch Vehicle (SSLV-D2) from the first launch pad of Satish Dhawan space centre at Sriharikota, Andhra Pradesh.

Key highlights of the launch

- It placed the Indian Space Research Organisation (ISRO) earth observation satellite **EOS-07** and two co-passenger satellites — **Janus-1 and AzaadiSat2** — developed by start-ups, in a 450-km circular orbit around the Earth.
- The objectives of the SSLV-D2 mission are the demonstration of a designed payload capacity of SSLV in low-Earth orbit, and the injection of an Earth Observation Satellite and two passenger satellites into a 450.7-kilometre circular orbit.

EOS-07

- EOS-07 is a 156.3 kg satellite designed, developed and realized by ISRO.
- EOS-07's primary mission objective to gather data for Geographic Information Systems (GIS) applications, such as cartography, regulation of the use of coastal land, urban and rural management, and many more.

Janus-1

- Janus-1 is a satellite by Antaris, XDLinks, and Ananth Technologies.
- It features a standardized satellite bus allowing easy attachment of payloads.
- The bus supports various applications like earth observation and signal monitoring.

AzaadiSat2

- AzaadiSat2 features payloads built by 750 girl students from India.
- Payloads include LoRa amateur radio, radiation level sensors, and health sensors.
- The satellite has an expandable design, increasing its size fourfold post-launch.

SpaceKidzIndia

- To promote space awareness among children — has made the satellite expandable: the 8-unit satellite will have a spring mechanism-based external frame, which will open up once the satellite is in orbit.
- After the frame opens up, the satellite will become four times its size.

About SSLV

- SSLV is a three-stage launch vehicle with solid propulsion stages and a liquid terminal stage.
- Features include low cost, flexibility, 'launch on demand,' and minimal infrastructure requirements.
- It offers quick turnaround time and can be integrated and launched within 24 hours.
- SSLV supports various satellite sizes and can carry up to a 500-kilogram payload to a 500-kilometer orbit.

- **Launch Vehicles:** Launch Vehicles are rockets that have powerful propulsion systems required to generate the huge amount of energy required to lift heavy objects like satellites into space, overcoming the gravitational pull of the earth.

29 ISRO'S ASTRONOMY MISSION 'ASTROSAT'

CONTEXT: The Indian Space Research Organisation (ISRO) has made an Announcement of Opportunity (AO) to allow scientists and researchers to analyse data from the first dedicated Indian astronomy mission, AstroSat.

AstroSat Mission:

- AstroSat is the **first dedicated Indian astronomy mission** aimed at studying celestial sources in X-ray and UV spectral bands simultaneously, providing a space astronomy observatory operated by ISRO.
- AstroSat was launched in 2015 and completed seven years in orbit at the end of September 2022.
- **Features:**
  - AstroSat with a lift-off mass of **1515 kg** launched into a **650 km orbit.**
  - The minimum useful life of the AstroSat mission is expected to be 5 years.
- **Study conducted:**
  - To understand high energy processes in binary star systems containing neutron stars and black holes.
  - Estimate magnetic fields of neutron stars.
  - Study star birth regions and high energy processes in star systems lying beyond our galaxy.
  - Detect new briefly bright X-ray sources in the sky.
  - Perform a limited deep field survey of the Universe in the Ultraviolet region

30 X-RAY POLARIMETER SATELLITE

CONTEXT: ISRO's next big space launch after Chandrayaan-3 and Aditya L-1 is the X-ray Polarimeter Satellite (XPoSat).

X-Ray Polarimeter Satellite (XPoSat) Mission:

- The primary objective of this satellite is to **"study various dynamics of bright astronomical X-ray sources in extreme conditions."**
- XPoSat is hailed as India's **first polarimetry mission** and the world's second of its kind after NASA's Imaging X-ray Polarimetry Explorer (IXPE), launched in 2021.

Polarimetry, in simple terms, is a method to study how light waves move. It helps us understand the direction and patterns in which light waves vibrate as they travel.

Understanding X-Rays in Space

- X-rays have high energy and short wavelengths, typically ranging from 0.03 to 3 nanometers.
- Some X-rays are incredibly small, even smaller than a single atom of various elements.
- When an object is very hot, it emits radiation with shorter wavelengths, and X-rays are a result of this. Celestial objects that emit X-rays are extremely hot, often reaching temperatures in the millions of degrees Celsius.
- **Pulsars, galactic supernova remnants, and black holes** are examples of such **scorching celestial bodies.**

- **XPoSat Payloads: It carries** two scientific payloads in low Earth orbit.
- **POLIX (Polarimeter Instrument in X-rays)**: To measure the polarization parameters (degree and angle) of X-rays from about 40 bright astronomical sources. POLIX is a collaborative effort between the Raman Research Institute (RRI) and **ISRO's UR Rao Satellite Centre (URSC)** in Bengaluru.
- **XSPECT (X-ray Spectroscopy and Timing): To** provide information on how light is absorbed and emitted by celestial objects. It will observe various sources like **X-ray pulsars, black hole binaries, and low-magnetic field neutron stars**, offering valuable spectroscopic details.

31 GAGANYAAN

CONTEXT: The Indian Space Research Organization (ISRO) is performing a host of tests in the run up to the ambitious 'Gaganyaan' astronaut mission.

About the mission:

- Gaganyaan, India's first human space mission, is set to launch in 2024.
- It is a mission by the **Indian Space Research Organisation (ISRO).**
- It has three flights will be sent into orbit. There will be two unmanned flights and one human spaceflight.
- The Gaganyaan system module, called the **Orbital Module** will have three Indian astronauts, including a woman.
- It will circle Earth at a low-earth-orbit at an altitude of 300-400 km from earth for 5-7 days.
- **Launch:** GSLV Mk III, also called the LVM-3 (Launch Vehicle Mark-3,) the three-stage heavy lift launch vehicle, will be used to launch Gaganyaan as it has the necessary payload capability.

Payloads of the mission:

- The payload of the mission comprises of Crew module, which will carry human beings.
- Service module, which will be powered by two liquid propellant engines.

After the successful completion of Mission, the next step will focus towards achieving capability for a sustained human presence in space.

- It can contribute in advanced technology capability for undertaking human space exploration, sample return missions and scientific exploration.

32 GAGAN

CONTEXT: Recently, Airports Authority of India (AAI) successfully conducted a light trial using GAGAN {GPS (Global Positioning System) Aided GEO Augmented Navigation} based LPV (Localizer Performance with Vertical Guidance) Approach Procedures.

What is GAGAN?

- GAGAN (GPS Aided GEO Augmented Navigation) is a Space-Based Augmentation System (SBAS) jointly developed by ISRO (Indian Space Research Organisation) and AAI (Airports Authority of India).
- It enhances GPS signal accuracy for better navigational services over Indian airspace and neighboring regions. GAGAN was certified by DGCA (Directorate General of Civil Aviation) in 2015 for aviation operations, including approach with vertical guidance and en-route navigation.

GAGAN provides a civil **aeronautical navigation signal consistent** with International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARPs) as established by the Global Navigation Satellite System (GNSS) Panel.

33 MARS ORBITER MISSION

CONTEXT: India's first interplanetary probe, Mars Orbiter Mission (MOM), was designed for only six months but lasted a good eight years the unmanned spacecraft had entered the end of its lifecycle.

About MOM

- Mars Orbiter Mission (MOM) was India's first interplanetary mission, launched aboard PSLV-C25 in 2013. ISRO became the fourth space agency to achieve Mars orbit insertion.
- Despite a designed mission life of 6 months, MOM completed 7 years in orbit on Sept 24, 2021.
- Its instruments included a color camera, thermal infrared sensor, and others to study Mars' atmosphere and surface.
- MOM sent valuable data, including stunning images, shared with NASA under an agreement.

34 LVM3-M2

CONTEXT: Recently, the Indian Space Research Organisation's (ISRO) heaviest rocket Launch Vehicle Mark 3 (LVM3 or GSLV Mark 3) has successfully orbited 36 satellites of U.K.-based OneWeb.

- OneWeb is a global communications network powered by a constellation of 648 Low Earth Orbit (LEO) satellites.

About:

- The LVM3-M2 mission marks India's first commercial launch for OneWeb via NewSpace India Limited (NSIL). It carries 36 OneWeb satellites, the heaviest payload of 5,796 kg for LVM3 to date.
- The rocket is capable of launching 4,000 kg to GTO and 8,000 kg to LEO.

- It features two solid strap-ons, a liquid core stage, and a cryogenic stage.
- Technical achievements include managing multiple satellite separations and ensuring data availability throughout the mission.

35 SAMPURNANAND OPTICAL TELESCOPE (SOT)

CONTEXT: The Governor of Uttarakhand recently highlighted the need for discussing future possibilities of the 104 cm Sampurnanand Telescope (ST), at a workshop organised to commemorate the completion of 50 years of successful operations of the telescope.

About:

- It is a world-class telescope located near Nainital.
- The telescope at **Manora Peak** was established in 1972 when **ARIES** was known as the **UP State Observatory (UPSO).**
- It has been extensively used for optical observations of **comets, occultation by planets and asteroids, star-forming regions and star clusters, variable stars, transients, active galactic nuclei, etc.**
- Some of the breakthrough science results contributed by the telescope include the discovery of new rings around Saturn and the rings of Uranus.
- The instrumentation and science capabilities of ST have paved the way for setting up National and International facilities by **ARIES**, such as the 3.6m DOT and the 4 meter **International Liquid Mirror Telescope at Devasthal.**

36 LUNA-25

CONTEXT: The Russian space agency, Roscomos, has successfully launched its first lunar lander in 47 years, marking a significant milestone in its space program.

The launch from **Russia's Vostochny spaceport** in the **Far East** of the Luna-25 craft to the moon is Russia's first since 1976 when it was part of the **Soviet Union.**

- Luna-25 is a lunar mission with two key objectives: to study the composition of the polar regolith and to analyze the plasma and dust components of the lunar polar exosphere.
- These studies are crucial for understanding the lunar environment and potential base construction.
- The spacecraft, about the size of a small car, will operate for a year at the moon's South Pole.
- This region is significant due to the presence of water ice, which could support future lunar bases by providing essential resources like fuel, oxygen, and drinking water.
- Success in this mission could reshape lunar exploration, positioning Russia as a leader in the space race.

37 CAPSTONE

CONTEXT: NASA launched CAPSTONE, a microwave oven-sized CubeSat weighing just 55 pounds (25 kg).

About:

A **near-rectilinear halo orbit (NRHO)** is a halo orbit with slightly curved – or nearly straight – sides between close passes with an orbiting body.

- CAPSTONE - Cislunar Autonomous Positioning System Technology Operations and Navigation Experiment, is designed to test a unique, elliptical lunar orbit known as a **near-rectilinear halo orbit (NRHO)** which is significantly elongated, and is located at a precise balance point in the gravities of Earth and the Moon.
- This offers stability for long-term missions like Gateway.
- **CAPS (Cislunar Autonomous Positioning System)** is **CAPSTONE's autonomous navigation software**
- If tested successfully, the software will allow future spacecraft to determine their location without.

38 ARTEMIS I MISSION

CONTEXT: NASA launches Artemis 1 moon mission on the Space Launch System (SLS) rocket, its most powerful rocket ever.

What is Artemis 1?

- Formerly called **Exploration Mission-1**, this **uncrewed mission** was an extensive test of the **Space Launch System (SLS)** and the **Orion module.**
- The Space Launch System is the **most powerful rocket ever built,** generating 8.8 million pounds of thrust on liftoff, making it 1.3 million pounds more powerful than the **Saturn V rocket** used in the **Apollo missions**.

NASA's Artemis Mission

- **Duration:** 2017–present
- **Launch vehicles:** Space Launch System (SLS); Commercial launch vehicles

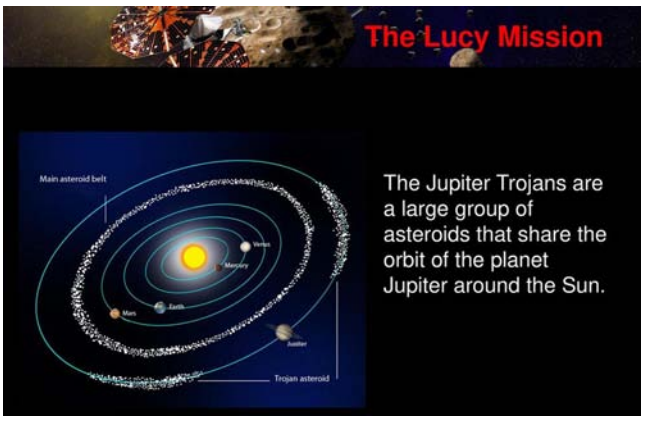
- **Crew modules:** Lunar Gateway, Orion, Human landing system (HLS)
- The Artemis programme is a series of ongoing space missions run by NASA.
- Three Artemis missions are currently in progress:
- **Artemis 1**, an un-crewed test flight completed 11 December which circled and flew past the Moon
- **Artemis 2**, a crewed flight beyond the Moon, which will take humans the furthest they've ever been in space
- **Artemis 3**, which will land the first female astronaut and first astronaut of colour on the Moon, and involve spending a week performing scientific studies on the lunar surface

39 NASA'S LUCY MISSION

CONTEXT: National Aeronautics and Space Administration (NASA) launched 'Lucy', its first mission to explore the Jupiter Trojan Asteroids.

Mission Lucy:

- **Duration:** The solar-powered mission is estimated to be over 12 years long, during which the spacecraft will visit eight asteroids covering a distance of about 6.3 billion km to deepen the understanding of the "young solar system".
- The mission is **named after 'Lucy', a 3.2 million-year-old ancestor** who belonged to a species of **hominins** (which include humans and their ancestors).



Trojan asteroids

- The probe's main objects of study are **the Trojan asteroids**.
- These objects are thought to be remnants from the **primordial disk** that formed the sun and planets, which were captured by **Jupiter's gravity** sometime near the beginning of the solar system.

C-type, D-type, and P-type asteroids

- **C-type asteroids** are rich in **carbon** and are where most meteorites on Earth originated. The **OSIRIS-REx and Hayabusa 2 missions** have previously collected samples from C-type asteroids to bring back to our planet for study.
- **D-type and P-type asteroids** are much redder than C-type asteroids and are hypothesized to be rich in organic and volatile elements.
- No mission has ever flown past a D- or P-type asteroid before.

40 DOUBLE ASTEROID REDIRECTION TEST (DART) MISSION

CONTEXT: Recently, NASA's Double Asteroid Redirection Test (DART) successfully crashed into its target asteroid Dimorphous successfully altered the asteroid's orbit.

About the DART Mission:

- It is a planetary defence-driven test of technologies for preventing an impact on Earth by a hazardous asteroid.
- **Objectives:**
  - DART is the first technology demonstration of the kinetic impactor technique that could be used to mitigate the threat of an asteroid hitting Earth.
  - The kinetic impactor mitigation technique is the impulsive deflection of the asteroid through the sudden addition of momentum. In simpler terms, DART is being sent to collide with an asteroid to change its orbital period.

Why Dimorphos?

- Didymos is a perfect system for the test mission because it is an eclipsing binary which means it has a moonlet that regularly orbits the asteroid and it can be seen when it passes in front of the **main asteroid.**
- The Didymos system is not an **Earth-crossing asteroid**, and there is no possibility that the deflection experiment could create an impact hazard.

Hera Mission

- After NASA's DART mission, the **European Space Agency (ESA)** plans to launch the **Hera mission** in October 2024.
- Hera is another **planetary defence test** that is currently under development.
- It will investigate the **Didymos binary asteroid system** and measure the outcome of the DART mission in great detail.

41 JAMES WEBB SPACE TELESCOPE (JWST)

CONTEXT: The James Webb Space Telescope has discovered a group of galaxies from the dawn of the universe.

About the discovered group (universe breakers)

- The galaxies are so massive they should not exist. They have been dubbed "universe breakers".
- The six gargantuan galaxies, which contain almost as many stars as the **Milky Way** despite forming only 500 to 700 million years after the **Big Bang.**
- That's because, if they are real, the discovery calls our entire understanding of galaxy formation into question.

James Webb Space Telescope (JWST)

- The James Webb Space Telescope (JWST) was launched in December 2021 atop the European Ariane 5 rocket. It is a collaborative effort between NASA, ESA (European Space Agency), and the Canadian Space Agency.
- **Purpose and Capability:** JWST is a versatile observatory equipped with a large aperture telescope optimized for infrared observations. It boasts a suite of cutting-edge astronomical instruments capable of addressing various unresolved questions in astronomy.
- **Namesake:** The telescope is named after James E. Webb, a former administrator of NASA.
- **Orbit and Location:** Operating from an orbit around the Earth-Sun L2 Lagrange point approximately 1.5 million kilometers away from Earth, JWST enjoys simpler operational requirements and increased stability compared to its predecessor, the Hubble Space Telescope (HST). It orbits the Earth at an altitude of approximately 570 kilometers.
- **Temperature Regulation:** To prevent its own infrared emissions from interfering with astronomical observations, JWST operates at an extremely low temperature of approximately -233°C.

What is L2 point?

- Lagrange Points are areas where gravity from the **Sun and Earth** balance the orbital motion of a satellite.
- Putting a spacecraft at any of these points allows it to stay in a fixed position relative to the Earth and Sun with a minimum amount of energy needed for course correction.
- There are five "Lagrange Points" in space.
  - L2 is short-hand for the **second Lagrange Point.**

James Webb Space Telescope (JWST) Observatory:

The JWST observatory includes three main elements-

- the Integrated Science Instrument Module (ISIM)
- the Optical Telescope Element (OTE)
- the Spacecraft Element which comprises the spacecraft bus and **the sunshield**

42 PARKER MISSION

CONTEXT: NASA's Parker Solar Probe is a solar mission by the National Aeronautics and Space Administration (NASA). It is the first spacecraft to fly into the Sun's corona, its outermost atmosphere. It is also the fastest spacecraft ever built, travelling at speeds of up to 430,000 miles per hour (700,000 kilometres per hour).

About the mission:

Sun's Corona

- The Sun's corona is the **outermost part of the Sun's atmosphere**.
- The corona is usually hidden by the bright light of the Sun's surface.
- That makes it difficult to see without using special instruments. However, the corona can be viewed during a total solar eclipse (moon blocks out the bright light of the Sun).
- The corona reaches extremely high temperatures. However, the corona is very dim. The corona is about 10 million times less dense than the Sun's surface.
- This low density makes the corona much less bright than the surface of the Sun.

- The mission was launched in 2018 aboard a **United Launch Alliance Delta IV Heavy rocket.**
- NASA's Parker Solar Probe is the first spacecraft to fly into the **Sun's corona, its outermost atmosphere.**
- The spacecraft will study **magnetic fields, plasma, and energetic particles, and image the solar wind.**
- It became the first spacecraft to "touch" the sun when it swooped inside the sun's outer atmosphere, or **corona,** during its eighth flyby on April 28, 2021.
- **Destination**: NASA's Parker Solar Probe will fly more than seven times closer to the Sun than any spacecraft before. Over seven years, the spacecraft will complete

24 orbits around the Sun, coming within about 3.9 million miles (6.2 million kilometres) of the Sun at its closest approach.

Important Instruments:

- **Fields Experiment (FIELDS)** measures the electric and magnetic fields in the solar corona and solar wind.
- **Integrated Science Investigation of the Sun (ISIS)** measures the plasma and dust in the solar corona and solar wind.
- **Wide Field Imager for Solar Probe (WISPR)** measures the composition and energy of the particles in the solar wind.
- **Solar Wind Electrons Alphas and Protons (SWEAP)** will take images of the solar corona and solar wind.

43 GAMMA RAY BURST (GRB)

CONTEXT: Analysis of light of a gamma-ray burst, which dates back three billion years ago, has revealed the presence of a previously undetected black hole.

What is a gamma-ray burst?

- The gamma-ray burst that is known as **GRB 950830** was detected in 1995.
- GRBs are the most energetic form of electromagnetic events in the universe having short bursts of gamma rays that ejected at the speed of light.
- Gamma-ray bursts are formed when a high-mass star collapses and creates a neutron star or black hole.

Gamma-Ray Burst [GRB] is one of the most high-energy events in the universe and is powerful enough to be spotted billions of light-years away. One light-year is the distance travelled by a beam of light in 9.5 trillion km which is an Earth year.

- A Gamma-Ray Burst is detected only when the objects from the star's collapse rush towards the Earth at the speed of light. All the GRBs identified till now have originated in space external to the Milky Way galaxy.

44 PARTIAL SOLAR ECLIPSE

CONTEXT: A Partial solar eclipse has been seen on the western horizon shortly before the sunset on 25th October, 2022.

About the Partial solar Eclipse:

- A solar eclipse occurs when the moon "eclipses" the sun.
- This means that the moon, as it orbits the Earth, comes in between the sun and the Earth, thereby blocking the sun and preventing any sunlight from reaching us.

There are **four types** of solar eclipses:

- **Partial solar eclipse**: The moon blocks the sun, but only partially. As a result, some part of the sun is visible, whereas the blocked part appears dark. A partial solar eclipse is the most common type of **solar eclipse**.
- **Annular solar eclipse:** The moon blocks out the sun in such a way that the periphery of the sun remains visible. The unobscured and glowing ring, or "**annulus**," around the sun is also popularly known as the "**ring of fire**." This is the second most common type of eclipse.
- **Total solar eclipse**: As the word "total" suggests, the moon totally blocks out the sun for a few minutes, leading to a period of darkness -- and the resulting eclipse is called a **total solar eclipse.**
  - During this period of darkness, one can witness the **solar corona**, which is usually too dim to notice when the sun is at its full glory.
  - Also noticeable is the **diamond ring** effect, or "**Baily's beads**," which occurs when some of the sunlight is able to reach us because the moon's surface is not perfectly round. These imperfections (in the form of craters and valleys) can allow sunlight to pass through, and this appears just like a bright, shining diamond.
- **Hybrid solar eclipse:** The rarest of all eclipses is a hybrid eclipse, which shifts between a total and an annular eclipse.
  - During a hybrid eclipse, some locations on Earth will witness the moon completely blocking the sun (a total eclipse), whereas other regions will observe an annular eclipse.

45 SARAS 3 TELESCOPE

CONTEXT: Recently, SARAS 3 has provided clues to the nature of the Universe's first stars and galaxies.

- Using data from the telescope which has been deployed over the **Dandiganahalli Lake and Sharavati backwaters** since 2020, astronomers and researchers have been able to determine properties of radio luminous galaxies formed just 200 million years post the Big Bang, a period known as the Cosmic Dawn.

About SARAS 3:

- The SARAS 3 radio telescope was invented and built by the astronomers at **Raman Research Institute (RRI).**

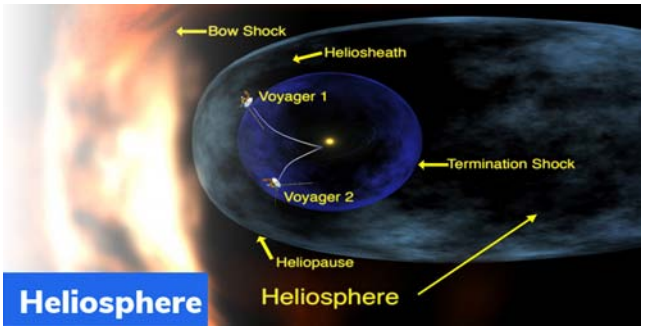
- It is the first telescope worldwide to reach the required sensitivity.
- The signal claimed to have been detected by the ASU/MIT team required exotic and non-standard physics and caused astrophysicists worldwide to invent new theories, which are all now redundant.
- It was a courageous attempt to design, build and deploy in India a precision radio telescope to detect extremely faint radio wave signals from the depths of time, from our "Cosmic Dawn" when the first stars and galaxies formed in the early Universe.

46 HELIOSPHERE

CONTEXT: Scientists have found unexplained structures and ripples at the border of solar system and interstellar space. Interstellar space begins after the heliosphere, a region where the sun's influence wanes.

About:

- **Heliosphere:** The solar wind, emanating from the Sun, creates a bubble that extends far past the orbits of the planets. This bubble is the heliosphere, shaped like a long wind sock as it moves with the Sun through interstellar space.
- **Heliosheath:** The heliosheath is the outer region of the heliosphere, just beyond the termination shock, the point where the solar wind slows abruptly, becoming denser and hotter. The solar wind piles up as it presses outward against the approaching wind in interstellar space.



- **Heliopause:** The boundary between solar wind and interstellar wind is the heliopause, where the pressures of the two winds are in balance. This balance in pressure causes the solar wind to turn back and flow down the tail of the heliosphere.
- **Bow shock:** As the heliosphere plows through interstellar space, a bow shock forms, similar to what forms as a ship plowing through the ocean.

47 NEUTRINO

CONTEXT: Tamil Nadu has made clear to the Supreme Court that it does not want the Indian Neutrino Observatory (INO) to be set up in a sensitive ecological zone in the Western Ghats at great cost to wildlife, biodiversity, and by ignoring the local opposition and public agitations to the project.

India-based Neutrino Observatory (INO) Project

Neutrinos

- Neutrinos were first proposed by Swiss scientist Wolfgang Pauli in 1930.
- They are the second most widely occurring particle in the universe, only second to photons, the particle which makes up light.

- The India-based Neutrino Observatory (INO) Project is a multi-institutional effort aimed at building **a world-class underground laboratory** with a rock cover of approx.1200 m **for non-accelerator based high energy and nuclear physics research in India.**
- The initial goal of INO is **to study neutrinos.**
- It is a mega-science project **jointly funded by the Department of Atomic Energy (DAE) and the Department of Science and Technology (DST).**

The project proposal includes:

- Construction of an underground laboratory and associated surface facilities at **Pottipuram in Bodi West hills of Theni District of Tamil Nadu.**
- Construction of an **Iron Calorimeter (ICAL) detector for studying neutrinos.**
- Setting up of **National Centre for High Energy Physics at Madurai,** for the operation and maintenance of the underground laboratory, human resource development and detector R&D along with its applications.

48 SHENZHOU-12

CONTEXT: A Chinese spaceship "Shenzhou-12" carrying a three-person crew docked with China's new space station module Tianhe-1.

About the mission

- China has launched three astronauts into orbit to begin occupation of the country's new space station.
- The three men are to spend three months aboard the **Tianhe module** some 380km (236 miles) above the Earth.

- The primary objective of the mission is to bring the **22.5-tonne Tianhe module** into service.

About Tianhe

- Tianhe is the foundational module for China's space station in low-Earth orbit.
- The module has a control center, docking hub and living quarters for three crew members. It'll also provide life support to those eventually on board.
- Tianhe was launched on April 29, 2021 on a Long March 5B rocket.

49 NASA'S TWO MISSIONS TO VENUS

CONTEXT: Recently, the new Chairman of Indian Space Research Organization (ISRO) has announced that it is expecting to launch the Venus mission by December 2024.

About the Mission

- The aim of the mission is to study Venus' atmosphere, which is toxic and corrosive in nature as clouds of sulfuric acid cover the planet.
- Earlier, the National Aeronautics and Space Administration (NASA) announced two new robotic missions (**DaVinci Plus and Veritas**) to Venus.
- **Objective:**
  - Investigation of **surface process and shallow subsurface stratigraphy.**
  - Until now, no prior observation of the sub-surface of Venus has been done.
  - Stratigraphy is a **branch of geology** in which **rock layers and layering are studied.**
  - Study of the **structure, composition and dynamics of the atmosphere.**
- Investigation of **Solar wind interaction with Venusian ionosphere.**

Overview of Venus

- Venus is the second planet from the Sun and is Earth's closest planetary neighbor.
- It's one of the four inner, terrestrial (or rocky) planets, and it's often called Earth's twin because it's similar in size and density.
- Venus has a thick, toxic atmosphere filled with carbon dioxide and it's perpetually shrouded in thick, yellowish clouds of sulfuric acid that trap heat, causing a runaway greenhouse effect.
- It's the **hottest planet** in the solar system, even though Mercury is closer to the Sun.

50 NASA'S OSIRIS-REX

CONTEXT: The National Aeronautics and Space Administration (NASA) is preparing for the final phase of the OSIRIS-REx mission as the spacecraft is set to drop a capsule containing samples from the asteroid Bennu on Earth.

The OSIRIS-REx mission,

- Short for Origins Spectral Interpretation Resource Identification Security - Regolith Explorer, is an ongoing project conducted by NASA. It recently made headlines by returning samples from the asteroid Bennu to Earth in September 2023. Now, it's gearing up to study another asteroid, Apophis, in 2029.
- **Launch (2016):** NASA launched the ambitious OSIRIS-REx mission in 2016 with the goal of journeying to Bennu, a near-Earth asteroid.
- **Arrival at Bennu (2018):** After a two-year journey, OSIRIS-REx entered orbit around Bennu in 2018.
- **Sample Collection (Oct. 20, 2020):** In a significant milestone, OSIRIS-REx made a brief touchdown on Bennu's surface on October 20, 2020, successfully retrieving a sample.
- **Return to Earth (Sept. 24, 2023):** The spacecraft then delivered the precious sample back to Earth on September 24, 2023, marking a historic achievement.
- **Extended Mission:** Following the sample return, OSIRIS-REx is embarking on an extended mission to study asteroid Apophis.
- The OSIRIS-REx mission is crucial for scientists as it offers insights into planetary formation and the origins of life. Additionally, it enhances our understanding of asteroids that could potentially pose a threat to Earth.

Facts about Asteroid

- Asteroids are the bits and pieces left over from the formation of the planets, and as such, they serve as rudimentary blueprints of the early solar system.

Bennu:

- Bennu is one of several thousand near-Earth objects orbiting within 120 million miles (190 million km) of Earth.
- Among those, Bennu was one of less than 200 objects whose orbit was well-known and sufficiently similar to Earth's orbit.
- This asteroid orbits the sun every 436 days and comes very close to Earth every six years.
- It was discovered by a team from the NASA-funded Lincoln Near-Earth Asteroid Research team in 1999.

- It is a **B-type asteroid**, implying that it contains significant amounts of carbon and various other minerals.

Apophis:

- Apophis is another potentially hazardous asteroid that was recently removed from the **Sentry Impact Risk Table** which keeps track of asteroids where an Earth impact cannot be ruled out.

51 NASA'S PSYCHE MISSION

CONTEXT: NASA's Psyche spacecraft is on its voyage to an asteroid which a metal-rich world that could tell us more about the formation of rocky planets.

About the mission:

- Psyche is a NASA mission set to explore the metallic asteroid '16 Psyche,' spanning 140 miles (225 kilometers) in diameter.
- This mission aims to investigate a metal-rich asteroid to gain insights into the formation of our planet.
- '16 Psyche' is unique, believed to be the exposed core of a shattered planet, and no spacecraft has ever visited a celestial object like it.
- Discovered in 1852 by Italian astronomer Annibale de Gasparis, '16 Psyche' is named after the ancient Greek goddess of the soul.
- With a mass of about 440 billion billion pounds (220 billion billion kilograms), '16 Psyche' constitutes 0.03% of Earth's moon's mass.
- Despite being the 11th most massive asteroid known, it's dwarfed by giants like Ceres and Vesta in the solar system.

Space Rock:

- Meteoroids are **fragments and debris in space** resulting from collisions among asteroids, comets, moons, and planets.
- They are among the smallest "space rocks." They can be seen when they streak through our atmosphere in the form of **meteors and meteor showers**.

52 "CONTACT BINARY" SATELLITE – 'SELAM'

CONTEXT: NASA's Lucy spacecraft discovered a surprise moonlet in orbit around Dinkinesh (nicknamed Dinky) during a flyby. Scientists have named it "Selam".

About NASA's Lucy

- NASA's Lucy spacecraft is on its way to study the Trojan moons of Jupiter, which are asteroids captured from the main belt between the **Red Planet** and the gas giant.
- There are two swarms of Trojan asteroids, one leading and one trailing the planet during its orbit around the Sun.
- Lucy will be visiting multiple targets in both the leading and the trailing swarm.
- Lucy will next be encountering the main belt asteroid **Donald Johanson** in 2025.

The **fossil Selam** was discovered in 2000 in Dikika, Ethiopia, and belonged to a 3-year-old girl of the same species as Lucy.

53 CHIME TELESCOPE

CONTEXT: Canadian Hydrogen Intensity Mapping Experiment (CHIME) has assembled the largest collection of fast radio bursts (FRBs).

- Researchers at the Pune-based Tata Institute for Fundamental Research (TIFR) and the National Centre for Radio Astrophysics (NCRA) achieved it.

About CHIME:

- **Stationary**: It is a **novel radio telescope** that has no moving parts.
  - It is located in **British Columbia, Canada.**
- **Tasks:** It was originally conceived to map the most abundant element in the universe that is Hydrogen.

Fast radio bursts (FRBs)

- **FRBs** are bright flashes of light that appear for a few milliseconds and then vanish. Since the first FRB was discovered in 2007.
  - CHIME has also discovered new "Fast Radio Bursts" and for monitoring many pulsars on a daily basis.
- **Working:** This telescope is optimized to have a high "mapping speed", which requires a large instantaneous field of view (~200 square degrees) and broad frequency coverage (400-800 MHz).

54 ENVISION MISSION TO VENUS

CONTEXT: Recently, European Space Agency (ESA) has announced a new mission- EnVision mission to Venus.

About:

- It is a **European Space Agency (ESA) led mission** with contributions from the **National Aeronautics and Space Administration (NASA).**
- It is likely **to be launched sometime in the 2030s.** Once launched on an **Ariane 6 rocket**, the spacecraft will take about 15 months to reach Venus and will take 16 more months to achieve orbit circularisation.
- **Aim:** The mission will carry a range of instruments to study the **planet's atmosphere and surface, monitor trace gases in the atmosphere** and **analyse its surface composition.**
  - EnVision will follow another ESA-led mission to Venus called **'Venus Express' (2005-2014)** that **focused on atmospheric research and pointed to volcanic hotspots** on the planet's surface.

Other Missions:

- **US:** NASA has announced two new robotic missions to Venus - **DAVINCI+ and VERITAS**. It will be launched between 2028-2030. Mariner series 1962-1974, Pioneer Venus 1 and Pioneer Venus 2 in 1978, Magellan in 1989.
- **Russia: Venera** series of space craft's 1967-1983, **Vegas** 1 and 2 in 1985.
- **Japan: Akatsuki spacecraft** has been studying the planet's atmosphere since 2015.

Indian Initiative:

- India plans to launch a new orbiter named **Shukrayaan to Venus in 2024.**

55 JUICE MISSION

CONTEXT: Europe's first-ever Jupiter mission (Jupiter Icy Moons Explorer (Juice)) is officially underway.

About

- Led by the **European Space Agency (ESA),** JUICE aims to explore three possible ocean-bearing moons – **Europa, Ganymede and Callisto.**

Ganymede	Ganymede is the largest moon in the solar system, according to NASA, and Earth is about 2.4 times bigger than it. It is larger than the planet Mercury. It is the only moon in the solar system that possesses its own magnetic field, like Earth.
Callisto	Callisto is believed to have the oldest surface in the solar system. Earth is about 2.6 times the heavily cratered object.
Europa	Earth is about 4.1 times the size of Europa and is believed to have a young and active surface that may vent water vapour to space via plumes and geysers.

  - JUICE will investigate Jupiter's gaseous complex surface in depth and its relationships with the oxygen and icy sub-surface saltwater ocean moons.
  - By July 2031, the spacecraft will have entered Jupiter's orbit, from which it will probe Ganymede, Europa and Callisto.

56 SHUKRAYAAN MISSION

CONTEXT: ISRO's Venus mission, Shukrayaan I may be postponed to 2031. ISRO's Venus mission was expected to be launched in December 2024.

- Both the U.S. and the European space agencies have **Venus missions planned for 2031 — VERITAS and EnVision, respectively** — while China may launch around 2026 or 2027.

What is Shukrayaan I Mission?

- Shukrayaan I will be **an Orbiter Mission.** Its scientific payloads **currently include a high-resolution Synthetic Aperture Radar (SAR)** and a ground-penetrating radar.

- **SAR** would examine Venus' surface, despite the clouds around the planet, which lowers visibility.
- It refers to **a technique for producing high-resolution images.** Because of the precision, the radar can penetrate clouds and darkness, which means that it can collect data day and night in any weather.
- The mission is expected to **study Venus's geological and volcanic activity,** emissions on the ground, wind speed, cloud cover, and other planetary characteristics from an elliptical orbit.
- Shukrayaan-I will be launched on either GSLV Mk II or **GSLV Mk III,**

Objectives:

- Investigation of surface process and **shallow subsurface stratigraphy.** Until now, no prior observation of the sub-surface of Venus has been done.
- Stratigraphy is a branch of geology in which rock layers and layering are studied.
- Study of the structure, composition and dynamics of the atmosphere.
- Investigation of **solar wind interaction with Venusian ionosphere.**

57 AIR BREATHING ENGINES

CONTEXT: In a quest to launch satellites in predetermined orbits at a low cost, India has crossed a key milestone by successfully conducting a hot test for its scramjet's engine.

About:

- A scramjet engine is an improvement over the **ramjet engine.**
- India is the fourth country to demonstrate the flight testing of a Scramjet Engine.
- In Supersonic Combustion Ramjet or Scramjet engines, the combustion takes place in supersonic airflow.
- Such engines use oxygen from the atmosphere in the combustion of fuel.

58 RISAT-2

CONTEXT: Recently, the Indian Space Research Organisation's (ISRO) RISAT (Radar Imaging Satellite)-2 satellites has made an uncontrolled re-entry into the Earth's atmosphere at the predicted impact point in the Indian Ocean near Jakarta.

- RISAT-2 is India's first "eye in the sky" which keep surveillance on the country's borders as part of anti-infiltration and anti-terrorist operations.

About:

- RISAT-2 is a **Radar Imaging Satellite** with all-weather capability to take images of the earth. This Satellite enhances **ISRO's capability for Disaster Management applications.**
- The principal sensor of Risat-2, considered a 'spy' satellite, was an X-band synthetic-aperture radar from Israel Aerospace Industries.
- Risat-2 was built more quickly following the 2008 Mumbai terror attacks due to delay with the indigenously developed **C-band** for **Risat-1 satellite**. The satellite, which was India's first dedicated reconnaissance satellite, possessed day-night as well as all-weather monitoring capability.
- It was also used to track hostile ships at sea that were deemed a military threat.
- **Launch:** Risat-2, weighing about 300 kg was launched on April 20, 2009, by the PSLV-C12 launch vehicle.

59 STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY (SOFIA) MISSION

CONTEXT: Recently, the National Aeronautics and Space Administration (NASA) announced the end of operations of its observatory Stratospheric Observatory for Infrared Astronomy (SOFIA) mission.

About SOFIA

- It is a joint program between **NASA and the German Aerospace Centre (DLR)**, and is a telescope capable of making observations from onboard an aeroplane.
- It is a 2.7-meter **infrared telescope** sitting inside a Boeing 747SP aeroplane, flying at an altitude of **38,000-45,000 feet above the surface.**
- It is **globally unique a**nd, with the **start of regular operations in 2014**.
  - It has been successfully used for scientific research during a total of approximately 800 flights.
- It was designed to **observe cosmic objects in far-infrared wavelengths.**
  - This allows researchers to watch star formation by looking through huge, cold clouds of gas.
- **Important discoveries and Achievements**
  - The project has generated **309 scientific studies**.
  - In 2020, SOFIA discovered water molecules (H2O) on the sun-facing side **of the Moon.**

- In 2019, SOFIA also discovered **helium hydride** — the first molecule formed in the **Universe almost 14 billion years ago.**
- SOFIA also identified **atmospheric circulation patterns** in **Jupiter.**
- It also mapped the **magnetic field within G47, one of the Milky Way's spiral arms.**

60 GAIA SPACE MISSION

CONTEXT: The European Space Agency's star-mapping Gaia probe, covering almost 1.8 billion stars in the Milky Way galaxy, has revealed an unexpected phenomena called 'starquakes', which are similar to earthquake-like movements but on the surface of stars.

About

- The Gaia Space Mission, launched in 2013 by the European Space Agency (ESA), focuses on studying the Milky Way.
- It aims to create the most precise 3D map of our galaxy by surveying one billion stars, representing 1% of the Milky Way's 100 billion stars.

About Starquakes

Starquakes are tiny motions on the surface of a star – that change the shapes of stars, something the observatory was not originally built for.

- Equipped with two optical telescopes and a billion-pixel camera, Gaia observes from a strategic position 1.5 million kilometers from Earth, stationed at the Lagrange 2 point.
- Gaia's observations include star positions, motions, velocities, brightness, temperatures, and compositions.
- Key revelations include a comprehensive map of the galaxy, insights into stars' chemical compositions, colors, temperatures, ages, and brightness levels, along with detailed 3D motions from our solar neighborhood to distant galaxies.

Milky Way

- The Milky Way, our home galaxy, is just one of the estimated one to two hundred billion galaxies of varied shapes and sizes in the universe.
- Roughly 13 billion years old, the Milky Way is a **barred spiral galaxy** consisting of 100 to 200 billion stars, with the **sun as its local star.**
- The Milky Way is part of a **local group of galaxies, including Andromeda**—its nearest large galaxy, and nearly 60 smaller galaxies.

61 GSAT-24

CONTEXT: Recently, New Space India Limited (NSIL) launched GSAT-24 in its first "demand-driven" communication satellite mission post space sector reforms.

About GSAT-24

- NewSpace India Limited (NSIL), a Government of India company under **Department of Space (DoS)** has undertaken **GSAT-24 satellite mission** as its 1st **Demand Driven mission** post space reforms.
  - It is built by **Indian Space Research Organisation (ISRO).**
- It is a **24-Ku band communication satellite** weighing **4180 kg** with **Pan India** coverage for meeting **DTH application need**s.
  - NSIL has leased the entire satellite capacity to M/s Tata Play.
- The **satellite** was successfully **placed into geostationary orbit** by the **Ariane 5 rocket,** operated by **French company Arianespac**e, from Kourou in French Guiana (South America) .
  - The Ariane 5 has successfully placed two satellites into geostationary orbit: **MEASAT-3d for the Malaysian operator MEASAT, and GSAT-24.**

62 KUAFU-1

CONTEXT: China launches first solar observatory to solve mystery of Sun's eruptions recently.

About Kuafu-1

- It is **Advanced Space-based Solar Observatory (ASO-S), named** after a giant in Chinese mythology who chased the sun.
- It is the **fourth big mission exploring the Sun after the Nasa Parker Solar Probe**.
- It **has been placed in an orbit about 720 km** above the planet, higher than the orbit of the International Space Station.
- **Aim:** To study the causality between the solar magnetic field and two major eruptive phenomena: solar flares and coronal mass ejections.

63 SPACE DEBRIS- NETRA PROJECT

CONTEXT: ISRO is building up its orbital debris tracking capability by deploying new radars and optical telescopes under the Network for Space Objects Tracking and Analysis (NETRA) project.

- For protecting its space assets, ISRO was forced to perform 19 **collision avoidance manoeuvres (CAM)** in 2021, of which 14 were in **Low Earth Orbit (LEO)** and five in the geostationary orbit.
  - The number of CAMs jumped from just three in 2015 to 12 in 2020 and 19 in 2021.

What is Network for Space Objects Tracking and Analysis (NETRA) project?

- Project NETRA is an **early warning system** in space to detect debris and other hazards to Indian satellites.
- ISRO SSA Control Centre, "NETRA", is now set up within the **ISTRAC campus at Peenya, Bangalore.**
- NETRA's eventual goal is to capture the GEO, or geostationary orbit, the scene at 36,000 km where communication satellites operate.
- Under NETRA, or Network for space object Tracking and Analysis, the ISRO plans to put up many observational facilities:
  - connected radars, telescopes
  - data processing units
  - a control centres.
- They can, among others, spot, track and catalogue objects as small as 10 cm, up to a range of 3,400 km and equal to a space orbit of around 2,000 km.

64 LONG MARCH 5B ROCKET

CONTEXT: Recently, China successfully launched the Long March 5B' rocket and prototype spacecraft.

Key-highlights

Space Station

- A space station is a spacecraft capable of supporting crew members, designed to remain in space for an extended period of time and for other spacecraft to dock.

- It is being considered as China's successful step to operate a permanent space station and send astronauts to the Moon.
- India is also planning to launch its own space station.

About LM-5:

- The LM-5 launch vehicle is a **heavy, cryogenic liquid launch vehicle** newly developed by **China Aerospace Science and Technology Corporation.**
- The payload capability of LM-5 is 25 tons for **low Earth orbit (LEO),** and 14 tons for **Geostationary Transfer Orbit (GTO)**, capable of launching different kinds of spacecraft, such as LEO, GTO and sun-synchronous orbit (SSO) satellites, space station and lunar probe, etc.

65 OTHER MISSIONS

LAUNCH DATE	SATELLITE	LAUNCH VEHICLE	REMARKS
2023	**EOS-07 MISSION**	**SSLV-D2**	**Mission Objectives** • Demonstration of designed Payload capability of SSLV in LEO. • Injection of EOS-07 satellite and two passenger satellites Janus-1 & AzaadiSAT-2 into 450 km circular orbit. • **Small Satellite Launch Vehicle (SSLV)** is capable of launching **Mini, Micro or Nano satellites (10 to 500kg mass)** in to 500km planar orbit. SSLV is a three-stage vehicle with all solid propulsion stages and liquid propulsion based **Velocity Trimming Module (VTM)** as terminal stage.

2022	**Thybolt-1 & Thybolt-2**	**PSLV-XL C54**	⦿ The **Thybolt** is a **0.5U spacecraft bus** that includes a communication payload to enable rapid technology demonstration and constellation development for multiple users from **Dhruva Space** using their own **Orbital Deployer** with a minimum lifetime of 1 year, was deployed in the intended orbit.
2022	**TD-1 Anand**	**PSLV-XL C54**	⦿ The Anand three axis stabilized Nano satellite is a technology demonstrator for miniaturized electro-optical payload and all other sub-systems like TTC, power, onboard computer and ADCS from Pixxel, India was also placed in the orbit successfully
2022	**India** **Bhutan INS-2B (BhutanSat)**	**PSLV-XL C54**	⦿ INDIA-BHUTAN SAT a collaborative mission between India and Bhutan is **INS-2B satellite** for Bhutan with two payloads viz. ⦿ **NanoMx**, a multispectral optical imaging payload developed by **Space Applications Centre (SAC)** and APRS-Digipeater which is jointly developed by DITT-Bhutan and URSC was successfully deployed.
2022	**Oceansat-3/EOS 06**	**PSLV-XL C54**	⦿ EOS-06 is **third generation satellite** in the Oceansat series, which provides continued services of Oceansat-2 with enhanced payload capability. ⦿ The satellite onboard carries four important payloads viz. **Ocean Color Monitor (OCM-3**), **Sea Surface Temperature Monitor (SSTM), Ku-Band Scatterometer (SCAT-3), ARGOS**. ⦿ The EOS-06 is envisaged to **observe ocean color data, sea surface temperature and wind vector data** to use in **Oceanography, climatic and meteorological applications**.
2022	**EOS 02**	**SSLV-D1**	⦿ EOS-02 is an earth observation satellite designed and realised by ISRO. ⦿ This micro-sat series satellite offers advanced optical remote sensing operating in infra-red band with high spatial resolution.
2022	**PS4 with POEM (PSLV Orbital Experimental Module) Payload**	**PSLV-XL C53**	⦿ POEM hosts six payloads. ⦿ The PSLV Orbital Experimental Module (POEM) also known as **PS4 Orbital Platform (PS4-OP)** utilizes the spent PSLV fourth stage (PS4) to provide a long duration in-orbit platform for hosting payloads.
2022	**CMS-02 (GSAT-24)**	**Ariane 5 ECA VA-257**	⦿ First demand driven satellite of NSIL.
2022	**India** **Bhutan INS-2TD**	**PSLV-XL C52**	⦿ Joint Indo-Bhutanese technology demonstration satellite which is a precursor to INS-2B, first Bhutanese satellite.

2022	**United States** **India** **Taiwan** **INSPIRESAT-1**	**PSLV-XL C52**	◉ Developed jointly by **Indian Institute of Space Science and Technology (IIST)** of India, Laboratory for Atmospheric and Space Physics from the US and **National Central University of Taiwan.** ◉ It is equipped with a combat ionosphere probe to study earth's Ionosphere.
2022	**EOS-04** **(RISAT-1A)**	**PSLV-XL C52**	◉ ISRO Radar Imaging Satellite designed to provide high quality images under all weather conditions for applications such as Agriculture, Forestry & Plantations, Soil Moisture & Hydrology and Flood mapping.
2021	**EOS-03** **(GISAT-1)**	**GSLV Mk II F10**	◉ First satellite of GISAT constellation and first Indian real-time earth observation satellite intended in geostationary orbit. ◉ Failed to reach orbit as upper-stage of rocket did not ignite.
2021	**Sri Shakthi Sat**	**PSLV-DL C51**	◉ Developed by Sri Shakthi Institute of Engineering and Technology as a part of **UNITYSat constellation.**
2021	**GHRCESat**	**PSLV-DL C51**	◉ Developed by G. H. Raisoni College of Engineering Nagpur as a part of **UNITYSat constellation**.
2021	**JITSat**	**PSLV-DL C51**	◉ Developed by Jeppiaar Institute of Technology as a part of **UNITYSat constellation.**
2021	**Satish Dhawan Satellite (SDSat)**	**PSLV-DL C51**	◉ Nanosatellite developed by Space Kidz India to study radiations. Carried 25,000 names and a copy of **Bhagvad Gita** into space.
2021	**Sindhu Netra**	**PSLV-DL C51**	◉ For use by **Indian Navy** to keep surveillance over **Indian Ocean**.

PRACTICE QUESTION

1. Consider the following statements regarding the DRDO's 'Pralay' missile:

1. It is a surface-to-surface short-range ballistic missile (SRBM).
2. The solid-fuel, battlefield missile is based on the Prithvi Defence Vehicle.
3. The missile is meant for deployment along the Line of Actual Control (LAC) and Line of Control (LoC).

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) All three (d) None

2. Consider the following statements regarding Vikram-1 rocket:

1. It is a multi-stage launch vehicle.
2. It has the capacity to put around a 300-kilogramme payload into Low Earth Orbit (LEO).

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

3. Regarding Supra Thermal and Energetic Particle Spectrometer (STEPS) instrument, consider the following statements:

1. It is a part of the Aditya Solar Wind Particle EXperiment (ASPEX) payload.

2. STEPS has six sensors, and each of them observes and measures suprathermal and energetic ions in different directions.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

4. India's XPoSat mission aims to study bright astronomical X-ray sources in extreme conditions. Which characteristic of X-rays makes them suitable for studying objects like pulsars, galactic supernova remnants, and black holes?

(a) X-rays have a longer wavelength than visible light.

(b) X-rays have a much lower energy than visible light.

(c) X-rays have a much shorter wavelength and higher energy than visible light.

(d) X-rays are not emitted by objects with high temperatures.

ANSWERS				
1. (c)	2. (c)	3. (c)	4. (c)	

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CHAPTER 05

DEFENCE

MISSILE SYSTEM

CLASSIFICATION OF MISSILES

Based on launching base

- **Surface-to-Surface Missile**: A surface-to-surface missile is a guided projectile launched from a hand-held, vehicle mounted, trailer mounted or fixed installation. It is often powered by a rocket motor or sometimes fired by an explosive charge since the launch platform is stationary.
- **Surface-to-Air Missile**: A surface-to-air missile is designed for launch from the ground to destroy aerial targets like aircrafts, helicopters and even ballistic missile. These missiles are generally called air defence systems as they defend any aerial attacks by the enemy.
- **Surface (Coast)-to-Sea Missile**: A Surface (Coast)-to-Sea Missile is designed to be launched from land to ship in the sea as targets.
- **Air-to-Air Missile**: An Air-to-Air Missile is launched from an aircraft to destroy the enemy aircraft. The missile flies at a speed of 4 Mach.
- **Air-to-Surface Missile**: An Air-to-Surface Missile is designed for launch from military aircraft and strikes ground targets on land, at sea or both. The missiles are basically guided via laser guidance infrared guidance and optical guidance or via GPS signals. The type of guidance depends on the type of target.
- **Sea-to-Sea Missile**: Sea-to-Sea Missile is designed for launch from one ship to another ship.
- **Sea-to-Surface (Coast) Missile**: A Sea-to-Surface (Coast) Missile is designed for launch from ship to land based targets.
- **Anti-Tank Missile:** An Anti-Tank Missile is a guided missile primarily designed to hit and destroy heavily-armoured tanks and other armoured fighting vehicles. Anti-tank missiles could be launched from aircraft, helicopters, tanks and also from shoulder mounted launcher.

Based on Speed

- **Subsonic cruise missile:** Subsonic cruise missile flies at a speed lesser than that of sound. It travels at a speed of around 0.8 Mach. Example: **American Tomahawk cruise missile**, **Harpoon of USA and Exocet of France**.
- **Supersonic cruise missile:** Supersonic cruise missile travels at a speed of around 2-3 Mach i.e.; it travels a kilometre approximately in a second.
- **Hypersonic cruise missile:** Hypersonic cruise missile travels at a speed of more than 5 Mach.

Based on intended target

- **Ballistic missiles**: After the boost stage, ballistic missiles follow a trajectory mainly determined by ballistics. The guidance is for relatively small deviations from that. **Ballistic missiles are largely used for land attack missions**. Although normally associated with nuclear weapons, some conventionally armed ballistic missiles are in service, such as MGM-140 ATACMS.
- **Cruise missile**: Cruise missiles are generally associated with **land-attack operations**, but also have an important role **as anti-shipping weapons**.
  - They are primarily launched from **air, sea or submarine platforms in both roles**, although land-based launchers also exist.
- **Anti-ship and Anti-submarine**: These missile are generally use the missile in order to deliver another weapon system such as a torpedo or depth charge to the location of the submarine, at which point the other weapon will conduct the underwater phase of the mission.
- **Anti-tank**: it is man-portable missile proved and may be launched from aircraft, vehicles or by ground troops in the case of smaller weapons.

1 ASTRA AIR-TO-AIR MISSILE

CONTEXT: Recently, the Light Combat Aircraft (LCA) Tejas Limited Series Production-7 (LSP-7) successfully test fired the ASTRA indigenous Beyond Visual Range (BVR) air-to-air missile off the coast of Goa.

About ASTRA indigenous Beyond Visual Range (BVR):

- The Astra Mk-1 is a **Air-to-Air Missile (AAM).**
- BVM missiles are capable of engaging beyond the range of **20 nautical miles or 37 kilometers**.
- AAMs are fired from an **airborne asset** to destroy **an airborne target.**
- **Range:** The range for Astra Mk-1 is around 110 km.
  - The Mk-2 with a range over 150 km is under development and Mk-3 version with a longer range is being envisaged.
  - One more version of Astra, with a range smaller than Mk-1 is also under development.
- **Designed and Developed by:**
  - Defence Research and Development Organisation (DRDO)

What is a missile?

- A **missile** is a guided airborne ranged weapon capable of **self-propelled flight** usually by a jet engine or rocket motor.
- The word **missile** referred to **any projectile** that is thrown, shot or propelled towards a target; this usage is still recognized today.
- Missiles are thus also called **guided missiles** or **guided rockets** (when in rocket form).
- T**ypes:** Missiles are generally classified on the basis of their **Type, Launch Mode, Range, Propulsion and Warhead.**

2 AGNI SERIES

CONTEXT: India's Agni-V ICBM (Intercontinental-range Ballistic missile) has undergone nine successful trials since its maiden flight in 2012.

About Agni Series:

- Agni missiles are **long-range ballistic missiles** and form the backbone of India's nuclear deterrence.
- The series includes
  - Agni-I (700 km range)
  - Agni-II (2,000 km range)
  - Agni-III (3,000 km range)
  - Agni-IV (4,000 km range)
  - Agni-V (5,000 km range)

SERIES	ABOUT
Agni-I	⦿ It is a **two-stage Agni technology** demonstrator with a solid-fuel first stage. ⦿ It was first tested at the Interim Test Range in Chandipur in 1989. ⦿ It has a strike range of 700-1200 km and can carry a payload of 1,000 kg. ⦿ As compared to Agni-II, Agni-I is less costly, simple, accurate and more mobile.
Agni-II	⦿ It is a two-stage ballistic missile with a strike range of 2,000-3000 km. ⦿ It can carry a payload of 1,000 kg and was first launched in 2012.

Agni-III	⦿ It is the third in the Agni series of missiles. ⦿ It is an intermediate-range ballistic missile with a 3,500-5,000 km range. ⦿ It can carry a payload of 1,500 kg.
Agni-IV	⦿ It is an intermediate-range ballistic missile with a range of around 4,000 km ⦿ Agni-IV bridges the gap between Agni II and Agni III. Agni-IV can take a warhead of 1,000 kg. ⦿ With state-of-the-art technologies, Agni-IV is designed to increase kill efficiency and higher range performance. ⦿ It can be fired from a road-mobile launcher.
Agni-V	⦿ It is a solid-fuelled intercontinental ballistic missile (ICBM) which has a strike range of over 7,000 km.
Agni-P	⦿ Agni-P is the sixth missile in the Agni (missile) series of ballistic missiles. ⦿ It is a family of medium to intercontinental range ballistic missiles developed by India, named after one of the five elements of nature.

3 AGNI P MISSILE

CONTEXT: In a significant milestone, India's Defence Research and Development Organisation (DRDO) successfully conducted a flight test of the new generation ballistic missile called 'Agni Prime'.

What is Agni Prime?

- The **Agni P missile**, developed by India's DRDO, is a **two-stage ballistic missile** that uses solid propellant and is stored in a canister.
- It is equipped with a redundant navigation and guidance system.
- The Agni Prime missile is an advanced version of Agni-I and Agni-II missiles which are currently in operational use by the Strategic Forces Command.
- Agni P incorporates significant upgrades including an improved composite motor casing, a **manoeuvrable re-entry vehicle (MaRV),** and enhanced propellants, navigation, and guidance systems.
- With the inclusion of a MaRV, the Agni-P missile gains the ability to deliver warheads to two distinct targets.

4 MULTIPLE INDEPENDENTLY TARGETABLE RE-ENTRY VEHICLE (MIRV)

CONTEXT: Agni-P, the latest but miniaturized version of Agni missiles, reportedly carried MIRVs or its decoys during its first test flight in June 2021 and during pre-induction night launch conducted by the Strategic Forces Command.

What is multiple independently targetable re-entry vehicle (MIRV)?

- A **multiple independently targetable re-entry vehicle (MIRV)** is a **sophisticated missile technology** that allows a **single ballistic missile** to carry multiple warheads, each capable of being aimed at hitting a different target.
- The concept of MIRV involves launching multiple independently targetable re-entry vehicles (ICBMs and SLBMs) carrying nuclear warheads.
- This technology is significant in strategic nuclear warfare, as it enables a single missile to effectively target several locations simultaneously.

Pakistan's Ababeel

- Pakistan successfully test-fired a **medium-range ballistic missile**, designed to penetrate **India's developing air defense system.**
- The Ababeel weapon system is designed to deliver multiple warheads in a single flight.
- Ababeel is capable of carrying **independently targetable re-entry vehicles (MIRVs).**

5 PRITHVI SERIES

CONTEXT: Seeking to enhance its precision strike capabilities, India is planning to replace its 150 km-range Prithvi ballistic missiles with the newly developed quick reaction Prahar missiles.

About Prithvi Series:

- The Prithvi is India's **first indigenously developed ballistic missile**.
- It is a **Short-Range Ballistic missile (SRBM)** and evolved from the **Integrated Guided Missile Development Program.**

- The missiles come in various variants like:
  - Prithvi-I (150 km range)
  - Prithvi-II (250 km range)
  - Prithvi-III (350 km range)
- These missiles are known for their tactical advantages and quick deployment.

6 PRALAY MISSILE

CONTEXT: India's surface-to-surface short-range ballistic missile (SRBM) "Pralay" was successfully test-fired.

About Pralay Missile

- Pralay is a **350-500 km short-range**, **surface-to-surface missile** with a payload capacity of 500-1,000 kg.
- It is a **solid-fuel, battlefield missile** based on the **Prithvi Defence Vehicle (PDV)** from **Indian Ballistic Missile Defence Programme** and **Prahaar tactical Missile.**
- Pralay has been developed for deployment along the Line of Actual Control (LAC) and Line of Control (LoC).
- The missile can be compared with China's 'Dong Feng 12' and Russia's 'Iskander'.

Prahaar Missile

- 'Prahaar', developed by the Defence Research and Development Organisation (DRDO), is capable of filling the gap between the multi-barrel rocket system 'Pinaka' and medium-range ballistic missile 'Prithvi'.
- It can also engage multiple targets in different directions.
- **High manoeuvrability.**

7 ASTRA MISSILE

CONTEXT: The Indian Air Force (IAF) has placed two contracts with Bharat Dynamics Limited (BDL) for the indigenous Astra Beyond Visual Range (BVR) Air to Air Missile and the first batch is expected to be inducted by the end of 2023.

What is Astra?

- Astra is a **state-of-the-art BVR air-to-air missile** with a range of over 100 km designed to engage and destroy highly manoeuvrable supersonic aerial targets.
- It is designed and developed by the **Defence Research and Development Laboratory (DRDL), Research Centre Imarat (RCI)** and other DRDO laboratories.

8 NIRBHAY MISSILE

CONTEXT: Bharat Dynamics, which has been reported to make the Nirbhay class of missiles, may get a shot in the arm as all three defence forces will reportedly induct these weapons designed to hit a target more than 1,000 kilometres away.

About

- The Nirbhay class cruise missiles complement the **supersonic BrahMos cruise missiles** that travel a shorter range.
- The Nirbhay class long-range cruise missiles have been developed by the **Defence Research and Development Organisation (DRDO)** indigenously and travel at a speed lower than that of sound.
- It equips a land-based mobile launcher and carries high-explosives or submunitions, although a small nuclear warhead with a 12 KT yield is also possible.

9 NAG ANTI-TANK GUIDED MISSILE (ATGM)

CONTEXT: India's Defence Research and Development Organisation (DRDO) recently confirmed that the Nag anti-tank guided missile (ATGM), the development of which was started in the 1980s, has cleared all the flight and user trials required for induction into the Indian Army.

What is Nag Missile?

- The Nag ATGM was developed by **Bharat Dynamics Limited (BDL)** and the **DRDO's Defence Research and Development Laboratory (DRDL)** to meet an Indian Army requirement for a vehicle- and air-launched ATGM with a maximum range of 4 km.
- The Nag is a **tripod-mounted ATGM** that can also be mounted on helicopters and the **Nag Missile Carrier (NAMICA) armoured vehicle**, a variant of the **Russian BMP-2 Sarath** developed by the DRDO.
- For targeting, the Nag missile employs a **passive mercury cadmium telluride (MCT) focal plane-array imaging infrared (IIR)/longwave IR (LWIR) seeker**.
- The missile uses a **lock-on before launch (LOBL) mode**; however, it is designed with stretch potential for **lock-on after launch (LOAL) capability.**
- It uses a high-energy nitramine-based, extruded double-band, smokeless sustainer propellant.
- The missile uses an **8 kg tandem high-explosive anti-tank (HEAT) warhead**.

- The warhead is capable of penetrating 800 mm of **rolled homogeneous armour equivalent (RHAe)** behind **explosive reactive armour (ERA).**
- The Nag has a length, diameter, and weight of 1.83 m, 0.15 m, and 42 kg respectively.

10 B-05LV MISSILE

CONTEXT: A Short-range B-05LV missile was successfully test-fired by DRDO.

About

- Also Known as **"Sagrika",** the **Short-range B-05LV missile** has a range of more than 700 kilometres and it is currently in service with **India's SSBN Fleet.**
- BS-05 is the code name for **K-15 Submarine launched Ballistic Missile (SSBN).**
- The K-15 is a two-stage submarine-launched ballistic missile which uses a gas booster to eject out of its launch platform and rise up to the surface of water. A solid rocket motor is fired after the missile reaches a fixed altitude.
- The missile has a modest range of around 750 kilometres. The missile has a maximum speed of Mach 7.5.
- The missile uses inertial navigation system with GPS/ NavIC satellite guidance for mid-course and Terrain contour matching for terminal stage. The missile has demonstrated single digit impact-accuracy in the previous trials.
- The Shaurya missile is a canister-launched **Hypersonic surface-to-surface tactical missile** is speculated to be the land version of the under-water **Sagarika K-15 missile.**

11 ATMOSPHERIC MISSILE

CONTEXT: Defence Research and Development Organisation (DRDO) and Indian Navy successfully conducted a maiden flight trial of a sea-based endo-atmospheric interceptor missile off the coast of Odisha in the Bay of Bengal.

Endo-atmospheric missiles

- **Endo-atmospheric interception** means the missile fired by Indian testing agencies had destroyed the incoming enemy ballistic missile within the Earth's atmosphere.
  - The endo-atmospheric missiles are those that function within the earth's atmosphere and have a range of less than 100 kilometres.
- **Exo-atmospheric interception**, on the other hand, is for destroying incoming enemy ballistic missiles outside of the Earth's atmosphere at a higher altitude.
  - The exo-atmospheric missiles are capable of completing missions in the uppermost part of the earth's atmosphere.
- **India's phase-II ballistic missile defence interceptor AD-1,** which can engage a wide variety of targets, successfully completed its first flight test in November.
  - **Long-range ballistic missiles** and planes can be intercepted by the **AD-1 long-range interceptor missile** in both "low exo-atmospheric" and "endo-atmospheric" settings.

12 IAF TEST-FIRES EXTENDED-RANGE BRAHMOS

CONTEXT: For the second time this year, the Indian Air Force (IAF) fired the "extended-range" version of the BrahMos air-launched missile from a Sukhoi-30 MKI fighter aircraft.

About

- The BrahMos supersonic cruise missile has a two-stage solid propellant booster engine as its first stage which takes it to supersonic speed.
- The second stage is the liquid ramjet engine which takes it closer to Mach 3 (3 times the speed of sound) speed in the cruise phase.
- The BrahMos missile is universal for multiple platforms and can be launched from air, land, and sea platforms.
- The missile works on the 'Fire and Forget principle', meaning it doesn't require further guidance after launch, and it maintains a high supersonic throughout the flight.
- The missile is said to have a low radar signature.

"Extended-Range" version:

- The "extended-range" version means the missile can travel more than 300 km.
- Before India joined the **MTCR,** the Russian technology of the BrahMos was restricted as the MTCR limits the export of missile technology which can travel beyond 300 km.
- The missile cap of 300 km range on India was lifted after it was inducted into the Missile Technology Control Regime (MTCR) six years ago.

13 INS MORMUGAO

CONTEXT: INS Mormugao, an indigenously developed missile destroyer has been commissioned into the Indian Navy.

Details:

- **INS Mormugao (Pennant D67)** is the second of the **Project 15B** stealth-guided missile destroyers.
- The ship, named after a **key port in Goa**, was commissioned a day before the Goa Liberation Day celebrations.

What is Project 15B?

- The contract for four ships of Project 15B was signed in 2011.
- This Project is follow-on of the **Kolkata class (Project 15A) destroyers** commissioned in the last decade.
- A total of four ships are being developed under this project.
  - **Visakhapatnam:** The lead ship of the Project - INS Visakhapatnam has already been commissioned into the Indian Navy on 21 Nov 21.
  - **Mormugao**
  - **Imphal**
  - **Surat**

14 PHASE-II BALLISTIC MISSILE DEFENSE INTERCEPTOR

CONTEXT: India has successfully conducted the maiden flight test of the Phase-II Ballistic Missile Defence (BMD) interceptor AD-1 missile.

About AD (Air Defense)-1:

- The AD-1 is a **long-range interceptor missile**.
- AD-1 is a unique type of interceptor with advanced technologies available with only a very few nations in the world.
- It is designed for both **low exo-atmospheric and endo-atmospheric interception** of long-range ballistic missiles as well as aircraft.
- It is propelled by a two-stage solid motor and equipped with an indigenously-developed advanced control system, navigation, and guidance algorithm to precisely guide the vehicle to the target.

What's Ballistic Missile Defence (BMD) System?

- A Ballistic Missile Defence system (BMD) is a missile defense system that acts as a shield against ballistic missile attacks.
- A ballistic **missile can be intercepted in three phases:**
- **Terminal phase**: During the atmospheric descent phase.
- **Mid-course interception (in-flight interception):** Most preferred interception.
- **Lift-off phase:** Targeting at the launch point- requires advanced radars.

Indian Ballistic Missile Defence Programme:

- The Indian Ballistic Missile Defence Program is an initiative to develop and deploy a multi-layered ballistic missile defense system to protect India from ballistic missile attacks.
- **It was launched in 2000 after Kargil War** by the Atal Bihari Vajpayee government.
- In 2006, India successfully conducted the PADE (Prithvi Air Defence Exercise) in which an anti-ballistic missile, called the Prithvi Air Defence (PAD), an exo-atmospheric (outside the atmosphere) interceptor system, intercepted a Prithvi-II ballistic missile.

TWO- TIERS OF INDIA'S BMD

PRITHVI AIR DEFENCE (PAD)	ADVANCED AIR DEFENSE (AAD)
Also referred as Pradyumna Ballistic Missile Interceptor.	It is also called Ashwin Ballistic Missile Interceptor.
It's designed for High altitude interception (exo-atmospheric interception).	It's an endo-atmospheric interception system (for low-altitude interception).
Intercept missiles at altitudes between 50 – 80 km.	Altitude of interception is range up to 30 km.
The interceptor is Prithvi Defense Vehicle (PDV) which has two-stage, both with solid propellants.	It has a single-stage solid-fueled missile.

15 IAF TO INCREASE SUKHOIS ARMED WITH BRAHMOS SUPERSONIC CRUISE MISSILE

CONTEXT: The Indian Air Force (IAF) is set to increase the number of Sukhoi 30 (SU-30) MKI fighters integrated with BrahMos supersonic missile, which now has a range of over 500 kilometres.

About BrahMos Missile

- The BrahMos is **a ramjet supersonic cruise missile** of a short-range developed by the **Defence Research and Development Organisation (DRDO) and the Russian Federation's NPO Mashinostroyeniya (NPOM)**.
- It is named after **two major rivers** of India and Russia: **Brahmaputra and Moskva.**
- The use of BrahMos missiles for**land as well as anti-ship attacks.**
- They can be launched from **land, air and sea**, and all three variants are in service in the Indian armed forces.
- It is a two-stage (solid propellant engine in the first stage and liquid ramjet in second) missile.
- It operates on the "**Fire and Forgets**" principle i.e. it does not require further guidance after launch.
- BrahMos missiles are manufactured in India.

The Sukhoi 30 (SU-30) MKI fighter Jets

- The **Sukhoi Su-30MKI** is a twinjet multirole air **superiority fighter** developed by Russia's Sukhoi and built under licence by India's Hindustan Aeronautics Limited (HAL) for the Indian Air Force (IAF).
- A variant of the Sukhoi Su-30, it is a heavy, all-weather, long-range fighter.

The IAF currently has **40 SU-30 MKI** with BrahMos, the only supersonic cruise missile in the world.

16 HYPERSONIC PLATFORMS

CONTEXT: Recently, Russia used a hypersonic missile for the first time in the ongoing conflict with Ukraine.

What is a Hypersonic Missile?

- hypersonic missile is a weapon system **that flies at least at Mach 5 i.e. five times the speed of sound** and is maneuverable.
- The maneuverability of the hypersonic missile is **what sets it apart from a ballistic missile as the latter follows a set course** or a ballistic trajectory.
- Thus, unlike ballistic missiles, **hypersonic missiles do not follow a ballistic trajectory** and can be maneuvered to the intended target.
- The two types of hypersonic weapons systems are **Hypersonic Glide Vehicles (HGV) and Hypersonic Cruise Missiles**.

The HGV is launched from a rocket before gliding to the intended target while the hypersonic cruise missile is powered by air-breathing high-speed engines or **'scramjets'** after acquiring their target.

17 IRON BEAM

CONTEXT: Israel deployed Iron Beam laser system on Gaza front.

About

- The Iron Beam, also known as Magen or "Light Shielf," is a 100 kW class High Energy Laser Weapon System (HELWS).
- It is made to destroy a wide variety of threats, including unmanned aerial vehicles (UAVs), Rocket Artillery, Mortars, and RAM from a few hundred yards to several kilometres away. It is anticipated that it would launch first in its class as an operational system.
- It is a directed-energy weapon that emits strong laser beams, and it was built by Rafael Advanced Defence Systems.

18 THIRD STEALTH FRIGATE OF PROJECT 17A TARAGIRI LAUNCHED

CONTEXT: Mazagon Dock Shipbuilders Ltd (MDL) recently launched the third Stealth Frigate of Project 17A "Taragiri".

About Taragiri:

- Taragiri is the **indigenously-designed Nilgiri-class stealth guided-missile frigate** constructed by **Mazgaon Dock Shipbuilders Limited (MDL).**
- Taragiri is the **third stealth frigate** built as part of **Project 17A**under which a series of such guided-missile frigates are being constructed for the Navy.

- The steel used in the hull construction of P17A frigates is indigenously developed DMR 249A, which is a low carbon micro-alloy grade steel manufactured by the Steel Authority of India Limited.
- **Construction methodology:** This ship has been built using integrated construction methodology.
- In this method, several modules of the vessel are pre-constructed and later fitted on the ship.

Important Features

- **Base-design:** It has been built with Niligir-like features.
- **Stealth and modular profile**: The two key features of the Taragiri ship are expected to be stealth and modular profile.
- **Undetectable:** The vessel has been constructed using composite materials which can decrease its infrared signal and maintain a low radar cross-section, making it almost undetectable.
- **Missile system:** It will be fitted with supersonic surface-to-surface missile system.
- **Air defence capability:** Designed to counter the threat of enemy aircraft and anti-ship cruise missiles will revolve around the vertical launch and long range surface to air missile system.
- **Gunfire support, Torpedo and rocket launcher**:

19 AGM-88 HARM

CONTEXT: US has supplied some "anti-radiation missiles" to Ukraine, which could be fired from some Ukrainian Air Force aircraft.

AGM-88 HARM missile:

- The acronym 'HARM' in the AGM-88 HARM air-to-surface missile stands for High-Speed Anti-Radiation Missile.
- It is a tactical weapon fired from fighter aircraft, and has the capability to detect and home into radiation emitted by hostile radar stations that have surface-to-air detection capabilities.
- The missile was originally developed by the Dallas-headquartered Texas Instruments, but is now produced by the major American defence contractor Raytheon Corporation.
- An advanced version of the weapon is manufactured by Dulles, Virginia-based Northrop Grumman.
- It also has an anti-radar homing seeker broadband RF antenna and receiver, and a solid state digital processor.
- The missile has a range of more than 100 km.
- The AGM-88 can detect, attack and destroy a target with minimum aircrew input.
- The proportional guidance system that hones in on enemy radar emissions has a fixed antenna and seeker head in the missile nose.
- A smokeless, solid-propellant, dual-thrust rocket motor propels the missile.

20 HELLFIRE R9X MISSILE

CONTEXT: Ayman al-Zawahiri was killed in a US strike recently. The US military used its 'secret weapon', the Hellfire R9X missile, to kill him.

About

- The Hellfire R9X, also known as the 'Ninja Missile,' is a US-made weapon designed for precision strikes with minimal collateral damage.
- Instead of a warhead, it deploys razor-sharp blades at the final stage of its attack to eliminate individual targets.
- This unique design allows it to penetrate thick materials and neutralize targets using kinetic energy, sparing nearby individuals and structures from harm.
- It has been in active service since 2017, but its existence became widely known in 2019.
- A variant of the original Hellfire missile family, it is used primarily in unconventional operations where precision and minimal collateral damage are crucial.
- The original Hellfire missile family, developed to target tanks from Apache AH-64 attack helicopters, has since expanded to various aircraft, ground vehicles, ships, and drones.
- The Hellfire missile has other variants such as 'Longbow' and 'Romeo' apart from the 'Ninja'.

21 C-295 TRANSPORT AIRCRAFT

CONTEXT: India received its first C-295 transport aircraft, providing a crucial boost to the nation's defence capabilities.

About

- Airbus' new generation C295 is a robust, reliable and highly versatile tactical transport that is tailored for missions that range from carrying troops and cargo, maritime patrol, airborne warning, surveillance and reconnaissance to signals intelligence, armed close air support, medical evacuation, VIP transport and airborne firefighting.

- Adding to its flexibility is the capability of being equipped for the air-to-air refuelling of fixed-wing aircraft and helicopters.
- Fitted with a retractable landing gear and featuring an unobstructed 12.69-meter-long pressurized cabin, the C295 cruises at altitudes up to 30,000 ft., while also retaining excellent low-level flight characteristics. It has remarkable short take-off & landing (STOL) performance from unpaved, soft, and sandy/grass airstrips.
- The C295 is powered by two Pratt & Whitney Canada PW127G turboprop engines that provide excellent manoeuvrability, outstanding hot-and-high performance, with fuel consumption for a very long endurance of up to 13 hours aloft.

DRONES

22 MQ-9B PREDATOR DRONES

CONTEXT: India is planning to deploy 16 MQ-9B Predator drones on the land border, out of the total 31 drones being bought from the United States.

What are the Predator drones?

- The Predator drone or the MQ-9 Reaper is an **unmanned aerial vehicle (UAV)**.
- **Developed by:** General Atomics Aeronautical Systems
- It is primarily used for **long-endurance, high-altitude surveillance and strike missions.**
- The Reaper is the successor to the **MQ-1 Predator drone**. The development of the Predator began in the 1990s.
- Its ISR capabilities, endurance, and armament make it an effective tool for tracking and targeting insurgent and terrorist networks, disrupting their activities, and supporting ground operations.

Role and capabilities

- The primary role of the Predator drone is **intelligence, surveillance, and reconnaissance (ISR).**
- **Precision airstrikes:** It is capable to conduct precision airstrikes. It can carry and employ a range of munitions, including the **AGM-114 Hellfire missiles** and **GBU-12 Paveway II laser-guided bombs.**
- **Close Air Support:** The Reaper can provide close air support (CAS) to ground forces engaged in combat operations.
- **Real-time support:** It can loiter over an area for extended periods, allowing it to provide real-time support, reconnaissance, and strike capabilities to troops on the ground.
- **Image gathering and transmission:** It is equipped with a range of sensors and cameras that enable it to gather real-time imagery and transmit it to ground stations for analysis.

23 SONOBUOY

CONTEXT: The Indian Navy plans to equip the MQ-9B Sea Guardian medium altitude long-endurance (MALE) drones, which it is procuring from the United States, with sonobuoys, enhancing their ability to detect and track Chinese submarines lurking in the Indian Ocean Region (IOR).

About

- A sonobuoy is a small device used for underwater acoustic surveillance.
- It contains hydrophones that detect underwater sounds, especially those made by submarines.
- These devices are deployed from aircraft or ships and transmit real-time acoustic data, helping pin-point potential submarine threats.
- Sonobuoys were first used during the Second World War to detect German U-boats, and they got plenty of use during the Cold War, too, to track nuclear submarines around the world.
- But now they are also deployed in search and rescue operations, from missing planes to submarines.

24 ISKANDER-M MISSILE SYSTEM

CONTEXT: Russia threatened to send nuclear capable short-range missile systems to its ally Belarus.

Iskander-M system:

- The Iskander-M is a mobile guided missile system code-named **"SS-26 Stone"** by NATO, which replaced the **Soviet "Scud**."
- Russia defines Iskander-M System as both the **transporter-erector launch system and the short-range ballistic missile (SRBM) it fires.**

- The system can **also fire ground-launched cruise missiles (GLCMs)** – the SSC-7 and the SSC-8.
- The **Iskander-M system has been exclusively used by the Russian military**, whereas **Iskander-E is the one meant for export.**
- US-based think tank, the Center for Strategic and International Studies (CSIS), says that the Iskander missiles are designed to confuse missile defences by flying on a low trajectory and manoeuvring in flight to strike targets within 2 to 5 metres accuracy.

Missile's capability and range:

- **Range:** The Iskander-M missile has a **range of 500 km** and it can carry a payload of up to **700 kg.**
- **Weapon:** It is capable of **carrying both conventional and nuclear warheads**.
- The conventional warheads can be equipped with include cluster bombs, electromagnetic pulse (EMP) warheads and bunker-buster munitions.
- The export variant, Iskander-E, has a range of 280 km with a reduced 480 kg payload.

25 MEDIUM RANGE SURFACE-TO-AIR MISSILE (MRSAM)

CONTEXT: The DRDO conducted two successful flight tests of the Army version of Medium Range Surface to Air Missile (MRSAM).

About MRSAM:

- The MRSAM is a **surface-to-air missile** jointly developed by **DRDO and Israel Aerospace Industries (IAI)** for use by the Indian Army.
- The missile will **replace the ageing Air Defence systems** of the Army.
- The MRSAM weapon system comprises **multi-function radar, mobile launcher system and other vehicles.**
- It has Army, Navy and Air Force variants.
- The mobile **launcher can transport, place and launch eight canisterised missiles**.
- These can be fired either in single mode or in ripple firing mode in a vertical firing position.
- The missile's management system uses the radar to track and correctly identify the target, calculates the distance from it and gives all the information to the Commander for a decision to be made on interception.

List of the surface to air missiles in India:

- Akash
- Akash-1S
- Akash Mk2
- Akash-NG
- QRSAM
- Barak 8
- MR-SAM
- LR-SAM
- XR-SAM

- The missile itself is **5 metres in length with a weight of around 275 kg.**
- It is equipped with fins and canards to stabilise its flight and provide it manoeuvrability.
- The missile is powered by a solid propulsion system coupled with a thrust vector control system.
- The missile can move at a maximum speed of Mach 2 (twice the speed of sound).
- It can engage multiple targets upto a range of 70 km.

About DRDO

- DRDO is the R&D wing of Ministry of Defence, Government of India.
- DRDO was formed in 1958 from the amalgamation of the then already functioning Technical Development Establishment (TDEs) of the Indian Army and the Directorate of Technical Development & Production (DTDP) with the Defence Science Organisation (DSO).
- DRDO's pursuit of self-reliance and successful indigenous development and production of strategic systems and platforms have given quantum jump to India's military might, generating effective deterrence and providing crucial leverage, such as:
  - **Agni and Prithvi** series of missiles
  - light combat aircraft, **Tejas**
  - multi-barrel rocket launcher, **Pinaka**
  - air defence system, **Akash**
  - a wide range of radars and electronic warfare systems; etc.,

26 AKASH MISSILE SYSTEM

CONTEXT: India demonstrated the capability of the Akash missile system to engage four aerial targets simultaneously at a range of 25 kilometres.

About

- The Akash, with a range of up to 25 km, is a short-range surface to air missile primarily used for protecting vulnerable areas and points from air attacks.
- The missile system is among the key platforms that India is exporting to friendly foreign countries.
- Akash has built-in **electronic counter-counter measures (ECCM) features**, which can help the missile punch through enemy jamming and other methods of evasion.
- The entire Akash weapon system has been configured on mobile platforms. This makes it agile and nimble as it can be transported fast anywhere.

- The missile is 5,870 mm long, has a diameter of 350 mm, and weighs 710 kg.
- It can be made fully automatic with a quick response time from target detection to kill. Its open-system architecture ensures adaptability to existing and futuristic air defence environments.

27 INDIA DEVELOPING LRSAM SYSTEM

CONTEXT: India is developing a three-layered long-range surface-to-air missile (LRSAM) defence system that will be capable of hitting enemy aircraft and missiles up to 400km away.

About LRSAM

- The **LRSAM system** will be designed and developed by the **DRDO.**
- It is envisaged to detect and neutralise aerial threats such as **stealth fighters, aircraft, ballistic and cruise missiles, precision-guided munitions**, and **unmanned aerial vehicles (UAVs)** to ranges of nearly 350 km.
- The programme is valued at over USD2.5 billion, and it seeks to build a three-tiered air-defence system with interceptor missiles capable of hitting at 150, 250, and 350 km.
- The IAF aims to operationally deploy the system by 2028–29.

28 HWASONG-17

CONTEXT: North Korea has dramatically ramped up missile tests this year and tested an intercontinental ballistic missile (ICBM).

What are ICBMs?

- An intercontinental ballistic missile (ICBM) is a missile with a minimum range of 5,500 kilometers primarily designed for nuclear weapons delivery.
- Conventional, chemical, and biological weapons can also be delivered with varying effectiveness, but have never been deployed on ICBMs.
- ICBMs are differentiated by having greater range and speed than other ballistic missiles.
- Short and medium-range ballistic missiles are known collectively as theatre ballistic missiles.
- **The International Code of Conduct against Ballistic Missile Proliferation (ICOC),** now known as **the Hague Code of Conduct against Ballistic Missile Proliferation (HCOC),** is a political initiative aimed at globally curbing ballistic missile proliferation.
- **India is a signatory to this convention.**
- Established in April 1987, the voluntary Missile Technology Control Regime (MTCR) aims to limit the spread of ballistic missiles and other unmanned delivery systems that could be used for chemical, biological, and nuclear attacks.
- **India has joined the MTCR in 2016.**
- **Countries that have ICBMs**:
- India, Russia, the United States, North Korea, China, Israel, the United Kingdom, and France.
- **North Korea** conducted the first successful test of its **Hwasong-14 ICBM** in July 2017.

29 ASTRA MK-1

CONTEXT: Recently, the Ministry of Defence has signed a contract with the Hyderabad-based public-sector Bharat Dynamics Ltd (BDL) for supply of the Astra Mark-1.

- Contract was signed at a cost of Rs 2,971 crore, for deployment on fighter jets of the **Indian Air Force and Indian Navy.**

What are the Astra Missile and its Variants?

- The Astra project was officially launched in the early 2000s with defined parameters and proposed future variants.

What are the Key Highlights of the Astra Mk-1 Missile?

- The Astra Mk-1 is a Beyond Visual Range (BVR), Air-to-Air Missile (AAM).
- BVM missiles are capable of engaging beyond the range of 20 nautical miles or 37 kilometres.
- AAMs are fired from an airborne asset to destroy an airborne target.

Range:

- The range for Astra Mk-1 is around 110 km.
- The Mk-2 with a range over 150 km is under development and Mk-3 version with a longer range is being envisaged.
- **Designed and Developed by:** Defence Research and Development Organisation (DRDO)

30 ANTI-RADIATION MISSILE

CONTEXT: US has supplied some "anti-radiation missiles" to Ukraine, which could be fired from some Ukrainian Air Force aircraft.

AGM-88 HARM missile:

- The acronym 'HARM' in the AGM-88 HARM air-to-surface missile stands for High-Speed Anti-Radiation Missile.

- It is a tactical weapon fired from fighter aircraft, and has the capability to detect and home into radiation emitted by hostile radar stations that have surface-to-air detection capabilities.
- The missile was originally developed by the Dallas-headquartered Texas Instruments, but is now produced by the major American defence contractor Raytheon Corporation.
- An advanced version of the weapon is manufactured by Dulles, Virginia-based Northrop Grumman.
- The AGM-88 HARM is 14 metres in length, but only 10 inches in diameter.
- It weighs around 360 kg and carries a fragmentation type warhead that is optimised for radar targets.
- It also has an anti-radar homing seeker broadband RF antenna and receiver, and a solid state digital processor.
- The missile has a range of more than 100 km.
- The AGM-88 can detect, attack and destroy a target with minimum aircrew input.

31 HIMARS MISSILE SYSTEM

CONTEXT: Poland received the first batch of US-made HIMARS rocket launchers.

What is the HIMARS missile system?

- The **US-made High Mobility Artillery Rocket Systems** is known as HIMARS.
- It is a multiple launch rocket system, or MLRS - a mobile unit that can simultaneously launch multiple precision-guided missiles.
- **HIMARS** has superior range and precision.
- The **M142 HIMARS system (High Mobility Artillery Rocket System)** is a modernized, lighter and more agile wheel-mounted version of the track-mounted M270 MLRS developed in the 1970s for US and allied forces.

32 'DESI' S-400: PROJECT KUSHA

CONTEXT: At the heart of 'Project Kusha' is the development of India's very own Long-Range Surface-to-Air Missiles (LR-SAM) that, according to reports, is comparable to Russia's S-400 Triumf air defence system.

Key-features of Project Kusha:

- This is part of the development Project Kusha, recently cleared by the **Cabinet Committee on Security.**
- The mobile LR-SAM, with its long-range surveillance and fire control radars would have different types of interceptor missiles designed to hit hostile targets at **150 km, 250 km, and 350 km ranges.**
- The LRSAM is **three-layered long-range surface-to-air missile defence system** that is capable of striking down enemy aircraft and missiles from surface.
- The range of this system is **400 km.**
- **Medium Range Surface-to-Air Missile (MRSAM)** is one such missile system that is used by all three defence services of India. The addition of **S-400** will boost India's defence capabilities.

PRACTICE QUESTION

1. Which of the following is the primary objective of the Indian Air Force's 'Project Kusha', recently mentioned in news?

(a) To enhance India's space exploration capabilities.

(b) To strengthen India's coastal security against potential threats.

(c) To boost India's defense capability by developing a high-tech air defense system.

(d) To promote international collaboration in the field of missile technology.

2. With reference to the 'Dhanush artillery gun', consider the following statements:

1. Dhanush is a towed Howitzer designed indigenously by the Ordnance Factory Board (OFB).
2. It is the first long-range artillery gun to be produced in Russia.
3. It is an improved version of the FH-77B 155 mm/39-calibre field howitzers.

Which of the above statement(s) is/are correct?

(a) 1 and 2 only (b) 2 only

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

3. Regarding DRDO's Abhyas, consider the following statements:

1. It is capable of reaching an altitude of more than Twenty five kilometres using a high gas turbine engine.
2. The target aircraft is equipped with Micro-Electromechanical Systems-based Inertial Navigation System for navigation
3. The vehicle is programmed for fully autonomous flight.

Which of the statement(s) given above is/are correct?

(a) 1 only (b) 1 and 2 only

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

ANSWERS				
1. (c)	2. (c)	3. (c)		

FIGHTER JET SYSTEM

33 ISRAEL'S IRON DOME

CONTEXT: As, the Hamas has launched a major attack in Israel, killing 250 natives, Israel's Iron Dome model has spotted light again.

What is the Iron Dome?

- The Iron Dome is a short-range, **ground-to-air**, air defence system.
- It is used for countering **rockets, artillery & mortars (C-RAM)** as well as aircraft, helicopters and unmanned aerial vehicles.
- **Components:** The Iron Dome has three main systems that work together to provide a shield over the area where it is deployed which are:
  - **Radar:** It has detection and tracking radar to spot any incoming threats.
  - **Weapon Control**: It has a battle management and weapon control system (BMC),
  - **Missile Fire**: It also has a missile firing unit. The BMC basically liaises between the radar and the interceptor missile.

How does it work?

- The Iron Dome has three main systems that work together to provide a shield over the area where it is **deployed, handling multiple threats.**
- It has detection and tracking radar to spot any incoming threats, a battle management and weapon control system (BMC), and a missile firing unit.
- The BMC basically liaises between the **radar and the interceptor missile**.
- It is capable of being used in **all weather conditions**, including during the day and night.

34 INDIA-US DEFENCE DEAL

CONTEXT: India and the US have planned for a mega defence deal for jointly manufacturing indigenous jet engines of 'GE F414 fighter aircraft'.

GE F414 aircraft:

- GE F414 will power all future fighter jets including the **Tejas Mk II**, Advanced Medium Combat Aircraft (AMCA) as well as the **indigenous Twin Engine Deck Based Fighter (TEDBF**) for the Indian Navy.
- The F414 is an afterburning turbofan engine in the **22,000 pound (98 KN)** thrust class of engines.
- The Boeing Super Hornets and the Gripen fighter jets are among those aircraft that run on this engine.

35 TEJAS COMPLETES 7 YEARS OF SERVICE

CONTEXT: Indigenous Light Combat Aircraft (LCA) Tejas completed seven years of service in the Indian Air Force (IAF) on July 1 2023.

Background

- The **Light Combat Aircraft (LCA) program** was started in the early 1980s, with the Government of India (GoI) establishing the project in 1983 to replace **Mig-21 fighters**.
- The first prototype took its first flight in January 2001 and the fighter was named
- **Induction:**
- After more than a decade of trials, the first jet was finally inducted by the IAF in 2016 in the No. 45 squadron **'Flying Daggers'.**
- In 2020, the No.18 squadron **'Flying Bullets'** became the second squadron to start operating the jet.

What is Tejas Mk-1?

- The Tejas Mk-1 is light **supersonic multirole jet**, capable of doing multiple missions including
  - air-defence (air-to-air)
  - intelligence, surveillance and reconnaissance (ISR)
  - air-interdiction (striking enemy targets deep into enemy territory)
  - maritime strike and reconnaissance missions
- The jet carries, an **Israeli laser designating pod**, multi-mode radar, helmet mounted display system and self-protection suite.
- **Tejas Mk-1A**: Its other variant — **Tejas Mk-1A** — 83 of which the IAF ordered from Hindustan Aeronautics Limited (HAL) in a deal worth Rs 48,000 crore in 2021, will be even more advanced.
  - **Tejas Mk-1A** will have 40 major improvements compared to the Tejas Mk-1.
  - It will have an active electronically-scanned array radar for detecting enemy aircraft at greater ranges and resistance to jamming, a new advanced self-protection jamming suite (ASPJ), digital flying control computer (DFCC), as well as, faster turnaround times for each aircraft after every sortie.

Current status of fighter jets

- The IAF presently has 32 squadrons (16-18 planes each) of fighter jets against the 42 needed to tackle a collusive two-front threat against Pakistan and China.
- Over the next two-three years, all four squadrons (each one has 16-18 planes) of the Soviet-era MiG-21 fighter jets will retire.
- The IAF's Jaguar, MiG-29 and Mirage 2000 jet fleets — all inducted in phases during the 1980s — are slated to retire in batches beyond 2029-30.

36 MULTILATERAL EXERCISE DESERT FLAG VIII

CONTEXT: Five indigenous Light Combat Aircraft (LCA) along with a contingent of 110 Indian Air Force (IAF) personnel arrived at Al Dahfra airbase of United Arab Emirates (UAE) for participating in the multilateral Exercise Desert Flag VIII.

Background:

- In 2021, the defence ministry awarded Rs 48,000-crore contract to **Hindustan Aeronautics Limited** for 83 LCA Mk-1A jets for the IAF.
- The **first Mk-1A** aircraft will be delivered in February 2024, with the rest slated to join the combat fleet by 2029.
- The government gave its nod for developing **the LCA Mk-2**, a platform that will form an important element of future air combat.

About the exercise:

- Exercise **Desert Flag** is a multilateral air exercise in which Air Forces from **UAE, France, Kuwait, Australia, UK, Bahrain, Morocco, Spain, Republic of Korea, and USA** would also be participating.
- The exercise is scheduled from **February 27 to March 17.**
- **Aim:** To participate in **diverse fighter engagements** and learn from the best practices of various Air Forces.

Light Combat Aircraft:

- The **Light Combat Aircraft (LCA)** programme was started by the **Government of India in 1984** when they established the **Aeronautical Development Agency (ADA)** to manage the LCA programme.
- It replaced the ageing **Mig 21 fighter planes**.
- **Designed by:** Aeronautical Development Agency under the Department of Defence Research and Development.
- **Features:**
  - The lightest, smallest and tailless multi-role supersonic fighter aircraft in its class.
  - Designed to carry a range of air-to-air, air-to-surface, precision-guided, weapons.
  - Air to air refuelling capability.
  - Maximum payload capacity of 4000 kg.
  - It can attend the maximum speed of Mach 1.8.
  - The range of the aircraft is 3,000km

Variants of Tejas:

- **Tejas Trainer**: 2-seater operational conversion trainer for training air force pilots.
- **LCA Navy**: Twin- and single-seat carrier-capable for the Indian Navy.
- **LCA Tejas Navy MK2**: This is phase 2 of the LCA Navy variant.
- **LCA Tejas Mk-1A:** This is an improvement over the **LCA Tejas Mk1** with a higher thrust engine.

37 B-1B LANCER

CONTEXT: The United States Air Force (USAF) has once again sent their B-1B Lancers and an array of other defence machinery to participate in the Aero Show 2023 held at Bengaluru.

What is B-1B Lancer?

- B-1B Lancer, also known as 'Bone' (for B-one), carries the largest conventional payload of both guided and unguided weapons in the USAF.
  - It is considered the backbone of America's long-range bomber force.
  - This is the second time that the long-range, supersonic, heavy bomber is participating in Aero India.
  - The aircraft performed a fly-by on the inaugural day of Aero India 2021, escorted by an **Indian Air Force Tejas fighter.**
- The long-range, supersonic heavy-bomber which is dubbed Bone (for "B-one") carries the largest conventional payload of both guided and unguided weapons in the USAF.
  - Apart from the B-1s, the US line-up at the biennial air show includes the USAF's newest fifth-generation fighters – the stealthy, supersonic, multirole F-35A Lightning II and F-35A Joint Strike Fighter.

38 LIGHT UTILITY HELICOPTERS (LUH)

CONTEXT: The Indian Army has started replacing its old Chetak and Cheetah helicopters with the indigenously-made Light Utility Helicopters (LUH).

Key-highlights

- The entire fleet of old Chetak and Cheetah helicopters will be replaced in the next 10 to 12 years as the armed forces is looking forward to modernise its capabilities with new helicopters and UAVs.
- The army is also looking to ramp up the fleet of **Unmanned Aerial Vehicle (UAV)** fleet in the next five years with a range of new UAVs including:
  - Israeli Heron Mk 2
  - Hermes Starliner

The **Army Aviation Corps** is currently operating around 190 **Chetak, Cheetah and Cheetal helicopters.**

What is LUH?

- The LUH is a **three-ton class new generation single engine** indigenously designed helicopter and can operate at 20,000 feet above sea level.
- Though it has been designed and developed indigenously, the single-engine LUH is powered by the **Ardiden 1U engine** from Safran, the French aerospace major.
- Hindustan Aeronautics **Limited (HAL) Helicopter Factory** in Tumakuru, Karnataka, India's largest helicopter manufacturing unit, will initially produce Light Utility Helicopters (LUHs).

Important Features:

- The LUH can transport six passengers at a time and can fulfil multiple roles including transportation, troop movement, and civil operations.
- It can achieve a maximum speed of up to 240 km per hour and the maximum take of weight for the helicopter is 3,150 kg.
- It can only carry around 75 kg at the peak of its operational ceiling, while the Cheetah and Chetak can carry only 30 kg to 40 kg respectively.

39 LCH 'PRACHAND'

CONTEXT: India and South Korea are manufacturing similar lines of products, which has positioned them as competitors in the global export market.

Details:

- India's Tejas and South Korea's FA-50 Light Combat Aircraft (LAC) can be seen competing for the Malaysian Light Attack Fighter contract.
- The South Korean aircraft appears to be having a slight advantage over the Indian LCA.
- South Korea has now also decided to accelerate the production of its Light Armed Helicopter.
- It authorized a 5.75 trillion won (US$4.3 billion) plan to begin mass production of a home-grown light-armed helicopter (LAH) in the coming months.

India's Light Combat Helicopter (LCH):

- The LCH is the **only attack helicopter in the world** which can land and take off at an altitude of 5,000 meters with a considerable load of weapons and fuel.
- The **helicopter uses radar-absorbing material to lower radar signature** and has a significantly crash-proof structure and landing gear.
- A pressurized cabin offers protection from Nuclear, Biological and Chemical (NBC) contingencies.
- The **helicopter is equipped with a countermeasure dispensing system** that protects it from enemy radars or infrared seekers of enemy missiles.

KAI Light Armed Helicopter (LAH) of South Korea.

- **Project Type:** Light-armed helicopter
- **Manufacturer:** Korean Aerospace Industries (KAI)
- **Engine:** The helicopter is powered by two Arriel 2L2 turboshaft engines.
- **First Flight:** July 2019
- **Cruise Distance:** 411 kilometres
- **Operation time:** Two hours and 35 minutes
- **Armament:** The rotorcraft is armed with a chin-mounted 20mm Gatling-type gun.

COMPARISON	
KAI Light Armed Helicopter (LAH)	**Light Combat Helicopter (Prachand)**
Weight: 4.9-ton	Weight: 5.8-ton
Maximum speed: 275 kmph	Maximum speed: 243 kmph

⊙ Maximum Range: 857 km	⊙ Maximum Range: 500 km
⊙ **Utility:** Destroying Tanks; light attacks; close-air support, escort, and troop transport.	⊙ **Utility**: Air-to-air operations; escort operations, support of combat search and rescue operations, and anti-tank and anti-infantry operations.
⊙ **Equipment:** four-axis automatic flight control system (AFCS), a helmet-mounted display, a fire control system (FCS), and an anti-jamming global positioning system (GPS).	⊙ **Equipment:** Electro-Optical Pod consisting of a CCD camera, FLIR, Laser Range Finder (LRF), and Laser Designator (LD)
⊙ **High Altitude Operations:** NO	⊙ **High Altitude Operations:** Yes. It is based on India's unique security considerations, which are different from that of Seoul.

India's recent developments in the Defence Sector:

- **INS Vikrant:** Aircraft Carrier
- **Dhanush:** Long-range artillery gun
- **Arihant:** Nuclear Submarine

40 LIGHT TANK ZORAWAR

CONTEXT: With the "increased threat" from China along India's northern borders "likely to remain in the foreseeable future", the Army is launching Project Zorawar — the induction of indigenous light tanks for quicker deployment and movement in high altitude areas.

Project Zorawar:

- The **Indigenous Indian Light Tank** aptly named **'Zorawar'** is designed to operate in varying terrain from **High Altitude Areas**, the marginal terrain to the Island territories will be highly transportable for rapid deployment to meet any operational situation.
- The **Army is looking at a light tank with a maximum weight of 25 tons**— with a margin of 10 per cent — with the same firepower as its regular tanks.
- The tank should be armed with Artificial Intelligence (AI), integration of tactical surveillance drones to provide a high degree of situational awareness and loitering munition, along with an **active protection system**.

The name game:

The project has been **named 'Zorawar'** after **Zorawar Singh Kahluria**, a military general who served under Jammu's Raja Gulab Singh, known as the 'conquerer of Ladakh'.

Swarm Drone Systems

- In another development Indian Army has also given go-ahead for the induction of indigenous **"swarm drone systems":**
- Indian Army has inducted **indigenously produced Swarm Drones Systems** aiming to employ them in **both offensive and defensive operations.**
- A swarm drone system **consists of a number of small drones which are AI-enabled and capable of communicating with the control station** as well as among them and provide asymmetric capabilities for taking out frontline assets of the adversary.
- Swarm drones consist of a number of drones controlled from the same station which can be programmed using an algorithm to carry out various tasks, including surveillance.

41 F-INSAS SYSTEM

CONTEXT: The Government handed over two new weapons – the Nipun mines, the Landing Craft Assault (LCA) and the F-INSAS system to the Army.

F-INSAS system:

- F-INSAS stands for **Future Infantry Soldier As A System**, a programme for infantry modernisation aimed at increasing the operational capability of the soldier.
- As part of the project, soldiers are being equipped with modern systems that are lightweight, all-weather-all-terrain, cost-effective and low maintenance.
- The full-gear of the F-INSAS system includes an **AK-203 assault rifle**, which is a Russian-origin gas-operated, magazine-fed, select-fire assault rifle with range of 300 metre.
- It also includes a ballistic helmet, ballistic goggles, a bulletproof jacket, elbow-pads, and knee pads.

- It is being made at **Korwa near Amethi in a Russia-India joint venture**.
- It looks to transform the soldiers deployed in the border areas into **'a self-contained fighting machine'.**
- F-INSAS also includes a **hands-free head-set** which will help enhance the operational capabilities of an infantry soldier and improve communication effectively.
- The project was conceptualised in the early 2000s by the **Defence Research and Development Organisation (DRDO)** in line with the targets of the Army's Infantry Soldier Modernisation Programme with an aim to optimise the soldier's performance across the full spectrum and duration of a military operation.

Nipun mines:

- Nipun mines are indigenously designed and developed anti-personnel mines, termed by the DRDO as '**soft target blast munition'**.
- These mines act as the **first line of defence** against the infiltrators and advancing enemy infantry.
- Anti-personnel mines are meant to be used against humans as against anti-tank mines that are aimed at heavy vehicles. They are smaller in size and can be deployed in large numbers.
- These mines are developed with the joint collaboration of the **Armament Research and Development** Establishment, a part of DRDO and an Indian firm.

Landing Craft Assault:

- The Landing Craft Assault (LCA) is a replacement for the boats with 'limited capabilities' operating **in Pangong Tso lake.**
- The LCA is much more versatile and has overcome the limitations of launch, speed and capacity.
- The LCA is touted to be the **replacement for boats for carrying personnel in battle operations.**
- These lightweight assault carriers can carry up to 35 troops.
- It has enhanced the capability to operate across the water obstacles in Eastern Ladakh.
- LCA has been indigenously **developed by M/s Aquarius Ship Yard Limited, Goa.**

42 INDIGENOUS AIRCRAFT CARRIER (IAC) VIKRANT

CONTEXT: Prime Minister Modi commissioned the country's first indigenous aircraft carrier Indian Naval Ship (INS) Vikrant at Cochin Shipyard Limited (CSL).

About Indigenous Aircraft Carrier 1: Vikrant

- IAC Vikrant is the **largest warship** to have ever been **built in India**.
- It is also the first indigenously designed and built Aircraft Carrier for the Indian Navy.
- IAC Vikrant is **262 m long and 62 m wide** and displaces approx. 43000 T when fully loaded, with a maximum designed speed of 28 Knots and an endurance of 7500 NM.
- **Designed by the Indian Navy's in-house Directorate of Naval Design (DND)**and built by the CSL, a Public Sector Shipyard under the Ministry of Ports, Shipping and Waterways
- It is capable of carrying more than 30 assorted aircraft including combat jets and helicopters.
- The ship will be **capable of operating 30 aircraft** including **MiG-29K fighter jets, Kamov-31 Air Early Warning Helicopters, MH-60R Seahawk multi-role helicopters**, as well as the Advanced Light Helicopters (ALH) built by Bengaluru-based Hindustan Aeronautics Ltd, and the indigenously manufactured Light Combat Aircraft (LCA) (Navy).
- The carrier is equipped with the **latest state-of-the-art equipment and systems**.

Proposed carrier:

- Since 2015, the Navy has been seeking approval to build a third aircraft carrier for the country, which, if approved, will become India's second Indigenous Aircraft Carrier (IAC-2).
- This proposed carrier, to be named **'INS Vishal'**, is intended to be a giant 65,000-tonne vessel, much bigger than both IAC-1 and the '**INS Vikramaditya'**

43 UNITED LAUNCH ALLIANCE'S ATLAS V ROCKET

CONTEXT: The United Launch Alliance (ULA) has launched an Atlas V rocket with the sixth and final Space Based Infrared System Geosynchronous Earth Orbit (SBIRS GEO 6) spacecraft for the United States Space Force's Space Systems Command.

About SBIRS

- SBIRS is an early missile warning system that will be the successor to the Defense Support Program, whose first satellite launch took place in the 1950s.
- SBIRS will consist of a constellation of three satellites in geosynchronous orbit and two other classified satellites on highly elliptical orbits around the poles.
- The first satellite of the constellation launched in 2011 and before SBIRS-6, the most recent launch was SBIRS-5 in 2021.

US Space Force

- The US Space Force is the sixth and newest department of the US military after its Army, Navy, Marine Corps, Coast Guard and Air Force.
- It was established in 2019, when the National Defense Authorization Act was signed into law.

44 MIG-21 FIGHTER JETS AND INDIA

CONTEXT: The MiG-21 trainer, which had taken off from the rom the Uttarlai airbase, crashed near Bhimda village in Rajasthan. MiG-21 Fighter was developed by the Soviet Union and India being its largest user should focus on its limited uses.

Background

- India is the largest operator of MiG-21s. In 1961, the Indian Air Force (IAF) opted to purchase the MiG-21 over several other Western competitors.
- As part of the deal, the Soviet Union offered India full transfer of technology and rights for local assembly.
- In 1964, the MiG-21 became the first supersonic fighter jet to enter service with the IAF.
- Due to limited induction numbers and lack of pilot training, the IAF MiG-21 played a limited role in the **Indo-Pakistani War of 1965.**
- However, the IAF gained valuable experience while operating the MiG-21 for defensive sorties during the war.

What is Mikoyan-Gurevich (MiG-21)?

- The **Mikoyan-Gurevich (MiG-21**) is a **supersonic jet fighter** and **interceptor aircraft**, designed by the Mikoyan-Gurevich Design Bureau in the **Soviet Union.**
- Approximately **60 countries** across four continents have flown the MiG-21, and it still serves many nations six decades after its maiden flight.
- It became the most-produced supersonic jet aircraft in aviation history, the most-produced combat aircraft since the Korean War.

45 HANSA-NG AIRCRAFT SUCCESSFULLY COMPLETED ENGINE RELIGHT TEST IN AIR

CONTEXT: 'HANSA-NG' successfully completed in-flight engine relight test at the aeronautical test range (ATR) facility of Defence Research Development Organisation (DRDO) at Challakere in Karnataka's Chitradurga recently.

About HANSA-NG:

- 'HANSA-NG' is the new generation **two-seater flying trainer aircraft**.
- It is designed and **developed by Council for Scientific and Industrial Research (CSIR)-National Aerospace Laboratories (NAL).**
- 'HANSA-NG' is designed to meet the Indian flying club needs and it is an ideal aircraft for commercial pilot licensing due to its low cost and fuel consumption.
- **Features:** The unique features of Hansa-NG are:
  - Glass cockpit with cabin comfort
  - Highly efficient digitally controlled engine
  - Electrically operated flaps
  - Long endurance
  - Low acquisition and low operating cost

46 MAN, PORTABLE AIR DEFENCE SYSTEM (MANPADS)

CONTEXT: Recently, the United States approved a $200-million arms package for Ukraine, which would include US-made Stinger Missiles, which are a type of shoulder-fired Man-Portable Air-Defence Systems (MANPADS).

What are MANPADS?

- Man-Portable Air-Defence Systems are **short-range, lightweight and portable surface-to-air missiles** that can be **fired by individuals or small groups** to **destroy aircraft or helicopters.**
- They help **shield troops from aerial attacks** and **are most effective in targeting low-flying aircrafts.**
  - MANPATs or Man-Portable Anti-Tank Systems work in a similar manner but are used to destroy or incapacitate military tanks.
- MANPADS can be **shoulder-fired, launched from atop a ground-vehicle**, fired from a tripod or stand, and from a helicopter or boat.
- **Features**
  - Weighing anywhere between 1**0 to 20 kilograms** and not being longer **than 1.8 metres.**
  - They are fairly **lightweight as compared** to o**ther elaborate weapon** systems, making them **easy to operate by individual soldiers.**

- Operating MANPADS requires substantially less training.

- Most MANPADS have passive or **'fire and forget' guidance systems,** meaning the operator is not required to guide the missile to its target, enabling **them to run and relocate immediately after firing**.
- The missile stays **locked-on to the targeted object**, not requiring active guidance from the soldier.
  - The **missiles are fitted with Infrared (IR) seekers** that identify and target the airborne vehicle through heat radiation being emitted by the latter.

47 LCH PRACHAND

CONTEXT: Recently, the Indian Air Force formally inducted the indigenously developed multi-role Light Combat Helicopter (LCH), Prachanda which is suitable for operating in high-altitude battlefields.

What is a Light Combat Helicopter?

- The LCH is the **only attack helicopter in the world** that can land and take off at an altitude of 5,000 meters with a considerable load of weapons and fuel.
- The **helicopter uses radar-absorbing material to lower radar signature** and has a significantly crash-proof structure and landing gear.
- A pressurized cabin offers protection from Nuclear, Biological and Chemical (NBC) contingencies.
- The **helicopter is equipped with a countermeasure dispensing system** that protects it from enemy radars or infrared seekers of enemy missiles.
- LCH is powered by **two French-origin Shakti engines** manufactured by the HAL.

SUBMARINE

48 SUBMARINE IN INDIA

CONTEXT: Experts say India has lost a decade in modernizing its submarine fleet, while China has marched ahead in its larger naval and more specific submarine capabilities.

Submarines first became a major factor in naval warfare during **World War I (1914–18)**, and also played a similar role on a larger scale in **World War II (1939–45).**

Number of Submarines in India:

- Currently, India has **15 conventional diesel-electric submarines, classified as SSKs,** and **one nuclear ballistic submarine, classified as SSBN.**
- Most of India's submarines are over 25 years old, and many are getting refitted.

Classification of Submarines:

Diesel electric submarines:

- Diesel-electric submarines use electric motors charged by diesel engines to move. These engines require air and fuel to operate, which means they **need to resurface more frequently,** making them easier to detect.
- Of the SSKs, **four are Shishumar Class,** which were bought and then built in India in collaboration with the Germans starting in the 1980s.
- **Eight are Kilo Class or Sindhughosh Class** bought from Russia (including erstwhile USSR) between 1984 and 2000.
- **Three are Kalvari Class Scorpene submarines (P-75)** built at India's Mazagon Dock in partnership with France's Naval Group.

Ballistic missile submarine:

- SSNs can stay and operate under water almost indefinitely; their endurance is limited only by food supplies for the crew. They are also equipped with a range of tactical weapons, such as torpedoes, anti-ship cruise missiles and land-attack cruise missiles.
- **India is among six nations that have SSNs,** alongside the US, the UK, Russia, France and China.
- India has **INS Chakra 2 SSN Submarine** leased from Russia until 2022.
- A **slow-moving 'bomber' and a stealthy launch platform** for nuclear weapons.
- The **Arihant and three more SSBNs** under construction are part of the **Strategic Forces Command.**

India's Modernisation Plan:

- **30 - Year Plan:** The 30-year plan (2000-30) for indigenous submarine construction, **approved by the Cabinet Committee on Security in 1999,** envisaged two production lines of six submarines each, built in India in partnership with a foreign **Original Equipment Manufacturer (OEM).**
  - The projects were called **P-75 and P-75I.**

- **P-75**: Of the six being built, **P-75 has delivered three Kalvari Class Scorpene submarines so far.**
- **P-75I**: It **is yet to take off,** the Request for Proposal was issued in July 2021.
  - It will be **India's first under the Strategic Partnership Model,** which came up in 2015.

49 AUKUS DEAL

CONTEXT: The AUKUS countries (US, UK and Australia) have turned towards sharing nuclear technology with India.

About the AUKUS pact:

- The **AUKUS pact** was signed on September 2021.
- This defense pact is a three-way cooperation program which essentially brings the former into the nuclear sub club while extending Britain and America's reach into a **Pacific region** rapidly becoming the key global theatre for the century to come.
- The **agreement** is aimed at preserving a "**free and open" Indo Pacific**.
- The core of AUKUS is a pledge by America and Britain to help Australia build at least eight nuclear-powered—but **not nuclear-armed**—attack submarines, which are known as **SSNS** (subs that carry intercontinental nuclear missiles are known as **SSBNS**, the "B" standing for "ballistic").
- **Important Pillars:**
  - **Pillar One:** The first and largest part of the agreement is the submarine contract, also known as **Pillar One.**
  - **Pillar Two:** The second AUKUS pillar will involve improving our defence capabilities with the assistance of the UK and the US in general.

What is a nuclear-powered submarine?

- A nuclear-powered submarine is **powered by a nuclear reactor**. But it is not **a nuclear weapon**.
- Every nuclear-powered submarine draws from its own miniature nuclear reactor on board, which is typically fuelled with uranium.
- For such a reactor to work, uranium has to be 'enriched' to contain 50 percent of a key isotope, **uranium-235.**
- Natural uranium consists of approximately 99.3 per cent of the **isotope uranium-238** and only 0.7 per cent of **uranium-235.**
- The process of enrichment can be carried out through gaseous diffusion, gas centrifuges or laser isotope separation.
- Only six nations own and operate these submarines currently: **China, France, India, Russia, the UK and the US.**

Types of nuclear-powered submarines:

SSNs are the oldest type of **nuclear-powered submarines** and the first of these, the American-made Nautilus, was deployed in 1954 by the US.

- Nuclear-powered submarines can be divided into **three broad categories**:
  - the nuclear-powered fast-attack submarines or SSNs
  - the nuclear-powered ballistic submarines or SSBNs
  - the nuclear-powered cruise missile submarines or SSGNs

India and the nuclear submarine industry:

- Currently, the Navy has 16 conventional submarines in service –
  - seven of the **Sindhughosh class** (Russian Kilo class)
  - four of the **Shishumar class** (modified German Type 209)
  - five of the **Kalvari class** (French Scorpene class)
- It does not have a **nuclear-powered conventional attack submarine.**

50 SUBMARINE VAGSHEER

CONTEXT: Vagsheer, the sixth submarine of the P75 project of the Indian Navy was launched recently.

About Submarine 'Vagsheer':

- Vagsheer is named after the sand fish, a deep sea predator of the Indian Ocean.
- The first submarine Vagsheer, from Russia, was commissioned into the Indian Navy on December 26, 1974, and was decommissioned on April 30, 1997.
- **Specifications:**
  - Vagsheer can take up to eight officers and 35 men.
  - It is 67.5 metres long and 12.3 metres high, with a beam measuring 6.2 metres.
  - Vagsheer can reach **top speed of 20 knots** when submerged and a top speed of 11 knots when it surfaces.
  - The **hull, fin and hydroplanes are designed for minimum underwater resistance** and all

equipment inside the pressure hull is mounted on shock-absorbing cradles for enhanced stealth.

- **Features:**
  - Vagsheer is a **diesel attack submarine**, **designed to perform sea denial as well as access denial warfare against the adversary.**
  - It can do offensive operations across the spectrum of naval warfare including **anti-surface warfare, anti-submarine warfare, intelligence gathering, mine laying and area surveillance.**
  - It is **enabled with a C303 anti-torpedo counter measure system.**
  - It can carry up to 18 torpedoes or Exocet anti-ship missiles, or 30 mines in place of torpedoes.
  - Its superior stealth features include advanced acoustic absorption techniques, low radiated noise levels, hydro-dynamically optimised shape, and it has the ability to launch a crippling attack using precision guided weapons, underwater or on surface.
  - Scorpene submarines can undertake various types of missions such as anti-surface warfare, anti-submarine warfare, intelligence gathering, mine laying, area surveillance etc.

List of other submarines under Scorpene-class submarines:

- First submarine: **INS Kalvari**- commissioned on 14 December 2017.
- Second: **INS Khanderi** – September 2019
- Third**: INS Karanj** – March 2021
- Fourth: **INS Vela** – November 2021
- Fifth: **INS Vagir**- launched in November 2020 and is undergoing sea trials.

What is Project-75 (India)?

- **Project-75 (India),** also known as **P-75(I),** is a **military acquisition initiative** by the **Ministry of Defence (MoD).**
- The P-75I class will succeed the Indian Navy's P-75 Scorpene-class submarines.
- The initiative aims to procure **diesel-electric attack submarines** with **fuel cells** and **Air-Independent Propulsion System (AIP)** for the Indian Navy to build India's naval strength and develop indigenous submarine-building capabilities.
- The P75I project is part of a 30-year submarine building plan that ends in 2030.
- As part of this plan, India was to build 24 submarines — 18 conventional submarines and six nuclear-powered submarines (SSNs) — as an effective deterrent against China and Pakistan.
- This project envisages the construction of six conventional submarines with better sensors and weapons and the Air Independent Propulsion System (AIP).
- The project has been cleared under the strategic partnership model.
- Under P75, **INS Kalvari, INS Khanderi, INS Karanj and INS Vela** have been commissioned. Sea trials are on for Vagir. **Vagsheer** is the sixth; its production was delayed due to the pandemic.

Project-75 was conceived in 1997 for the construction of two indigenous SSK Submarines known as Type 1500. The project was approved by the Cabinet Committee on Security (CCS), the decision-making body of the Ministry of Defence (MoD).

51 AMINI

CONTEXT: The Indian Navy has launched its most advanced and State-of-the-art anti-submarine warfare shallow watercraft, named Amini.

About:

- The vessel is named after a strategically important island in the Lakshadweep archipelago on India's western coast, almost **400 km** off Kochi, Kerala.
- This is the fourth in the series of **eight anti-submarine warfare** shallow watercrafts being built in India by domestic shipyards for the Indian Navy.
- Four of these ships, each with more than **80 per cent** indigenous content, have been launched this year.
- The **77-meter-long anti-submarine** warfare shallow watercraft has a displacement of **900 tonnes**, a maximum speed of **25knots** (46.3kmph) and an endurance of approximately **1800 Nautical miles (3333kms).**

52 INS SINDHUDHVAJ

CONTEXT: The Navy's Kilo-class submarine, INS Sindhudhvaj, has been decommissioned at Visakhapatnam after 35 years in service.

About INS Sindhudhvaj

- Commissioned into the Navy in June
- It was one of the **10 Kilo-class submarines** India acquired from **Russia** between the year **1986 and 2000.**
- The submarine crest depicts a **grey colour nurse shark** and the name means **flag bearer** at sea.

- Sindhudhvaj was the flag bearer of indigenisation and Indian Navy's efforts towards achieving **Atmanir bharat** in the Russian built '**Sindhughosh'** class submarines.
- **Key-features:**
  - The submarines have a displacement of **3,000**
  - It has a maximum diving depth of 300 meters, top speed of 18 knots, and they are able to operate solo **for 45 days** with a **crew of 53.**
  - It has anti-ship cruise missiles with a range of **220 km.**
  - After the decommissioning **of Sindhudhvaj, Indian** Navy now has **15 conventional submarines** in service.

What are kilo-class submarines?

- **Kilo** is a class of **diesel-electric attack submarines** originally designed in the 1970s and built in the **Soviet Union** for the **Soviet Navy.**

Sindhughosh class Submarines in India Navy

- **Sindhughosh-class submarines** are Kilo-class **diesel-electric** submarines in active service with the Indian Navy.
- Their names are mainly in **Sanskrit.**
- The Sindhughosh submarines, were designed as part of **Project 877**, and built under a contract between **Rosvooruzhenie (Russian firm) and the Ministry of Defence (India).**

Some Submarines under Sindhughosh are:

- INS Sindhudhvaj
- INS Sindhuratna
- INS Sindhukesari

53 SHISHUMAR CLASS

- The Shishumar class vessels (Type 1500) are diesel-electric submarines which have been developed by the German yard Howaldtswerke-Deutsche Werft (HDW).
- The first two of these vessels were built by HDW at Kiel, while the remainder has been built at Mazagon Dock Limited (MDL) in Mumbai.
- The ships were commissioned between 1986 and 1994.
- The submarines have a displacement of 1660 tons when surfaced, a speed of 22 knots (41 km/h), and a complement of 40 including eight officers, and have the provision of an IKL-designed escape system.

54 ARIHANT CLASS

- The Arihant is a class of Indian nuclear-powered ballistic missile submarines being built for the Indian Navy.
- They were developed under the Rs 900 billion Advanced Technology Vessel (ATV) project to design and build nuclear-powered submarines.
- India has classified these vessels are classified as 'strategic strike nuclear submarines'.
- Launched on July 26, 2009, INS Arihant (SSBN 80), designated S2 Strategic Strike Nuclear Submarine, is the lead ship of India's Arihant class of submarines.

55 MATSYA 6000

CONTEXT: The government recently shared images of India's Matsya 6000 submersible on social media.

What is Matsya 6000?

- The Matsya 6000 is a **three-person submersible** that will be able to go 6,000 metres under the sea.
- Meaning 'fish' in Hindi, the vessel is being developed by Chennai's **National Institute of Ocean Technology (NIOT).**
- Made of 80mm-thick titanium alloy, it will be able to withstand a pressure 600 times greater than that at sea level.
- All research missions globally rely on titanium
- The Matsya 6000 will be able to operate from 12 to 16 hours straight and will have an oxygen supply of 96 hours.
- It will feature the **ultra-short baseline acoustic positioning system (USBL).**

Only five nations – **France, the US, China, Russia and Japan** – have thus far created man submersibles.

  - This will allow the mothership carrying the transponder to send information and the submersible to respond.
  - This will let the mothership know where the submersible is.
- It will likely undergo trials in 2024 in the Bay of Bengal.
- It is part of **India's Samudrayaan project** to explore the deep sea. The Samudrayaan project is part of India's Rs 4,077-crore **Deep Ocean Mission**.

OTHERS

56 LIGO-INDIA PROJECT

CONTEXT: Prime Minister Narendra Modi laid the foundation stone of Laser Interferometer Gravitational Wave Observatory – India (LIGO-India), on the occasion of the 25th anniversary of the Pokhran-II nuclear tests.

What is LIGO-India?

- LIGO-India will be an **advanced gravitational-wave observatory** to be located in India as part of a worldwide network.

Brief about LIGO

- LIGO is a **network of laboratories**, spread around the world, designed to detect gravitational waves produced by the movement of large celestial objects like stars and planets.
- These ripples were first postulated in **Albert Einstein's General Theory of Relativity** that encapsulates our current understanding of how gravitation works.
- In **2015**, LIGO made history by detecting gravitational waves for the first time.

- **Background:** LIGO-India had received the government's in-principle approval in February 2016. Since then, the project reached several milestones towards selecting and acquiring a site and building the observatory.
- **Collaboration**: It is envisaged as a collaborative project between a consortium of Indian research institutions and the **LIGO Laboratory in the USA**, along with its international partners.
- **Built by:** The LIGO-India project will be built by the D**epartment of Atomic Energy and the Department of Science and Technology**, with a memorandum of understanding (MoU) with the **National Science Foundation**, the US, along with several national and international research and academic institutions.
- **Location:** Hingoli district of Maharashtra.

Gravitational waves are 'ripples' in space-time caused by some of the most violent and energetic processes in the Universe.

- LIGO-India will be an **extremely sensitive interferometer** capable of sensing **gravitational waves** generated during the **merger of massive astrophysical objects** such as **black holes, and neutron stars**.
- The observatory comprises **two 4-km-long vacuum chambers**, built perpendicular to each other. **Highly reflective mirrors** are placed at the end of the vacuum chambers.
- **Fifth node:** LIGO India would be the **fifth node** of this international network of gravitational wave observatories. Currently, there are following operational gravitational wave observatories around the world–
  - two in the United States (Hanford and Livingston)
  - one in Italy (Virgo)
  - one in Japan (Kagra)

National Technology Day

May 11 marks the **25th anniversary** of the 1998 nuclear tests carried out at **Pokhran test range**, including its first test of a thermonuclear device, which has since been celebrated as the **National Technology Day** to honour scientists, engineers and technologists who made the tests possible.

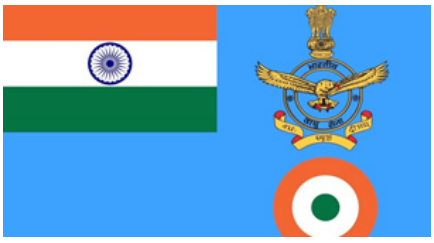
57 INDIAN AIR FORCE UNVEILS ITS NEW ENSIGN AFTER 72 YEARS

CONTEXT: In a historic moment, Indian Air Force (IAF) unveiled the Air Force's new ensign at the annual Air Force Day parade at Prayagraj.

- This is the first change to the **ensign since 1951**, when the Royal Indian Air Force (RIAF) ensign was changed to make it look 'Indian'.

About the New ensign:

- The IAF ensign was created by replacing the Union Jack with the **Indian tricolour** and the RAF roundels with the **IAF tricolour roundel** in the lower right canton.



- A **new IAF ensign set to**:
  - The crest has the national symbol, the **Ashoka lion**, on the top with the words '**Satyameva Jayete**' in Devanagari below it.

- A Himalayan eagle, with its wings spread, has a ring in **light blue colour** encircling it with words "Indian Air Force".
- The existing motto of the IAF "Touching the sky with Glory" taken from the verse 24, Chapter 11 of the Bhagavad Gita will remain on the ensign.

58 CLUSTER BOMBS AND THERMOBARIC WEAPONS

CONTEXT: Human rights groups Amnesty International and Human Rights Watch accused Russia of using cluster bombs and vacuum bombs in the ongoing war (on Ukraine).

What are cluster munitions?

- A **cluster munition means a "conventional munition that is designed to disperse or release explosive sub-munitions** each weighing less than 20 kilograms, and includes those explosive sub-munitions".
- Essentially, cluster munitions are **non-precision weapons that are designed to injure or kill human beings indiscriminately over a large area,** and to destroy vehicles and infrastructure such as runways, railway or power transmission lines.
- They can be dropped **from an aircraft or launched in a projectile** that spins in flight, scattering many bomblets as it travels.
- The **Convention on Cluster Munitions** specifically identifies "cluster munition remnants", which include "failed cluster munitions, abandoned cluster munitions, unexploded sub-munitions, and unexploded bomblets".

What is a thermobaric weapon?

- Thermobaric weapons — also known **as aerosol bombs, fuel-air explosives, or vaccum bombs** — use oxygen from the air for a large, high-temperature blast.
- A thermobaric weapon causes **significantly greater devastation than a conventional bomb** of comparable size.
- The weapons, which go off in two separate stages, can be fired as rockets from tank-mounted launchers or dropped from aircraft.
- As they hit their target, a first explosion splits open the bomb's fuel container, releasing a cloud of Fuel and metal particles that spreads over a large area.
- A second explosion then occurs, igniting the aerosol cloud into a giant ball of fire and sending out intense blast waves that can destroy even reinforced buildings or equipment and vaporize human beings.

59 UKRAINE WEAPON SYSTEM

- Below is the list of major weapons used in the course of Ukraine war:

TANKS	
The US is sending Abrams tanks	The Abrams is a full-tracked, low-profile, land combat assault weapon enabling expeditionary Warfighters to dominate their adversaries through lethal firepower, unparalleled survivability, and audacious maneuver.
The UK is providing 14 Challenger 2 tanks	Challenger 2 is heavily armoured and highly mobile, designed for use in direct fire zones. It is one of the most protected tanks in the world.
Germany is providing 14 Leopard 2 tanks	The Leopard 2 is a German-manufactured main battle tank with a range of about 500km (311 miles).
The US and the UK are also providing depleted uranium tank rounds	Depleted uranium is naturally-occurring uranium which has been stripped of much - but not all - of its radioactive matter. It is a by-product from the process which prepares uranium for use in nuclear power plants and nuclear weapons.
FIGHTING VEHICLE/SYSTEM	
US has also donated Bradley infantry fighting vehicles	The Bradley infantry fighting vehicle is a tracked, medium-armoured vehicle armed with a 25mm gun.
US sent the Patriot missile system to Ukraine	The MIM-104 Patriot is the U.S. Army's primary air and missile defense system. It is a mobile system that usually includes powerful radar, a control station, a power generator, launch stations and other support vehicles.

Soviet-era S-300 surface-to-air systems	⦿ The S-300 is a long-range surface-to-air system, originally developed in the Soviet Union during the 1960s and 1970s.The S-300 is a surface-to-air missile system designed to provide long-range air defense capabilities. It is capable of engaging and neutralizing a wide range of airborne threats, including aircraft, drones, and missiles.
UK has provided Starstreak	⦿ StarStreak is a short-range, man-portable, air-defence system manufactured by Thales in the UK and is optimised to provide defence against air threats including fixed-wing Fighter Ground Attack aircraft and late unmasking Attack Helicopters.
US sent the M142 High Mobility Artillery Rocket System or Himars	⦿ Himars - the M142 High Mobility Artillery Rocket System - is a missile launcher mounted on a five-tonne truck which can fire six guided missiles in quick succession. Himars can also fire a single Army Tactical Missile System missile, which has a range of 186 miles (300 km).
Ground-Launched Small Diameter Bombs (GLSDB)	⦿ GLSDB can be fired from the High Mobility Artillery Rocket System (HIMARS). It can defeat some electronic jamming, it is usable in all weather conditions and can be used against armored vehicles.
Australia, Canada and the US sent advanced M777 howitzers	⦿ M777 is the world's first 155mm Howitzer weighing less than 10000 lbs (4218 kg). Highly portable by land, sea and air, the system features a minimal logistical footprint alongside maximum reliability.
DRONES	
Turkey sold Bayraktar TB2 armed drones to Ukraine	⦿ The Armed UAV Bayraktar TB2 is a multi-purpose platform as it can perform Target Acquisition using the onboard laser designator.

PRACTICE QUESTION

1. Consider the following statements regarding Iron Beam, the cutting-edge laser weapon system:

1. It is a 100 kW class High Energy Laser Weapon System (HELWS).
2. It uses fibre laser is used by the Iron Beam to destroy airborne threats.
3. This system is specifically designed to be used as part of a larger air defence system.
4. The Iron Beam fires at a significantly faster rate.

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) Only three (d) All four

2. Which of the following statements is correct regarding 'Sonobuoy', recently seen in news?

(a) It is used for underwater acoustic surveillance, often to detect submarines.

(b) It is used to collect oceanographic data on temperature and salinity.

(c) It is a specialized camera used for underwater photography.

(d) It is devices used to monitor weather patterns in the Earth's atmosphere.

3. Consider the following statements with reference to C295 plane, often mentioned in news:

1. The military plane is powered by two Pratt & Whitney Canada PW127G turboprop engines.
2. In-flight refuelling capability is not option for the aircraft.
3. It is fitted with a retractable landing gear.

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) All three (d) None

4. Regarding the 'Astra' Missile, consider the following statements:

1. It is Beyond Visual Range Air-to-Air Missile (BVRAAM).
2. It is designed and developed by the Defence Research and Development Organisation.
3. It is developed for deployment on fighter jets like Sukhoi-30 MKI and Tejas of the IAF and the Mig-29K of the Navy.

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) All three (d) None

ANSWERS				
1. (b)	2. (a)	3. (a)	4. (c)	

CHAPTER 06

PHYSICS

1 ESA LAUNCHES EUCLID SPACECRAFT

CONTEXT: The European Space Agency launched its Euclid spacecraft on a SpaceX Falcon 9 rocket to chart the history of the universe as far back as 10 billion years ago.

What is Euclid Mission?

- The **European Space Agency's Euclid mission** is designed to study the so-called "dark universe."
- **3D map of the Universe**: Euclid will observe billions of galaxies out to 10 billion light-years to create the largest, most accurate 3D map of the Universe, with the third dimension representing time itself.
- This detailed chart of the shape, position and movement of galaxies will reveal
  - **Matter distribution:** how matter is distributed across immense distances
  - **Evolution:** how the expansion of the Universe has evolved over cosmic history, enabling astronomers to infer the properties of **dark energy and dark matter**
- This will help theorists to improve understanding of the **role of gravity and pin down the nature of these enigmatic entities.**
- **Developed by:** Euclid was designed and built entirely by ESA, with the US space agency, NASA, supplying photodetectors for its near-infrared instrument.
- Euclid is a medium-class mission in **ESA's Cosmic Vision Programme**.

What is Dark Matter?

- Dark matter is the **predominant form of matter** in the universe.
- Without it, the stars probably would not have formed in the early universe, and the presence of dark matter across the universe is essential to all **cosmic structure formation.**
- Dark matter is **not visible and does not absorb radiation**.
- It **deflects light** because of its **gravitational pull** and deforms the **shape of the galaxies** as seen by the observer.
  - This effect is called **gravitational weak lensing**.

Spacecraft and instruments:

- The Euclid spacecraft is approximately 4.7 m tall and 3.7 m in diameter. It consists of two major components: the service module and the payload module.
- **Payload module:** The payload module comprises a 1.2-m-diameter telescope and two scientific instruments:
  - **Visible-wavelength camera (1.2-m reflecting telescope that feeds the two innovative scientific instruments):** It takes very sharp images of galaxies over a large fraction of the sky and can view the universe in visible and near-infrared light
  - **Near Infrared Spectrometer and Photometer (NISP) instrument:** It can analyse galaxies' infrared light by wavelength to accurately establish their distance.
  - **Service module:** The service module contains the satellite systems: **electric power generation and distribution, attitude control, data processing electronics, propulsion, telecommand and telemetry, and thermal control.**

2 NAGRAPHENE

CONTEXT: Scientists have found a potential new application of graphene for detecting Amyotrophic Lateral Sclerosis (ALS).

About ALS

- **Amyotrophic Lateral Sclerosis (ALS) is** a **progressive brain disorder** for which there is currently "no objective diagnostic test."

About Graphene:

- Graphene is perhaps the most well-known nanomaterial. It was discovered in 2004 by Andre Geim and Konstantin Novoselov.
- It is the-
  - **thinnest (one atom thick)** compound known to man
  - **lightest material** known (1 sq mt weighing around 0.77mg)
  - **strongest compound** discovered (between 100-300 times stronger than steel and with a tensile stiffness of 150,000,000 psi)
  - **best conductor of heat** at room temperature
  - **best conductor of electricity** known (electron mobility is more than 200,000 cm^2.V–1.s–1)

Applications

- **Boosting capacity:** Graphene is being used to boost not only the capacity and charge rate of batteries but also the longevity.
- **Increasing life:** With **graphene tin oxide** being used as an **anode** in lithium ion batteries for example, batteries can be made to last much longer between charges (potential capacity has increased by a factor of 10), and with almost no reduction in storage capacity between charges, effectively making technology such as electronically powered vehicles a much more viable transport solution in the future.
- **Corrosion resistant**: Graphene is highly inert and so can act as a **corrosion barrier between oxygen and water diffusion**. Future vehicles could be made to be **corrosion resistant** as graphene can be made to be grown onto any metal surface (given the right conditions).
- **Possible building material:** Due to its strength, graphene is also being developed as a **potential replacement for Kevlar** in protective clothing, and will eventually be seen in vehicle manufacture and possibly even used as a building material.

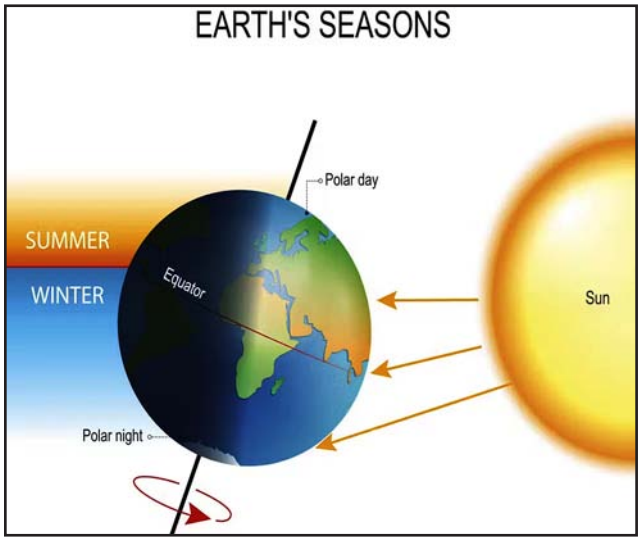
3 GROUNDWATER EXTRACTION AFFECTED EARTH'S ROTATION: STUDY

CONTEXT: A recent study has highlighted that, the Groundwater pumped up from the earth and moved elsewhere for humans activities, resulted in the earth's axis tilting nearly 80 cm to the east.

- Scientists estimated that **nearly 2,150 billion tonnes of groundwater** have been pumped and drained into the oceans.

Highlights of the study:

- A study published in 2016, showed that the **movement of water** around the world contributed to the **wobble in the earth's axis**.
- But the role of groundwater hadn't been considered before.
- However the recent study found that nearly **2,150 billion tonnes of groundwater** has been pumped and drained into the oceans in 1993-2010, making it one of the important **contributors to global sea-level rise.**
- The earth's rotational pole tends to vary in a **circular pattern** several meters wide every year due to the **weather, seasonal changes, the molten core, and even powerful hurricanes**.
- The scientists also mentioned that the **location of groundwater depletion** is important to identify the extent of tilt.
- Using this model, they found that pumping groundwater from **mid-latitude areas** would impact the drift the most.
- They also found that the **most amount of groundwater redistribution** took place in **northwest India** and **western North America**, both situated at mid-latitudes.



Earth's rotation and tilt:

- Earth is tilted on a **23.5° axis relative** to our orbit around the sun.
- Because of this tilt, we are able to experience ***winter, autumn, summer and spring***.
- The **earth's rotational pole** is the point along which **the planet rotates**.

- This point, which lies on the **axis of rotation of the planet**, moves in a process called polar motion.
- In other words, the location of the earth's pole **varies relative to the earth's crust**.

Status of India's groundwater profile:

- Groundwater depletion has been a particular concern across India since the last decade.
- About **95% of India's groundwater depletion** was traced to north India where groundwater is primarily **used for irrigation**.
- **Punjab, Haryana, Delhi, and western Uttar Pradesh** have critical groundwater levels due to the indiscriminate use of groundwater.
- **Rajasthan and Gujarat** have low groundwater levels due to arid climate.
- Groundwater availability is also low in parts of **Karnataka, Tamil Nadu, Telangana, and Andhra Pradesh** due to the crystalline nature of the aquifers found here.

Effects of Earth-tilted axis:

- Earth's axial tilt is responsible for the '**formation of seasons'**.
- When a hemisphere is **tilted towards the sun**, that region receives more sunlight and becomes warmer, while the hemisphere that is tilted away receives **less solar energy and is cooler**.

4 HOW THE EARTH'S TILT CREATES SHORT AND COLD JANUARY DAYS?

CONTEXT: Above the equator, winter officially begins in December, but in many areas, January is when it really takes hold which is mainly due to the earth's tilt and it seems to be different for different locations on earth. About the earth's axial tilt:

- Earth's axial tilt (also known as the **obliquity of the ecliptic**) is about **5 degrees**.
- Due to this axial tilt, the sun shines on different latitudes at different angles throughout the year.
- **The earth's spin axis is tilted with respect to its orbital plane**.
- This is what causes the seasons. When the earth's axis points towards the sun, it is summer for that hemisphere. When the earth's axis points away, winter can be expected.

How does the Earth's orbit influence our daylight and temperatures?

- As the Earth orbits the sun, it spins around an axis from the **North Pole to the South Pole**.
- **During the 24 hours** that it takes for the Earth to rotate once around its axis, every point on its surface faces toward the Sun for part of the time and away from it for part of the time. This is what causes daily changes in sunlight and temperature.
- There are **two other important factors**:
  - First, the **Earth is round,** although it's not a perfect sphere.
  - Second, its **axis is tilted about 23.5 degrees** relative to its path around the Sun.
- As a result, light falls **directly on its equator** but strikes the **North and South poles at angles.**
- When one of the poles points more toward the Sun than the other pole, that half of the planet gets more sunlight than the other half, and it's summer in that hemisphere.
- When that pole tilts away from the Sun, that half of the Earth gets less sunlight and it's winter there.

Impact on earth due to the tilt

- **Existence of seasons:** As the Earth orbits the Sun, sunlight strikes the surface at varying angles because of the planet's tilt. This creates seasons.

- The four seasons can be determined by the **solstices (the point of maximum axial tilt toward or away from the Sun) and the equinoxes (when the direction of tilt and the Sun are perpendicular**).
- In **the northern hemisphere**, the winter solstice occurs around **December 21st**, the summer solstice around **June 21st,** the spring equinox around **March 20th**, and the autumnal equinox on or about **September 22nd or 23rd.**
- In the **southern hemisphere**, the situation is reversed, with the summer and winter solstices exchanged and the spring and autumnal equinox dates swapped.

- **Changes in Wind directions**: As the Earth rotates; air circulates around it in the atmosphere. Mostly, in the northern hemisphere, the air comes from the Arctic region which is comparably cold**.**
- **Distribution of Sunlight:**
  - **At Poles**: Seasonal changes are the most dramatic at the poles, where the changes in light are the most extreme. During the summer, a pole receives 24 hours of sunlight and the Sun never sets. In the winter, the Sun never rises at all.
  - **At the Equator:** At the equator, which gets consistent direct sunlight, there's very little change in day length or temperature year-round. People, who live in high and middle latitudes, closer to the poles, can have very different ideas about seasons from those who live in the tropics.

5 E-SIM

CONTEXT: Transition from regular sim to e-sim

What is eSIM?

- An eSIM is a **digital version of the physical SIM card**—identifying your device virtually to provide network connection.
- It's **programmable remotely** via software and is built into newer smartphones, meaning you wouldn't have to go purchase a new SIM card if you wanted to swap phones or wireless carriers.
- eSIMs are used in **tablets, smart watches, drones**, and even cars. They're basically space-saving gamechangers for connectivity.

1 SIM SWAPPING

CONTEXT: Cases of SIM swaps leading to significant financial losses are on the rise in the crypto space.

What is SIM Swapping?

- As the name suggests, SIM swapping is a process where scammers access the SIM card, essentially digital identity theft.
- Once they gain access, they extort money from friends and family of the user. They access online banking, take control of social media profiles, and more.
- With OTP-based two-factor authentication becoming mainstream for various online products and services, including Internet banking, perpetrators with access to a SIM card could cause significant damage.
- This is why it's crucial to stay vigilant and learn how to protect oneself from this type of cybercrime.

What is SIM?

- 'SIM' stands for 'subscriber identification module'.
- Specifically, it is an integrated circuit, or a microchip, that identifies the subscriber on a given network.
- SIM cards are designed according to the ISO/IEC 7816 international standard maintained by – as its name indicates – the **International Organisation for Standardisation and the International Electrotechnical Commission.**
  - It applies to **electronic identification cards, including smart cards.**

What is an eSIM?

- Over the years, the SIM card has shrunk from the SIM to the mini SIM to the micro SIM to the nano SIM.
- The latest on this path is the eSIM, with specifications defined by the GSM Association.
- In the eSIM paradigm, the SIM software is loaded to a UICC that is permanently installed in the mobile equipment in the factory itself, i.e. it can't be removed. (This is called the eUICC.)

7 SUPERCOMPUTER

CONTEXT: The AI Supercomputer 'AIRAWAT', installed at C-DAC, Pune has been ranked 75th in the world.

What is Supercomputer?

- A supercomputer is a computer with a high level of performance compared to a general-purpose computer.
- Performance of a supercomputer is measured in **floating-point operations per second (FLOPS)** instead of million instructions per second (MIPS).
- Supercomputers contain **tens of thousands of processors** and can perform billions and trillions of calculations or computations per second.
- Some supercomputers can perform up to a **hundred quadrillion FLOPS**.
- Since information moves quickly between processors in a supercomputer (compared to distributed computing systems) they are **ideal for real-time applications**.

A line-up of supercomputers & the institutions housing them

- **Param Shivay** — IIT-BHU, Varanasi
- **Param Siddhi-AI** — IIT-Hyderabad
- **Param Pravega** — IISc, Bengaluru
- **Param Utkarsh** — C-DAC, Bengaluru
- **Param Porul** — NIT-Trichy
- **Sahasrat** — IISc, Bengaluru
- **Param Brahma** — IISER, Pune
- **Param Ananta** — IIT-Gandhinagar
- **Param Seva** — IIT-Hyderabad
- **Param Himalaya** — IIT-Mandi
- **Annapurna** — IMSc, Chennai
- **HP Apollo 6500** — IIT-Delhi
- **Param Ishan** — IIT-Guwahati
- **Param Yuva II** — C-DAC, Pune
- **Param Kamrupa** — IIT-Guwahati
- **Param Yuva** — C-DAC, Pune
- **Param Sanganak** — IIT-Kanpur
- **Param Shakti** — IIT-Kharagpur
- **Param Ganga** — IIT-Roorkee
- **Pratyush** — Indian Institute of Tropical Meteorology, Pune
- **Param Smriti** — National Agri-Food Biotechnology Institute, Mohali
- **Param Yukti** — Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru
- **Mihir** — National Centre for Medium Range Weather Forecasting, Noida

- Supercomputers are used for **data-intensive and computation-heavy scientific and engineering** purposes such as quantum mechanics, weather forecasting, oil and gas exploration, molecular modelling, physical simulations, aerodynamics, nuclear fusion research and cryptoanalysis.

Key highlights:

- India is today home to 23 supercomputers — powerful computers that are primarily used for scientific and engineering work that demands ultra high-speed computations.
- Indigenous development of supercomputers began in 1980 — with the involvement of organisations such as BARC, C-DAC and C-DOT.
- National Supercomputing Mission (NSM) was launched in 2015 that accelerated efforts in a big way.

8 NAVIC

CONTEXT: The Department of Space (DoS) has told the Parliamentary Committee of Science and Technology that the Navigation with Indian Constellation or (NavIC) is going to be integrated into Aadhaar enrolment devices.

What is Navigation with Indian Constellation or (NavIC)?

- NavIC or the **Indian Regional Navigation Satellite System (IRNSS)** is designed with a constellation of 7 satellites and a network of ground stations **operating 24×7.**
- There are a total of **eight satellites** however only seven remain active.
- Three satellites in **geostationary orbit** and four satellites in **geosynchronous orbit**.
- The constellations' **first satellite (IRNSS-1A)** was launched on 1st July 2013 and the eighth satellite IRNSS-1I was launched in April 2018.
- It is fully under the control of the Government of India.

9 LOCKBIT RANSOMWARE

CONTEXT: Cybercriminals have developed new ransomware encryptors designed to target macOS devices, making this the first major ransomware operation to specifically target Apple computers.

What is LockBit ransomware?

- First reported in September 2019 and dubbed the "abcd" virus, due to the file extension used when encrypting victims' files, the LockBit ransomware is designed to infiltrate victims' systems and encrypt important files.
- The virus is categorised as a "cryptovirus" due to its requests for payment in cryptocurrency to decrypt the files on the victim's device.
- The ransomware is therefore typically deployed against victims who feel hindered enough by the disruption to pay heavy sums in exchange for access and can afford to do so.

LockBit ransomware gang

- The group behind this is known as the LockBit gang. It is considered the most prolific ransomware group ever.
- It operates on the ransomware-as-a-service (Raas) model and comes from a line of extortion cyberattacks.

10 WORLD SCIENCE DAY FOR PEACE AND DEVELOPMENT

CONTEXT: The World Science Day for Peace and Development is celebrated annually on November 10.

About the day

- The origin of World Science Day for Peace and Development is linked to the positive outcomes that emanated from the 1999 World Conference on Science in Budapest, Hungary.
- These achievements led UNESCO to formally declare the celebration of this day in 2001.
- **The theme for World Science Day 2023** is "Building Trust in Science," which emphasises the importance of trust in science to our common destiny.

11 NOBEL PRIZE IN PHYSICS 2023

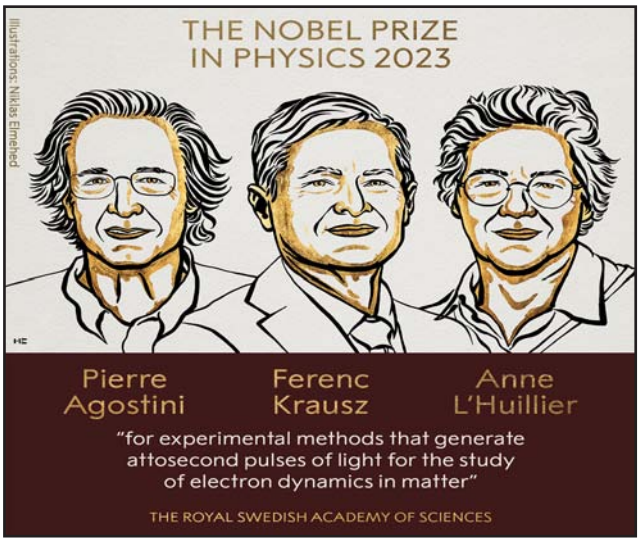
CONTEXT: The Royal Swedish Academy of Science has announced that the 2023 Nobel Prize in Physics.

About the Prize:

- The prize, which was raised this year to **11 million Swedish crowns (about $1 million),** is awarded by the Royal Swedish Academy of Sciences.

These prizes announced on consecutive weekdays in **early October**, the physics prize announcement will be followed by ones for **chemistry, literature, peace and economics.**

- The Nobel Prize in Physics has been awarded to **Pierre Agostini, Ferenc Krausz and Anne L'Huillier** for their work in "**experimental methods that generate attosecond pulses of light for the study of electron dynamics in matter.**"
- Their experiments gave humanity new tools to explore the **world of electrons inside atoms and molecules**.



Their Contribution:

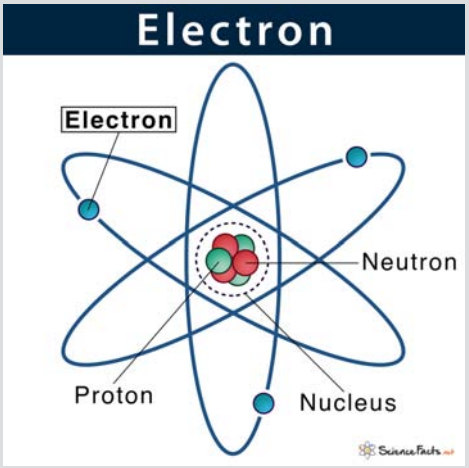
- Agostini, Krausz and L'Huiller developed a new way to create **extremely short pulses of light** that can be used to measure the rapid processes by which **electrons move or change energy.**
- Their experiments helped produce pulses of light so short that they can be measured **in attoseconds.**
- This means that the pulses can be used to provide **images of the processes inside atoms and molecules**.

An attoseconds is equal to a quintillionth (10–18) of a second.

- The research conducted by the Laureates over a span of several decades allowed them to investigate processes that were so rapid that they were previously impossible to follow.
- This new technology is important to understand and control **how electrons behave in a material**.

What are electrons?

- An electron is a **negatively charged subatomic particle** that can be either bound to an atom or free (not bound).
- An electron that is bound to an atom is one of the three primary types of particles within the atom -- **the other two are protons and neutrons.**
- **Key features:**
  - Electrons are unique from the other particles in multiple ways.
  - They exist outside of the nucleus, are significantly smaller in mass and exhibit both **wave-like and particle-like characteristics.**
  - An electron is also an elementary particle, which means that it is not made up of smaller components.
  - Protons and neutrons are thought to be made **up of quarks**, so they are not elementary particles.



PYQ (2013)

1. Consider the following:

1. Electromagnetic radiation
2. Geothermal energy
3. Gravitational force
4. Plate movements
5. Rotation of the earth
6. Revolution of the earth

Which of the above are responsible for bringing dynamic changes on the surface of the earth?

(a) 1, 2, 3 and 4 only (b) 1, 3, 5 and 6 only

(c) 2, 4, 5 and 6 only (d) 1, 2, 3, 4, 5 and 6

Correct Option: (d)

CHAPTER 07

BIOLOGY

1 ELECTRONIC-SKIN (E-SKIN)

CONTEXT: Chinese researchers have recently developed a novel electronic skin with what they said "excellent isothermal regulation."

About:

- E-skins are **flexible electronic systems** that try to mimic the sensitivity of their natural human skin counterparts.
- Applications range from skin replacement and medical sensors on the body to artificial skin for humanoid robots and androids.
- Tiny surface hairs can perceive and anticipate the slightest tactile sensation on human skin and even recognize the direction of touch.
- **Modern electronic skin systems lack** this capability and cannot gather this critical information about their vicinity.

2 CENTRE MOOTS POLICY ON SYNTHETIC BIOLOGY

CONTEXT: A draft foresight paper on synthetic biology released by the Department of Biotechnology has stressed the need for a national policy that can consolidate India's stand on the issue.

About Synthetic biology:

- Synthetic biology refers to the science of using **genetic sequencing, editing, and modification to create unnatural organisms or organic molecules** that can function in living systems.
- Synthetic biology enables scientists to **design and synthesise new sequences of DNA from scratch.**
- The term 'synthetic biology' was first used by **Barbara Hobomin in 1980, to**describe bacteria that had been genetically engineered using recombinant DNA technology.
- Synthetic biology was initially synonymous with '**bioengineering**'.
- In **2000,** the term 'synthetic biology' was again introduced by **Eric Kool** and other speakers at the annual meeting of the American Chemical Society in San Francisco.

3 BIOHACKING

CONTEXT: Biohacking has been in focus lately due to its significant contribution in the evolving landscape of human enhancement.

What is Biohacking?

- Biohacking is a term used to describe do-it-yourself biology. It involves people making incremental changes to their bodies, diet, and lifestyle to improve their health and well-being.
- Also known as human enhancement, biohacking ranges from efforts to improve brain function to faster weight loss.
- Some types of biohacks are relatively safe to try at home, while others may pose health risks and produce varying results.

4 FUNGI

CONTEXT: The United Nations Biodiversity has initiated a campaign urging the global community to incorporate the term "funga" alongside "flora and fauna" to emphasize the significance of fungi.

About

- Fungi are a very diverse group of organisms encompassing a wide range of life forms, from single celled to very complex multicellular organisms.
- They can be microscopic or present large fruiting bodies with underground systems that extend for miles or even hectares.
- About 100,000 species have already been identified, but scientists estimate a vast number of species are yet to be cataloged, with the total number ranging from 0.8 to 3.8 million species.
- Fungi are an important part of soil biodiversity, and this diverse group of organisms can help tackle global challenges, including climate change and hunger.
- Fungi are closely interlinked with vegetation and carbon and nutrient cycling.
- As a result, they are major drivers of soil health and carbon sequestration, among other ecosystem functions.

5 HAEMOGLOBIN

CONTEXT: A new discovery has revealed that haemoglobin isn't used by RBCs alone and has reported that 'chondrocytes' – cells that make cartilage, the connecting tissue between bones – also make haemoglobin and seem to depend on it for their survival.

About Haemoglobin:

- Haemoglobin is an **iron-containing protein** in the blood of animals that transports oxygen to the tissues.
- It is present in RBCs of vertebrates. All vertebrates except **cold-water ice fish** transport oxygen via haemoglobin.
- Haemoglobin forms an **unstable reversible bond** with oxygen.
- In oxygenated state, it is called **oxyhemoglobin (bright red)** and in reduced state it is called **deoxyhemoglobin (purple-blue).**
- Haemoglobin develops in cells in bone marrow that **become RBCs.**
- **RBC (aka erythrocytes)** carries oxygen from lungs to every cell in body.
- RBC is covered with a membrane composed of proteins and lipids, lacks a nucleus, and contains haemoglobin.

6 HYBRID SEEDS IN INDIA

CONTEXT: The increase in the share of private companies in India's seed market has promoted use of these seeds. Hybrid seeds could threaten the country's crop diversity and the hardy traditional varieties suited to grow in their native climate.

What are Hybrid seeds?

- A hybrid is created by crossing **two different varieties of the same plant**.
- Crossing involves taking the pollen from the **male flower of one plant** and transferring it **to the female flower parts** of a different plant.
- Once the **ovary of the female flower is pollinated**, it will begin to swell and form a fruit. The seeds that develop inside that fruit are **hybrid seeds.**
- Hybrid seeds are **listed as F1 types**, as opposed to **open pollinated (OP) types.**

Open pollinated seeds result from a simple sharing of pollen between **two like parent plants**.

7 RNA RECOVERY TO RESURRECT EXTINCT 'TASMANIAN TIGER'

CONTEXT: In a groundbreaking achievement, researchers have announced that they successfully recovered RNA, from preserved Tasmanian tiger skin and muscle specimens dating back to 1891 stored in a museum in Stockholm.

About the study:

- This study marks the **first time RNA**, which is less stable than DNA, has been retrieved from an extinct species.
- **Significance:** This research could have significant impact to recreate the species and moreover, the ability to recover RNA from ancient viruses may aid in understanding viruses.

What are DNA and RNA?

Nucleic acids, **deoxyribonucleic acid (DNA)** and **Ribonucleic acid (RNA),** carry genetic information which is read in cells to make the **RNA and proteins** by which living things function.

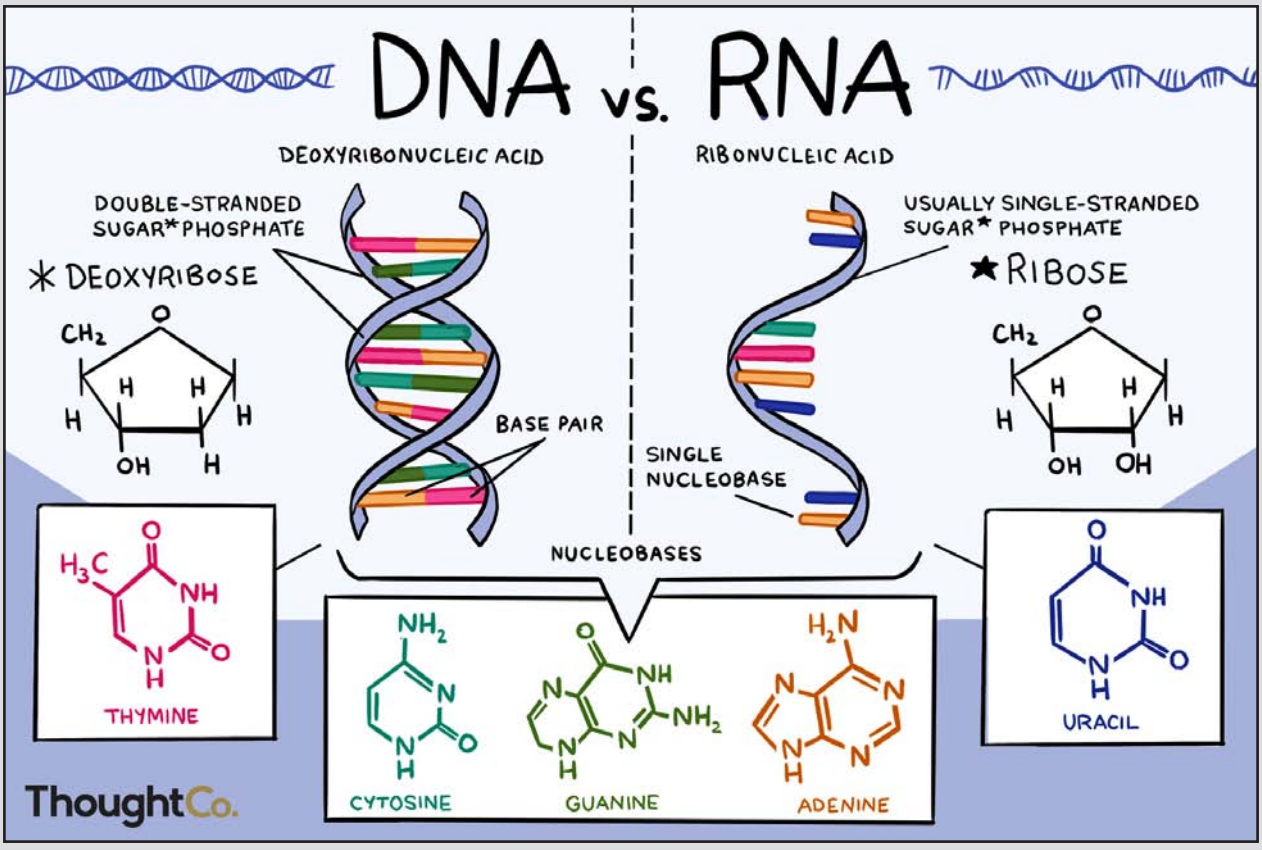
- **DNA**: DNA is a molecule that carries the genetic instructions necessary for the growth, development, functioning, and reproduction of all known living organisms, from simple bacteria to complex humans.

DNA was discovered in 1869 by a Swiss biochemist, Friedrich Miescher.

- Humans have a **diploid genome**, inheriting one set of chromosomes from each parent.
- DNA has a unique double helix structure composed of four nucleotide bases: **adenine (A), thymine (T), cytosine (C), and guanine (G).**
- **RNA:** Chemically RNA is similar to DNA; it is a chain of similar monomers.
- The building blocks are nucleotides containing the **5-carbon sugar ribose, a phosphate and a nitrogenous base.**
- RNA contains four bases **adenine, guanine, cytosine and uracil.**

DNA vs. RNA:

- RNA is more labile (easily broken down) than DNA and most RNA molecules **do not form stable secondary structures**.



8 EVOLUTION OF PROKARYOTES TO EUKARYOTES

CONTEXT: Recently, it was found that evolution of eukaryotes from prokaryotes can answer the question of how complex cells with nuclei and organelles emerged.

- The **existing 'theory of endosymbiosis'**suggests that eukaryotes evolved from a symbiotic relationship between an ancient **archaeon (a primitive group of microorganisms that thrive in extreme habitats)** and a bacterium.

What are Prokaryotes and Eukaryotes?

- **Prokaryotes:** They are organisms that lack a true nucleus and membrane-bound organelles.
- Their genetic material, typically a circular DNA molecule, is present in the cytoplasm without being enclosed within a nuclear membrane.
- Prokaryotes include bacteria and archaeon.
- Key features include **small, simple cells without a nucleus or organelles.**
- **Eukaryotes:** are organisms that have cells containing a well-defined nucleus enclosed within a membrane.
- Eukaryotic cells have a variety of membrane-bound organelles such as mitochondria, endoplasmic reticulum, Golgi apparatus, and a complex network of internal membranes**.**

9 CHIMAERAS OF NATURE

CONTEXT: In a recent landmark study, scientists reported successfully generating a live chimaera in non-human primates.

Background

- At present, more than 3 lakh people are waiting for an organ transplant in India alone; the global number is far higher, with no respite in sight.
- There is an alarming disparity in the **number of organ donors** and the number of recipients – and animals have played an important part in filling this gap.

About Induced pluripotent stem cells (iPSCs) technology:

- The successful application of animal insulin and the more recent use of animal heart valves in human surgeries have saved human lives.
- Researchers have also made attempts to grow full human organs inside the bodies of animals using advancements in **induced pluripotent stem cells (iPSCs) technology**.

Chimaeras in nature:

- A **genetic chimaera** is a **single organism** composed of **cells of more than one distinct genotype** (or genetic makeup).
- The animal kingdom has several examples of varying degrees of chimerism.
- The **half-sider budgerigar**, a type of **common parakeet** widely adopted as pets, has different colours on either side of its body due to chimerism.
- The **anglerfish** displays an extreme degree of **symbiotic chimerism** in which the male fish fuses with and is eventually absorbed into the female fish, mixing their genetic makeups into a single animal.
- **Marine sponges** are known to have up to four distinct genotypes in a single organism.

Chimerism in Humans:

- Natural Chimera occurs when the genetic material in one cell changes and gives rise to a clonal population of cells different from all the other cells.
- **Zygote:** The fusion of two fertilised zygotes early in the embryonic stage can also lead to a condition in which two genetic makeups coexist in a single individual.
- **Foetus**: Chimerism can also result from twin or multiple pregnancies evolving into a single foetus or a twin foetus being absorbed into a singleton.
- **Blood Types:** Researchers have also documented individuals living with two blood types.
  - In fact, blood-group chimerism during multiple births is relatively common.
  - Most chimaeras are detected during routine blood tests in hospitals or when family members undergo tests ahead of an organ transplant.
  - Pregnant women have been known to harbour the genetic material of her foetus in the bloodstream during the pregnancy.

- **Microchimerism:** A phenomenon called microchimerism, in which traces of the foetus's genetic material are observed in mothers' tissues many years after childbirth, resulting in two different genetic materials in a single person.

10 'CARBON NANOFLORETS' FOR EFFICIENT HEAT CONVERSION

CONTEXT: Scientists at the Indian Institute of Technology (IIT), Bombay have made a remarkable discovery in the field of solar energy by developing novel material called carbon nanoflorets that exhibit unprecedented efficiency in converting sunlight into heat.

What are Carbon Nanoflorets?

- Carbon nanoflorets are novel materials which are **spherical nanostructures** composed of carbon cones and exhibit excellent light-absorbing capabilities.

How they are made?

- The process begins with a white material called **dendritic fibrous nanosilica (DFNS)** which is heated along with acetylene gas.

Dendritic fibrous nanosilica (DFNS): A white material used in the production of carbon nanoflorets that undergoes a transformation upon heating and reacting with acetylene gas.

- The white powder undergoes a transformation, turning black as carbon is deposited onto the DFNS surface.
- Further treatment removes the silicon particles, leaving behind spherical nanostructures composed of carbon cones.

11 HELA CELLS

CONTEXT: The estate of Henrietta Lacks filed a lawsuit accusing biopharmaceutical company Ultragenyx Pharmaceutical (RARE.O) of unlawfully profiting from cells that were taken from Lacks' body without her consent during a medical procedure in 1951.

What are HeLa cells?

- HeLa cells are a type of immortal human cell line that were the first to be successfully cultured and continuously propagated outside the human body.
- These cells were derived from a cervical cancer biopsy taken from Henrietta Lacks, an African-American woman, in 1951. The name "HeLa" is derived from the first two letters of her first and last names.
- HeLa cells have been widely used in scientific research, including cell biology, genetics, virology, and drug testing.
- They have contributed to a multitude of medical advancements, such as the development of the polio vaccine, understanding cancer, and various other scientific breakthroughs.
- HeLa cells are known for their ability to divide and multiply rapidly, making them an invaluable resource in laboratories worldwide.

12 CONVERSION THERAPY

CONTEXT: The National Medical Commission (NMC) banned 'conversion therapy' and categorised it as professional misconduct in 2022. But the lack of legislation is a major hurdle in criminalising conversion therapy.

What is Conversion Therapy?

- "Conversion therapy," also known as "**reparative therapy**," is a **range of dangerous and discredited practices** that falsely claim **to change a person's sexual orientation or gender identity or expression.**
- Such practices have been rejected by every mainstream medical and mental health organization for decades, but due to continuing discrimination and societal bias against LGBTQ people, some practitioners continue to conduct conversion therapy.
- **Minors are especially vulnerable**.
- Conversion therapy can lead to depression, anxiety, drug use, homelessness, and suicide.

PYQ (2013)

1. Recombinant DNA technology (Genetic Engineering) allows genes to be transferred

1. across different species of plants
2. from animals to plants
3. from microorganisms to higher organisms

Select the correct answer using the codes given below:

(a) 1 only

(b) 2 and 3 only

(c) 1 and 3 only

(d) 1,2 and 3

Correct Option: (a)

GS SCORE

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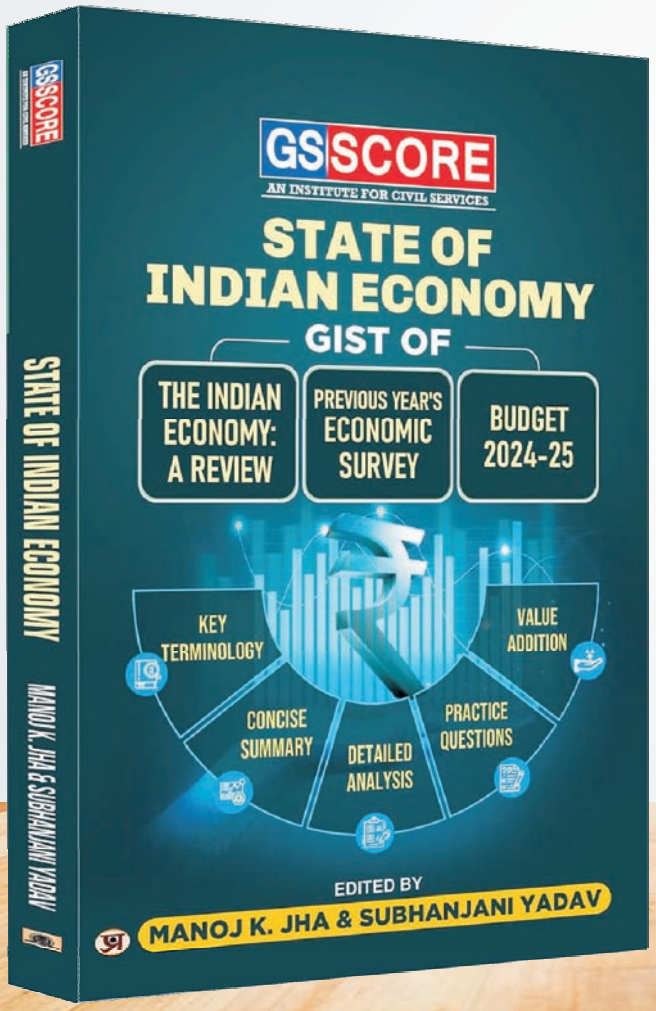
STATE OF INDIAN ECONOMY



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CHAPTER 08

CHEMISTRY

1 LIGHT-EMITTING DIODES (LEDS)

CONTEXT: The emergence of light-emitting diodes (LEDs) as the lighting choice of the 21st century, recognized by the Nobel Prize in Physics in 2014, marks a significant shift from traditional incandescent bulbs and fluorescent lamps

What is an LED?

- A **Light Emitting Diode (LED)** is a **semiconductor device**, which can emit light when an electric current passes through it.
- To do this, holes from p-type semiconductors recombine with electrons from n-type semiconductors to produce light.
- The wavelength of the light emitted depends on the bandgap of the semiconductor material.
- **Harder materials** with stronger molecular bonds generally have wider bandgaps.
- **Aluminum Nitride semiconductors** are known as ultra-wide bandgap semiconductors.

What is the band gap?

- The band gap, crucial in LED functioning, **represents the energy required for electrons to jump from lower to higher energy levels**.
- In LEDs, the energy released during **electron-hole recombination** corresponds to the band gap, determining the emitted light's color.

What colors can an LED produce?

- By carefully selecting **materials for the p-layer and the n-layer, researchers engineer LEDs to emit visible light**.
- LEDs can produce **red, green, and blue, allowing the creation of a spectrum of colors on display boards and various applications.**

What are diodes?

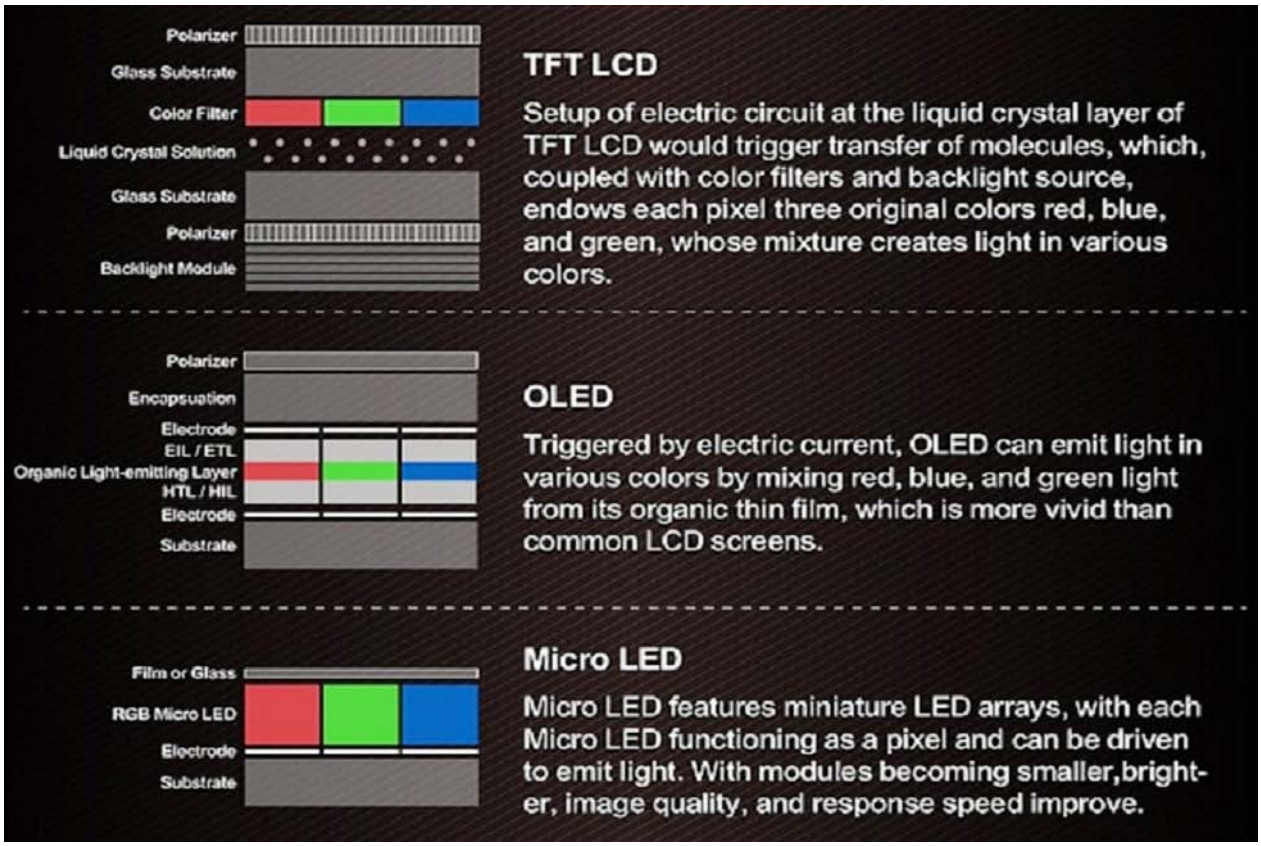
- A diode, a fundamental electronic component, allows the **flow of current in only one direction through a p-n junction**.
- This junction comprises a **p-type material with positive charge-carriers (holes) and an n-type material with negative charge-carriers (electrons)**.

2 MICROLED TECHNOLOGY

CONTEXT: Apple is currently working on to shift to microLED display technology and plans to implement the same on future watch models starting in 2024.

What is microLED display technology?

- The basis of microLED technology are sapphires. A sapphire can shine on its own forever. A microLED screen is filled with such small but strong light.
- The picture in a microLED screen is generated by several **individual light-emitting diodes**.
- A microLED is as small as cutting a centimetre of hair into 200 smaller pieces. Each of these microLEDs are semiconductors that receive electric signals.
- Once these microLEDs are gathered, they form a module. Several modules are then combined to form screens.



3 LITHIUM-ION BATTERY FIRES

CONTEXT: The onset and intensification of lithium-ion battery fires can be traced to multiple causes, including user behavior, such as improper charging or physical damage.

What are Lithium-ion batteries?

- A lithium-ion battery is a type of **rechargeable battery** that uses **lithium ions** as the primary component in its electrochemical system.
- It is widely used in portable **electronic devices, electric vehicles, and various energy storage applications**.
- **Basic structure:**
- A battery is made up of an anode (a negative electrode), cathode (a positive electrode), separator, electrolyte, and two current collectors (positive and negative).
- The electrodes are typically made of materials that can intercalate lithium ions during charging and discharging cycles.
- Common cathode materials include lithium cobalt oxide (LiCoO2), lithium manganese oxide (LiMn2O4), and lithium iron phosphate (LiFePO4).
- Graphite is commonly used as the anode material.

4 WEBB MAKES FIRST DETECTION OF KEY CARBON MOLECULE

CONTEXT: The CH3+ molecule has been detected in space for the first time by the James Webb Space Telescope (JWST).

What has been found?

- Known as **methyl cation** (CH3+), the molecule was detected in a young star system, with a protoplanetary disk, known as **d203-506,** which is located about 1,350 light-years away in the Orion Nebula.
- The findings, published in the ***journal Nature***, showed that although the star in **d203-506** is a **small red dwarf**, the system is bombarded by strong **ultraviolet (UV) light** from nearby hot, young, massive stars.

Organic Molecule

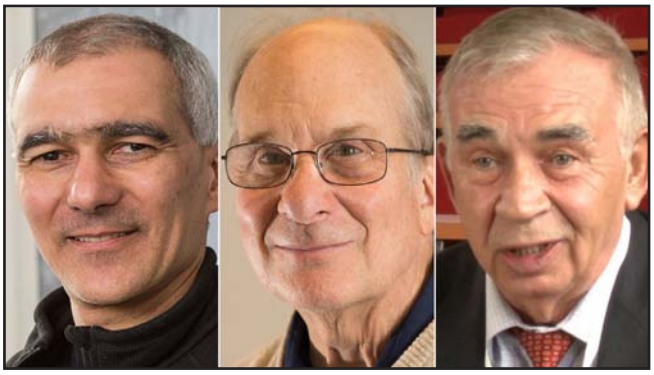
- Organic molecules are carbon based. They contain carbon atoms bonded to hydrogen atoms but can also bond to other elements, such as oxygen, nitrogen or phosphorus.
- Everything that makes us and all life on Earth is carbon based.

What is carbocation CH3+?

- The methyl cation, also known as the **carbocation CH3+** is a very simple **organic molecule**, just one carbon atom and 3 hydrogen atoms.
- But it reacts with other molecules to form more complex ones.
- The CH3+ consists of a positively charged carbon atom (C+) with three hydrogen atoms (H) attached to it.
- It is the simplest carbocation and belongs to the alkyl cation family.
- **This simple molecule has a unique property:** it reacts relatively inefficiently with the most abundant element in Universe (hydrogen) but reacts readily with other molecules and therefore initiates the growth of more complex carbon-based molecules.

5 CHEMISTRY NOBEL 2023

CONTEXT: Moungi G. Bawendi, Louis E. Brus and Alexei I. Ekimov trio has been awarded the Nobel Prize in Chemistry 2023 for the discovery and development of quantum dots.



What are quantum dots?

- Quantum dots (QDs) are **man-made nanoscale crystals** that exhibit unique optical and electronic properties, including the ability to transport electrons and emit light of various colors when exposed to UV light.
- These artificially synthesized semiconductor nanoparticles have a wide range of potential applications, including use in composites, solar cells, fluorescent biological labeling, displays, lighting, and medical imaging.
- They were first discovered **in 1980.**

The discovery:

- Their study revealed that, Electrons can absorb energy and emit light of a certain colour, depending on **the size of the quantum dot.**
- When semiconductor particles are **made small enough**, they exhibit **quantum effects**, which restrict the energies at which **electrons and holes** (the absence of electrons) can exist within the particle.
- As energy is linked to wavelength (or color), this results in the optical properties of the particle being tunable based on its size.
- By controlling the size of the particle, it can be made to **emit or absorb specific wavelengths** (colors) of light.

About contributions:

- **Alexei Ekimov** maps the mysteries of coloured glass, studying optical methods, used as diagnostic tools for assessing the quality of semiconducting material. Researchers shine light on the material and measure the absorbance.
- This reveals what substances the material is made from and how well-ordered the **crystal structure is.**
- **Louis E. Brus** shows that the strange properties of particles are quantum effects: This was the first time someone had succeeded in deliberately producing quantum dots – nanoparticles that cause **size-dependent quantum effects**.
- **Moungi Bawendi** and his research group succeeded in growing nanocrystals of a specific size. During this phase, the solvent helped give the crystals a smooth and even surface.
- The nanocrystals that Bawendi produced were almost perfect, giving rise to distinct quantum effects. Because the production method was easy to use, it was revolutionary – more and more chemists started working with nanotechnology and began to investigate the unique properties of quantum dots.

Application and Uses of Quantum dots:

- **In Television**: The luminous properties of quantum dots are utilised in computer and **television screens based on QLED technology,** where the Q stands **for quantum dot**.
  - In these screens, blue light is generated using the energy-efficient diodes that were recognised with the Nobel Prize in Physics 2014.
  - Quantum dots are used to **change the colour of some of the blue light**, transforming it into **red or green**.
  - This makes it possible to produce the **three primary colours of light** needed in a television screen.
- **In LED lamps**: Similarly, quantum dots are used in some LED lamps to adjust the cold light of the diodes.
  - The light can then become as energising as daylight or as calming as the warm glow from a dimmed bulb. The light from quantum dots can also be used in biochemistry and medicine.

- **In Biochemistry**: Biochemists attach quantum dots to biomolecules to map cells and organs.
  - Doctors have begun investigating the potential use of quantum dots to **track tumour tissue** in the body.
  - Chemists instead use the catalytic properties of quantum dots to **drive chemical reactions**.

PRACTICE QUESTIONS

1. What is the term "biohacking" commonly associated with?

(a) Unauthorized genetic modification of organisms

(b) Hacking into medical databases for personal information

(c) Improving one's own biology through DIY biology techniques

(d) Illicit pharmaceutical drug manufacturing

2. With reference to the benefits of fungi, consider the following statements:

1. They can propel nitrogen fixation and phosphorus mobilization.
2. They contribute to the carbon cycle through the soil food web.
3. They help degrade various pollutants from the environment.

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) All three (d) None

3. With reference to legionella bacteria, consider the following statements:

1. Legionella bacteria proliferate in water systems with appropriate temperature conditions, such as hot tubs and air conditioners.
2. Legionnaires' disease, caused by inhaling small droplets of water containing the bacteria, can lead to severe pneumonia.
3. Pontiac fever, a more severe illness than legionnaires' disease, is the common outcome when exposed to legionella bacteria.

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) Only three (d) None

4. Which of the following immortal cell line, derived from cervical cancer cells in 1951, has played a pivotal role in medical research, including vaccine development and cancer studies?

(a) ME-180 cells (b) A549 cells

(c) HeLa cells (d) WI-38 cells

ANSWERS				
1. (c)	2. (c)	3. (b)	4. (c)	

CHAPTER 09

DISEASE IN NEWS

TYPES OF DISEASE

There are four main types of disease:

- **Infectious diseases:** Infectious diseases are caused by pathogens – microorganisms that enter the body and then reproduce. They can easily be spread through direct or indirect contact.
  - **Example:** Typhoid, smallpox, cholera, diphtheria, influenza (flu), measles, common cold.
- **Deficiency diseases:** Deficiency diseases are caused by dietary deficiency. This means the body is deprived of one or more essential vitamins or minerals.
  - **Example:** Scurvy, Rickets, Osteoporosis
- **Hereditary diseases: Hereditary diseases**, also known as inherited diseases or **genetic disorders**, are defined and categorised as being a set of genetic diseases that are caused by **changes** in one's genetic material (**DNA**). These diseases are then transmitted from generation to generation, or in other words, they are **inherited** from **parents** to their **children**.

Example: skin cancer, hypertrophic cardiomyopathy, arthritis, sudden arrhythmic death syndrome (SADS), marfan syndrome, breast cancer, prostate cancer, lung cancer, muscular dystrophy

- **Physiological diseases:** Physiological diseases are caused by body malfunction.
  - **Example:** Diabetes, Cancer, Hypertension, Heart disease

1 BATTENS DISEASE

CONTEXT: In the United States, of every 100,000 children, around 2-4 gets affected by this condition. Unfortunately, there is no cure for Battens Disease.

About

- Battens Disease refers to a group of genetic disorders classified as neuronal ceroid lipofuscinoses (NCLs).
- NCLs, which are rare and fatal, can affect adults as well as children.
- There are 13 NCLs under Batten disease. They are classified under the following parameters
  - Onset age
  - Symptom
  - Severity
- According to the Cleveland Clinic, Battens Disease is passed down from parents to children.
- It is caused by a faulty gene that impacts the body's ability to properly break down and dispose of cellular waste.
- This causes the body to stop functioning properly.
- While symptoms vary, the first signs of it are
  - Vision loss (not in adults)
  - Seizures
  - Cognitive issues
  - Trouble speaking
  - Coordination problems

2 OSTEOPOROSIS

CONTEXT: The experts at the Osteoporosis Awareness Summit observed that osteoporosis is a public health emergency, however early screening and preventive lifestyle can help in proactive management and effective treatment.

About

- Osteoporosis is a bone disease that develops when bone mineral density and bone mass decreases, or when the structure and strength of bone changes.
- This can lead to a decrease in bone strength that can increase the risk of fractures (broken bones).
- Osteoporosis is a "silent" disease because you typically do not have symptoms, and you may not even know you have the disease until you break a bone.
- Osteoporosis is the major cause of fractures in postmenopausal women and in older men.
- Fractures can occur in any bone but happen most often in bones of the hip, vertebrae in the spine, and wrist.

3 25 BY 25 TARGET

CONTEXT: India will likely miss reaching targets set by the World Health Organization (WHO) and the United Nations-mandated Sustainable Development Goals (SDG) to reduce premature deaths from four major Non-Communicable Diseases (NCD), according to an analysis by the Indian Council of Medical Research (ICMR).

About

- The "25 by 25 target" was outlined when the WHO adopted a global NCD monitoring framework in 2013.
- In quick succession 8 months later, the 65th World Health Assembly adopted a resolution to reach a 'global target of 25 % reduction in premature mortality from noncommunicable diseases such as cardiovascular disease, cancer, diabetes and chronic respiratory diseases by 2025'.
- The SDG target to reduce premature deaths from the four major NCDs by a third from 2015 to 2030 will also likely be missed by India as the researchers projected a decline of 15.6 per cent from 2015 to 2030.
- Non-communicable diseases are diseases that are not spread through infection or through other people, but are typically caused by unhealthy behaviours. They are the leading cause of death worldwide and present a huge threat to health and development, particularly in low- and middle-income countries.

4 H5N1, THE AVIAN FLU

CONTEXT: A deadly variant of bird flu known as avian flu has been found in the fifth-largest continent.

What is H5N1?

- H5N1, the avian flu subtype has been circulating all across the world.
- The first human H5N1 avian flu outbreak occurred in 1997 in Hong Kong.
- A fatal variant of the H5N1 sub-type is to blame for the current pandemic, said Nature magazine. In 2020, the strain first appeared in Europe. Since then, it has quickly spread to several countries like South America.
- Due of the enormous number of deaths it causes in poultry, H5N1 is known as a highly pathogenic avian influenza (HPAI) virus. Bird flu outbreaks are seasonal, however, they have been persistent since 2021, as per NDTV.
- Millions of birds died in 2022 as a result of the illness.
- The H5N1 virus is difficult to spread from animals to humans, as per US-based Centres for Disease Control (CDC). Even more difficult is for the virus to spread from one person to another.
- However, there are worries that if a person with the flu contracts this bird flu, the H5N1 sub-strain may be able to interchange genetic material with the seasonal flu virus. Thus, there can be serious repercussions as a result.
- Experts have long been concerned about its possible effects on Antarctica's ecosystem due to the fact that many species are found only in the region and have never been known to be exposed to bird flu viruses.

5 LYMPHATIC FILARIASIS (LF)

CONTEXT: Lao PDR becomes second country in 2023 after Bangladesh to eliminate lymphatic filariasis.

About

- Lymphatic filariasis (LF), also known as elephantiasis, is a preventable mosquito-borne infectious disease targeted for global elimination as a public health problem.
- It occurs when one of the filarial parasites — Wuchereria bancrofti, Brugia malayi and B. timori — are transmitted to humans through mosquito bites.
- The parasites nest in the lymph vessels, damaging them.
- This leads to hydrocele, lymphedema, and elephantiasis.

- WHO recommends the triple therapy combination of ivermectin (I), diethylcarbamazine (D) and albendazole (A), for MDA against LF.
- Lymphatic filariasis is transmitted via mosquito bite.
- It is transmitted by different types of mosquitoes, for example by the Culex mosquito, widespread across urban and semi-urban areas, Anopheles, mainly found in rural areas, and Aedes, mainly in endemic islands in the Pacific.

6 TILAPIA PARVOVIRUS (TIPV)

CONTEXT: Tilapia parvovirus (TiPV) has been detected in farmed Nile tilapia, Oreochromis niloticus, from two geographical regions of India, Maharashtra and Uttar Pradesh. TiPV has been associated with heavy mortalities in tilapia as a single infection or in co-infection with Tilapia lake virus (TiLV).

About

- Tilapia Parvovirus (TiPV) is a virus that affects tilapia fish.
- It is a pathogen known to cause diseases in tilapia, which can lead to significant losses in aquaculture.
- The virus primarily affects the immune and reproductive systems of tilapia, making it a concern for the aquaculture industry.
- Tilapia lake virus disease, or syncytial hepatitis of tilapia (SHT), is caused by infection with tilapia lake virus (TiLV).
- TiLV is an enveloped, negative-sense, single-stranded RNA virus that has been classified as a relative of the Orthomyxoviridae family of viruses.

7 PROGRAMME FOR NON-¬COMMUNICABLE DISEASES RENAMED

CONTEXT: The Union health ministry has decided to rename its national programme and portal aimed at tackling the rising challenge of non-communicable diseases.

Non-communicable diseases (NCD)

- NCDs refer to chronic diseases that are not passed from person to person. It includes **heart disease, stroke, cancer, diabetes, and chronic lung diseases.**
- Non communicable diseases (NCDs) kill 41 million people each year worldwide, equivalent to 71% of all deaths globally.

The Previous Programme

- Earlier the programme on **non-communicable diseases** included **diabetes, cardiovascular diseases, cancer, and stroke**, and hence it was known as the **National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS).**
  - NPCDCS was being implemented under the **National Health Mission (NHM)** across the country.

The new programme

- The **Ministry of Health and Family Welfare** has decided to rename 'NPCDCS' as the **National Programme for Prevention & Control of Non-Communicable Diseases (NP-NCD).**

National NCD Portal:

- The government has also renamed the portal which enables population enumeration, risk assessment, and screening for five common NCDs, including hypertension, diabetes, and oral, breast and cervical cancer of the population aged above 30 years.
- While earlier, the application or software called **Comprehensive Primary Healthcare Non-Communicable Disease (CPHC NCD IT)** was rolled out under the programme for screening and management, now it will also be renamed **National NCD Portal.**

8 FIRST-EVER FUNGAL PRIORITY PATHOGENS LIST (FPPL)

CONTEXT: The WHO published a report highlighting the first-ever list of fungal "Priority pathogens" – a catalogue of the 19 fungi that represent the greatest threat to public health.

About the list:

- The WHO **fungal priority pathogens list (FPPL)** is the first global effort to systematically prioritize fungal pathogens, considering the unmet research and development (R&D) needs and the perceived public health importance.

- The 19 Fungi identified as categorically as fungi of concern are mentioned in the table below.
- **Objective:** The WHO FPPL aims to focus and drive further research and policy interventions to strengthen the global response to fungal infections and antifungal resistance.
- Fungal pathogens are a major threat to public health as they are becoming increasingly common and resistant to treatment with only four classes of antifungal medicines currently available.
- **The WHO FPPL list is divided into three categories:**
  - **Critical priority**: It includes Candida auris, which is a highly drug-resistant fungi, Cryptococcus neoformans, Aspergillus fumigatus, and Candida albicans.
  - **High priority:** It includes a number of other fungi from the Candida family as well as others such as Mucorales, a group containing "black fungus", an infection which rose rapidly in seriously ill people, particularly in India, during Covid-19.
  - **Medium priority:** It includes a number of other fungi, including Coccidioides spp and Cryptococcus gattii.
- The fungal pathogens in each priority category are so ranked primarily due to their public health impact and/or emerging antifungal resistance risk.

Target Population:

- These fungal infections often affect severely ill patients and those with significant underlying immune system related conditions.
- Populations at greatest risk of invasive fungal infections include those with **cancer, HIV/AIDS, organ transplants, chronic respiratory disease, and post-primary tuberculosis infection.**

9 TUBERCULOSIS (TB)

CONTEXT: TB causes the largest number of deaths among all other infectious diseases in India. India has a little less than 20 percent of the world's population, but has more than 25 percent of the total TB patients of the world.

What is Tuberculosis (TB)?

- Tuberculosis (TB) is **a bacterial infection** spread through inhaling tiny droplets from the coughs or sneezes of an infected person.
- It mainly **affects the lungs**, but it can affect any **part of the body**, including the **tummy (abdomen), glands, bones and nervous system.**
- India is committed to eliminating tuberculosis from the country by 2025, five years ahead of the global target by the **World Health Organisation (WHO) i.**e. 2030.

Vaccination for TB:

- The **BCG vaccine** offers protection against TB, and is recommended on the **NHS** for babies, children and adults under the age of 35 who are considered to be at risk of catching TB.
- The BCG vaccine is not routinely given to anyone over the age of 35 as there's no evidence that it works for people in this age group.

Important initiatives

- **National Tuberculosis Elimination Programme:** The programme is aligned with the ambitious goal; the programme has been renamed from the **Revised National Tuberculosis Control Programme (RNTCP) to National Tuberculosis Elimination Programme (NTEP).**
- **TB Harega Desh Jeetega Campaign**: Launched In September 2019 it is showcasing the highest level of commitment for the elimination of TB.
- **Saksham Project:** It is a project of the Tata Institute of Social Sciences (TISS) that has been providing psycho-social counselling to DR-TB patients.

10 CANCER

CONTEXT: There is an increasing trend of cancer incidence and deaths due to cancer in India and according to Indian Council of Medical Research's (ICMR) study, one in every nine Indians will develop cancer during their lifetime.

About Cancer

- Cancer is a large group of diseases that can start in almost any organ or tissue of the body when abnormal cells grow uncontrollably, go beyond their usual boundaries to invade adjoining parts of the body and/or spread to other organs.
- The latter process is called **metastasizing** and is a major cause of death from cancer.
  - A **neoplasm and malignant tumour** are other common names for cancer.

Risk Factors

The modifiable risk factors which are high in Indians can lead to cancer are:

- Alcohol
- Obesity
- Infection
- Tobacco related cancers

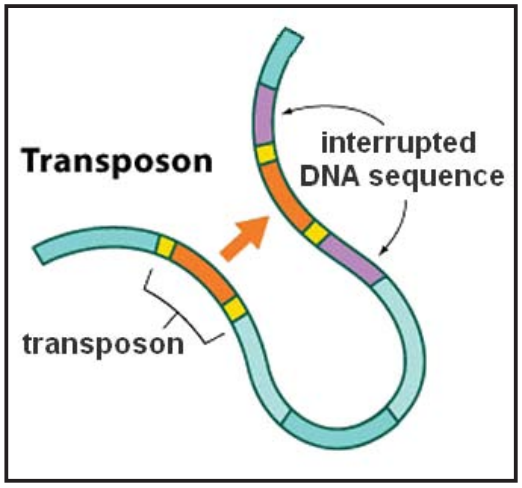
- When cancer develops, this orderly process breaks down.
- As cells become more and more abnormal, old or damaged cells survive when they should die and new cells form when they are not needed.
- These extra cells can divide without stopping and forms **tumors,** which can spread through the blood or the lymph system and form **new tumors** far from the **original tumor.**

11 JUMPING' GENES

CONTEXT: US scientists have found that jumping genes can protect against certain blood cancers and they can also help in developing new therapeutic targets.

What are Jumping genes?

- Jumping genes are also known as **transposons**.
- They are DNA sequences that can move or jump from one location to another location in the genome after activation.



- Jumping genes act as **mutating agents** and are behind several human diseases. They change the gene sequence and genome size.

12 'MISMATCH REPAIR DEFICIENT' CANCER

CONTEXT: Twelve patients in the United States were completely cured of rectal cancer without requiring any surgery or chemotherapy found in a medical trial.

What is Rectal Cancer?

- Rectal cancer is cancer that begins in the rectum. The rectum is the last several inches of the **large intestine.**
- It starts at the end of the final segment of colon and ends when it reaches the short, narrow passage leading to the anus.
- While rectal cancer's treatments are quite different. This is mainly because the rectum sits in a tight space, barely separated from other organs and structures.
- The tight space can make surgery to remove rectal cancer complex.
- **Signs and symptoms of rectal cancer include**:
  - A change in bowel habits, such as diarrhea, constipation or more-frequent bowel movements
  - Dark maroon or bright red blood in stool
  - Narrow stool
  - A feeling that your bowel doesn't empty completely
  - Abdominal pain
  - Unexplained weight loss
  - Weakness or fatigue

What is PD1 Therapy?

- PD1 is a type of protein that regulates certain functions of the immune system, including by suppressing **T cell activity**, and PD1 blockade therapy looks to release the T cells from this suppression.
- T-cells are the **White Blood cells (WBCs)**. They are critical for developing immunity towards common pathogens or antigens.
- Although the therapy is usually used for cancers that have metastasised (spread to locations other than where the cancer formed), it is now recommended for all mismatch repair deficient cancers as they result in quicker improvement and lesser toxicity as compared to traditional chemo and radiotherapy.
- Eliminating other treatments can improve a patient's quality of life by preserving fertility, sexual health, and bladder and bowel functions.

What are monoclonal antibodies?

- Monoclonal antibodies are laboratory-produced molecules engineered to serve as substitute antibodies that can restore, enhance, modify or mimic the immune system's attack on cells that aren't wanted, such as cancer cells.

Mismatch repair deficient cancer:

- It is most common among colorectal, gastrointestinal, and endometrial cancers.
- Patients suffering from this condition **lack the genes to correct typos in the DNA** that occur naturally while cells make copies.
- The anomalies in the DNA result in cancerous growths in patients.

13 MACROPHAGES

CONTEXT: Macrophages can initiate an immune response against cancers. However, like other cells, macrophages can experience senescence, which can promote lung tumor growth: Study

About

- Macrophages are a type of white blood cell that play an important role in the human immune system and carry out various functions including engulfing and digesting microorganisms; clearing out debris and dead cells; and stimulating other cells involved in immune function.
- Macrophages confer innate immunity, which is typically the first line of defense against foreign antigens.
- Adaptive immunity, on the other hand, is the subtype of the immune system that involves specialized immune cells and antibodies.
- In addition to having an immune role, macrophages also secrete anti-inflammatory cytokines (i.e., small signaling proteins) and help mediate reparative processes.
- Macrophages form from monocytes, which themselves derive from the bone marrow.
- Monocytes circulate through the blood for one to three days before migrating into tissues, where they become macrophages or dendritic cells (i.e., a type of antigen presenting cell that plays a role in linking the innate and adaptive immunity).
- Macrophages can be found within many organs in the body, including the liver, brain, bones, and lungs, as well as in the blood, particularly at sites of infection.

14 MALARIA

CONTEXT: The rollout of the world's first malaria vaccine began in Cameroon, which is said to be a "transformative chapter in Africa's public health history".

The **RTS,S vaccine** – 662,000 doses of it – will be administered to children in the west African country, the first to be vaccinated after successful trials of the drug in Ghana, Kenya and Malawi between 2019 and 2021.

About Malaria

- Malaria is a parasitic infection transmitted by **Anopheline mosquitoes.**
- **Host:** Humans and anopheline mosquitoes are both considered to be the parasite's hosts.
- **Vectors:** Vectors are living organisms that can transmit infectious pathogens between humans, or from animals to humans.
- **Vector-borne diseases:** Vector-borne diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by vectors.

Genome

- A genome is all genetic material (coding as well as noncoding regions) of an organism. It consists of **DNA (or RNA in RNA viruses).**
- It also included **mitochondrial DNA and chloroplast DNA (in photosynthetic organisms).**
- The study of the genome is called **Genomics.**

15 TOMATO FLU

CONTEXT: A new virus known as tomato flu, or tomato fever, has emerged in India and children are the most vulnerable to the disease.

About the disease:

- Tomato flu is a viral illness that starts with rashes, blisters or ulcers in the mouth.
- **Type:** Very Contagious
- **Caused by:** The infection is caused by **Coxsackievirus A16.**
- **Target:** It primarily targets young children between 1 to 10 years of age and adults with weak immunity.
- **Symptoms:** Its symptoms ranges to;
  - Fever, fatigue, and body aches initially, and some patients also report rashes on the skin.
- **Treatment:** Tomato flu is a **self-limiting illness** and no specific drug exists to treat it.

16 MONKEYPOX

CONTEXT: With 3,417 cases of Monkeypox across 58 countries, monkeypox has recently been declared a pandemic by the World Health Network (WHN).

About

- Monkeypox is now known as mpox (name changed by WHO).

- **Type:** viral zoonotic disease
- **Caused by:** Mpox is a **rare disease** caused by infection with the **mpox virus**.

- The virus was first discovered in 1958 in two outbreaks of a pox-like disease among colonies of research monkeys.
- The first human case of mpox was recorded in 1970 in the Democratic Republic of the Congo (DRC). The disease is endemic in central and western Africa.
- Recently, an on-going outbreak of the viral disease monkey-pox was confirmed in May 2022.

- **Comparison with Smallpox:** The mpox virus is in the same family of viruses as the smallpox virus. But mpox is less contagious than smallpox. And its disease causes milder symptoms and is usually not fatal.
  - Orthopoxvirus genus, which also includes variola virus (the cause of smallpox)
- **Symptoms:** Initial symptoms of mpox include: fever, headache and body aches, fatigue, and swollen lymph nodes, followed by a rash of lesions on the skin.
- **Treatment:** While there are **no specific treatments** for monkey-pox infections, **antiviral drugs licensed for smallpox use are effective and can be used against monkey-pox**.
- **Transmission:** Human-to-human transmission of mpxv occurs through direct contact with body fluids, lesions, prolonged face-to-face contact, including sexual contact, and indirect contact with contaminated clothing or bedding.

Mode of transmission:

- **Human-to-human transmission is** known to occur primarily through large respiratory droplets generally requiring prolonged close contact.
- It can also be transmitted through direct contact with body fluids or lesion material, and indirect contact with lesion material, such as through contaminated clothing or linens of an infected person.
- **Animal-to-human transmission**: may occur by bite or scratch of infected animals like small mammals including rodents (rats, squirrels) and non-human primates (monkeys, apes) or through bush meat preparation.

17 MARBURG VIRUS DISEASE

CONTEXT: Marburg virus outbreak has been detected in West Africa.

About Marburg virus disease:

- According to WHO, Marburg virus disease (MVD), earlier known as Marburg haemorrhagic fever, is a severe, often **fatal hemorrhagic fever**.
- Marburg, like Ebola, is a **filovirus**; and both diseases are clinically similar.
- **Rousettus fruit-bats** are considered the natural hosts for Marburg virus.
- However, **African green monkeys** imported from **Uganda** were the **source of the first human infection.**
- It was **first detected in 1967** after simultaneous outbreaks in **Marburg and Frankfurt** in Germany; and in Belgrade, Serbia.
- The disease has an **average fatality rate of around 50%.**
- **Treatment: No treatment or vaccine** has been developed for Marburg, yet.

18 KYASANUR FOREST DISEASE (KFD)

CONTEXT: A new point-of-care test for KFD has been developed by Indian Council of Medical Research (ICMR) which is a battery-operated Polymerase Chain Reaction (PCR) analyzer that aids in sample processing at the point of care.

About KFDV

- It is a **tick-borne viral hemorrhagic fever**, also referred as **monkey fever.**
- It is caused by **Kyasanur Forest disease virus (KFDV),** a member of the virus family **Flaviviridae.**
- KFDV was first identified in 1957 when it was isolated from a sick monkey from the **Kyasanur Forest in Karnataka (formerly Mysore) State.**
- **Hard ticks (Hemaphysalis spinigera)** are the reservoir of KFD virus and once infected, remain so for life.
- Rodents, shrews, and monkeys are common hosts for KFDV after being bitten by an infected tick.
- KFDV can cause epizootics with high fatality in primates.

19 MENINGITIS

CONTEXT: The World Health Organization (WHO) and its partners launched the first-ever global strategy to defeat meningitis, a debilitating disease that kills hundreds of thousands of people each year.

What is Meningitis?

- Meningitis is an inflammation of the membranes (meninges) that protect the spinal cord and brain, causing life-threatening problems.
- An infection of the fluid surrounding the brain and spinal cord usually causes the swelling.
- However, injuries, cancer, certain drugs, and other types of infections also can cause meningitis.

Types of meningitis

- **Viral meningitis** is the most common type of meningitis.
- **Bacterial meningitis** caused by infection from certain bacteria and it is most deadly.
- **Fungal meningitis** is a rare type of meningitis.
- **Parasitic meningitis** is less common than Viral and Bacterial.
- **Non-infectious meningitis** can be caused by cancers, certain drugs, injury, head surgery, etc.

20 MYOSITIS

CONTEXT: Myositis was seen in news frequently.

About the disease:

- Myositis is the name for a group of rare conditions.
- **Symptoms:** The main symptoms are weak, painful or aching muscles. This usually gets worse, slowly over time.
- Myositis is usually caused by **a problem with immune system, where it mistakenly attacks healthy tissue.**

Causes:

- Some researchers believe that myositis may also be caused by:
- autoimmune diseases such as rheumatoid arthritis and lupus
- viruses such as the common cold, flu, and HIV
- drug toxicity

Types of Myositis:

There are generally **three types** of myositis –

- **Polymyositis** – It affects multiple muscles at the same time. It usually causes symptoms in muscles or near the centre of the body. Polymyositis develops gradually over time. It mostly affects adults.
- **Dermatomyositis** – It is a form of myositis that affects skin in addition to muscles. If it affects children, it is known as juvenile dermatomyositis.
- **Inclusion Body Myositis (IBM)** – It is a degenerative muscle disease. It usually affects persons older than 50.
  - It causes muscle weakness in hands and legs (below knees). It can also affect throat muscles. Around 30% of people with IBM develop dysphagia (difficulty swallowing).

21 NOMA

CONTEXT: The World Health Organization (WHO) officially added noma, a severe gangrenous disease affecting the mouth and face, to its list of neglected tropical diseases (NTD).

What is Noma?

- Commonly known as cancrum oris, it is a rapidly progressing severe gangrenous disease of the mouth and the face.
- It mostly affects children aged 2–6 years suffering from malnutrition, affected by infectious diseases, living in extreme poverty with poor oral health or with weakened immune systems.
- Noma can also occur among immunocompromised adults due to HIV, leukaemia and other diseases.
- The disease is mostly found in **sub-Saharan Africa**, although cases have also been reported in **Latin America, Asia and other regions**.
- Noma starts as a **soft tissue lesion (a sore)** of the gums.
- It then develops into an **acute necrotizing gingivitis** that progresses rapidly, destroying the soft tissues and further progressing to involve the hard tissues and skin of the face.

22 GENERIC DRUGS TO TREAT FOUR RARE DISEASES

CONTEXT: The Union Health Ministry has made available generic drugs to support the care and treatment of four ailments:

- Tyrosinemia-Type 1
- Gauchers Disease
- Wilson's Disease
- The Dravet-Lennox Gastaut Syndrome

What is Rare Disease?

- A rare disease is a health condition of particularly low prevalence that affects a small number of people.
- It collectively afflicts 6-8% of the population in any country at any given time.

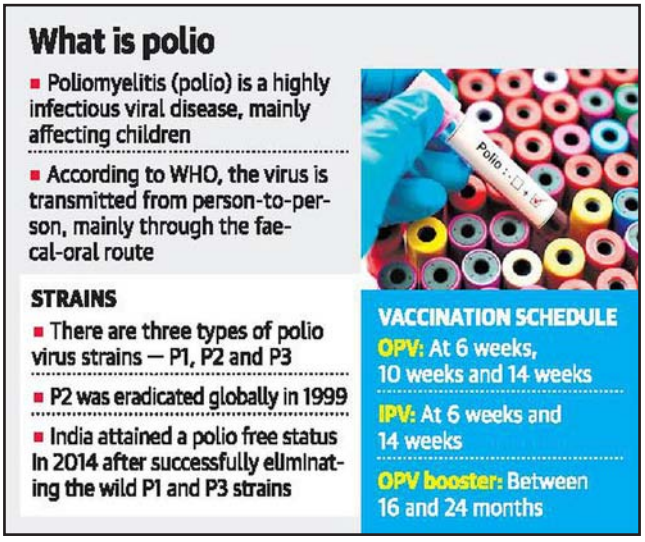
- According to the Health Ministry, India could have 8.4 crore to 10 crore such cases.
- Nearly 80% percent of these diseases are genetic in nature.
- The Government has prioritised **13 rare diseases along with sickle cell anemia.**

23 POLIO

CONTEXT: Polio is on the brink of eradication.

About the disease:

- Poliomyelitis, commonly called polio, is a **highly infectious viral disease** that can leave patients disabled, and in some cases, even prove fatal.
- The virus enters the nervous system and can cause total paralysis in just a few hours.
- **Symptoms** - Initial symptoms of the infection include fever, fatigue, headache, vomiting, stiffness of the neck and pain in the limbs.
- **Treatment** - There is no known cure for polio. It can only be prevented by way of vaccination.



Types of Polio virus –

- Wild poliovirus (WPV) has three known strains – **types 1, 2, and 3** – each with a slight difference in structure.
- Immunity to one type does not guarantee immunity to others.
  - **Type 1 WPV** - remains in circulation and endemic to **Pakistan and Afghanistan.**
  - **Type 2 WPV** - declared eradicated in September 2015.
  - **Type 3 WPV** - declared eradicated in October 2019.
- **Spread of the disease** - The polio virus is most commonly spread through the faecal-oral route.
  - It can also spread through contaminated water or food.
  - The virus multiplies in the host's intestines.
- **Susceptible age group** - Most polio cases are recorded in children less than five years of age, but all unvaccinated people can contract the disease.

Government Interventions:

WHO removed India from its list of endemic countries with active poliovirus transmission and **India is polio free.**

- The Government of India launched the **National Immunisation Day (NID),** the Pulse Polio immunisation programme in 1995. It aims to administer polio drops to all children **less than 5 years**.
- Additionally, Sub-National Immunisation Days are also conducted every year in high-risk areas.

Treatment and vaccines:

- There are two types of vaccines – **oral poliovirus vaccine (OPV) and inactivated poliovirus vaccine (IPV).**
  - **Inactivated poliovirus vaccine (IPV):** IPV consists of **inactivated (killed) poliovirus strains** of all three types.
    - The vaccine is administered through an intramuscular or intradermal injection.
    - It produces antibodies in the blood against all three types of the poliovirus.
  - **Oral poliovirus vaccine (OPV):** OPV uses a weakened (also called attenuated) form of poliovirus, which can either be one strain or a combination. OPVs are administered orally; they are more suitable for mass vaccination.

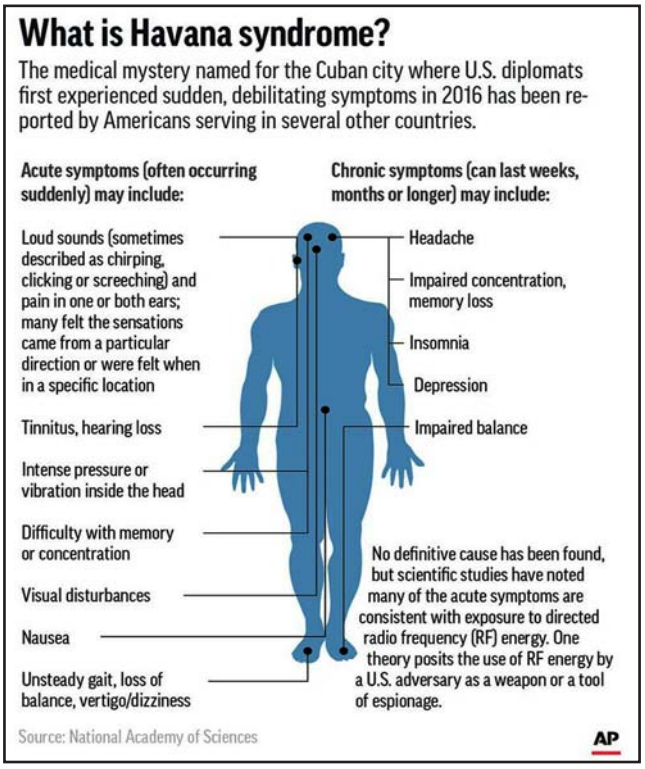
24 HAVANA SYNDROME

CONTEXT: The central government has agreed to investigate the possibility of the presence of the Havana Syndrome in India.

About the disease:

- Havana Syndrome refers **to a set of mental health symptoms** that are said to be experienced by US intelligence and embassy officials in various countries.
- **It typically involves symptoms** such as hearing certain sounds without any outside noise being present, nausea, vertigo and headaches, memory loss and issues with balance.

- As the name suggests, it traces its roots to Cuba.
  - Back in 2016, **reports first emerged of US diplomats and other employees of the government falling ill in Havana,** the capital of Cuba.
  - The patients said they **heard strange sounds and experienced odd physical sensations** in their hotel rooms or homes, and had **symptoms of nausea, severe headaches, fatigue, dizziness**, sleep problems and hearing loss.
  - This **mysterious illness** came to be called the "**Havana Syndrome".**



25 ANTIMICROBIAL RESISTANCE

CONTEXT: World Antimicrobial Awareness Week (WAAW) is celebrated on November 18-24 globally to create awareness and understanding on the issue of Antimicrobial drugs by Humans and Animals.

What is Antimicrobial Resistance?

- Antimicrobial Resistance is the resistance acquired by any microorganism (bacteria, viruses, fungi, parasite, etc.) against antimicrobial drugs that are used to treat infections.

World Health Organisation (WHO) has identified AMR as one of the top ten threats to global health.

Factors Responsible:

- Antibiotic consumption in humans
- Access to antibiotics without prescription
- Lack of knowledge about when to use antibiotics
- Steroidal injection to Animals
- Anti-microbial drugs to animals
- Untreated disposal of sewage water bodies

26 VASCULITIS

CONTEXT: Pregnancy in patients with vasculitis had a higher risk for preterm delivery and preeclampsia/ eclampsia.

About the disease:

- **A vasculitis** is a group of disorders that destroy blood vessels by inflammation. It is also called angiitis **("inflammation within blood vessels")** or arteritis ("inflammation in arteries").

Types of Vasculitis:

There are around 20 different disorders that are classified as vasculitis. A few important among them have been given below:

- **Polyarteritisnodosa**: This affects small- to medium-sized blood vessels in many different parts of the body, especially the skin, intestines, kidneys and nerves.
- **Takayasu's arteritis**: This vasculitis affects medium and large-sized arteries, especially the aortic arch and its branches near the heart. It most **commonly affects teenage girls and young women, and it is most common in Asia.**
- **Kawasaki disease**: This vasculitis affects the lymph nodes, skin, mucous membranes, and heart, including the coronary arteries (arteries that supply blood to the heart). It is seen most commonly in children.
- **Behcet's Disease:** Oral and genital ulcers and eye inflammation.
- **Buerger's Disease:** Mainly affects smokers and leads to decreased flow of blood to the hands and feet.
- **Churg-Strauss Syndrome:** Associated with asthma, and sinusitis, and tends to involve the lungs, kidneys, and heart as well.
- **Lecocytoclastic Vasculitis**: Purpura, skin rashes

- It is an **auto-immune disease** in which the body's immune system turns on healthy blood vessels, causing

them to swell up, narrow down, stretched, or be weak. The blood vessels might close entirely.

- In vasculitis, the body's immune system turns on healthy blood vessels, causing them to swell up and narrow down.
- The trigger for vasculitis may be an infection or a drug or blood cancer or immune system diseases, although the **precise reason is often uncertain or unknown.**
- Vasculitis can be only a minor problem affecting the skin, or it can be a serious condition that impacts the heart, kidneys or other vital organs.

Causes:

- The exact cause of vasculitides (plural of vasculitis) is multifactorial (genes, gender, and environment) and is unknown.
- Secondary vasculitis is due to a known cause and appears in the course of other defined diseases. Some causes of secondary vasculitis are listed below:
  - **Infection** - Viruses (Hepatitis B and C, HIV, Varicella zoster, etc.), bacteria (TB, gonorrhoea, streptococci, staphylococci, etc.), fungi, and others (e.g., syphilis)
  - **Cancer** - Most malignancies (solid organ tumours, lymphoma, and others).
  - **Drugs** - Vaccines and desensitization agents, drugs used for nasal allergies (montelukast and others from this group), propylthiouracil, hydralazine, heroin, cocaine, amphetamine, etc. The vasculitides appear after prolonged exposure to the drug, are usually limited to the skin, and disappear on early withdrawal of the offending agent.

27 WORLD DIABETES DAY

CONTEXT: World Diabetes Day is observed on 14th November every year

About Diabetes:

- Diabetes is a ***Non-Communicable Disease (NCD)*** that occurs either when the pancreas does not produce enough insulin (a hormone that regulates blood sugar, or glucose), or when the body cannot effectively use the insulin, it produces.
- **Type 2 diabetes** is age-related; it often develops at the age of 45 and beyond.
- **Type 1 diabetes** is largely genetic in nature, while Type 2 depends on the lifestyle of the individual.

Its Types:

- **Type I diabetes:** Also known as juvenile diabetes, this type occurs when the body fails to produce insulin. People with type I diabetes are ***insulin-dependent***, which means they must take artificial insulin daily to stay alive.
- **Type 2 diabetes:** It affects the way the body uses while the body still makes insulin, unlike in type I, the cells in the body do not respond to it as effectively as they once did.
  - This is the most common type of diabetes and it has strong links with obesity.

About Insulin:

- **Insulin** is a peptide hormone produced by beta cells of the pancreatic islets;
- It is considered to be the main ***anabolic hormone*** of the body.
- It regulates the metabolism of carbohydrates, fats, and protein by promoting the absorption of glucose from the blood into the liver, fat, and skeletal muscle cells.

28 WORLD LEPROSY DAY

CONTEXT: Every year the last Sunday of January is dedicated to the observation of World Leprosy Day. This year the event is being marked on 30 January, which is the last Sunday of January, 2022.

Important facts about Leprosy

- **Leprosy (Hansen's disease)** is an infectious disease caused by **Mycobacterium leprae that involves the skin and peripheral nerves.**
- The disease mainly affects the **skin, the peripheral nerves, mucosa of the upper respiratory tract and eyes.**
- The disease is not hereditary, leprosy does not trasmit from parents to children.
- **Transmission:** While the mode of transmission of leprosy is not known, the most widely held belief is that the disease was transmitted by contact between those with leprosy and healthy persons.
  - More recently, the possibility of transmission by the respiratory route is gaining ground.
  - There are also other possibilities such as transmission through insects which cannot be completely ruled out.
- **Most affected:** Although leprosy affects both sexes, in most parts of the world males are affected more frequently than females, often in the ratio of 2:1, according to **WHO's Global Leprosy Report.**
- **Treatment:** Leprosy is curable with **MDT (multi drug therapy)** and treatment in the early stages can prevent disability.

29 NATIONAL DEWORMING DAY

CONTEXT: National Deworming Day is observed on 10 February annually to spread awareness about the importance of deworming in all preschool and children of school age between 1 to 19 years.

About the National Deworming Day

- The National Deworming Day is a **single fixed-day approach** to treating **intestinal worm infections** in all children aged 1- 19 years.
- It aims to mobilize health personnel, state governments and other stakeholders to prioritize investment in control of **Soil Transmitted Helminth (STH) infections**, one of the most common infections.
- All the children are provided deworming tablets in schools and anganwadis.
  - Besides the deworming tablet, various health promotion activities related to **Water, Sanitation and Hygiene (WASH)** are organised in schools and anganwadis.
- The NDD program is a cost-effective program at scale that continues to reach crores of children and adolescents with deworming benefits through a safe medicine **Albendazole.**

Background

- India carries the highest burden of worm infestation and 64% of the Indian population less than 14 years of age are at risk of **Soil Transmitted Helminths (STH) or worms' infestation (WHO).**
- **Soil Transmitted Helminths (STH)** interfere with nutrients uptake in children; can lead to anaemia, malnourishment and impaired mental and physical development.
- The situation of undernutrition and anaemia which is linked to STH ranges from 40% to 70% in different population groups across the country (WHO).
  - They also pose a serious threat to children's education and productivity later in life.

30 INTERNATIONAL EPILEPSY DAY

CONTEXT: International Epilepsy Day is observed every year on the second Monday of February across the world.

What is Epilepsy?

- **Epilepsy** is derived from the **Greek word which means 'to be seized, to be overwhelmed by surprise'.**
- Suffering from epilepsy means **having a tendency to have recurring seizures.**
- It is said that if the brain is exposed to a strong enough stimulus then anyone can have a seizure.

Cause of Epilepsy

- There are various types of epilepsy. Some types of it **start at a young age and some in later life.**
- Some types **last for a short period of time and some for the whole life.**
- It could be **due to brain damage occurring by a difficult birth, a severe blow to the head, or due to an infection of the brain like meningitis.**
- Occasionally it is **caused by a brain tumour.** It is said that in around **six of ten people, doctors don't know the reason for their epilepsy.**

31 KALA-AZAR

CONTEXT: Recently, informed by the Ministry of Health that the Kala-azar cases in India fell to 834 in 2022 from 44,533 in 2007 — a *98.7 percent decline.*

About the disease:

- Kala-azar or black fever is a **chronic** and potentially fatal **parasitic disease** of the internal organs, particularly the **liver, spleen, bone marrow and lymph nodes.**
- **Caused by**: It is caused by bites from **female phlebotomine sandflies** – the vector (or transmitter) of the **leishmania parasite.**
- **Transmission: Leishmania donovani** is transmitted by sandfly bites in parts of Asia (primarily India), Africa (primarily Sudan), South America (primarily Brazil), Europe (primarily in the Mediterranean region) and in North America.
- According to WHO, if the disease is not treated, the fatality rate in developing countries can be as high as **100% within 2 years.**
- **Symptoms:** Fever, loss of appetite (anorexia), fatigue, enlargement of the liver, spleen and nodes and suppression of the bone marrow.
- **Diagnosing Kala azar:** The first oral drug found to be effective for treating kala-azar is **miltefosine**.

32 LYME DISEASE

CONTEXT: According to a study, more than 14 percent of the world's population has had Lyme disease, the most common tick-borne illness.

Lyme disease:

- Lyme disease is the most **common vector-borne disease**.
- Lyme disease is caused by the bacterium **Borrelia burgdorferi** and rarely, Borrelia mayonii.
- It is transmitted to humans through the bite of **infected blacklegged ticks**.
- Since it was **first identified in 1975**, Lyme disease has become the **most common tick-borne zoonotic disease**
- **Symptoms:**
  - **Rash:** From three to 30 days after an infected tick bite, an expanding red area might appear that sometimes clears in the center, forming a bull's-eye pattern.
  - **Other Symptoms** include fever, headache, rash and weakness can appear days to weeks after a tick bite.
- **Treatment:** Most cases of Lyme disease can be **treated with antibiotics**, but without intervention, the pathogen can cause long-lasting damage and inflammation throughout the body.

33 SPINAL MUSCULAR ATROPHY (SMA)

CONTEXT: Spinal muscular atrophy (SMA) is a genetic disease affecting the central nervous system, peripheral nervous system, and voluntary muscle movement (skeletal muscle).

About

- SMA is a genetic condition caused by a change in a gene called 'survival motor neuron 1' (*SMN1*). Everybody has two copies of the *SMN1* gene – one inherited from each parent. People with SMA have a gene change in both copies of the *SMN1* gene.
- This is what is called an 'autosomal recessive' inheritance.
- The parents of a person with SMA each carry one copy of the changed *SMN1* gene and are known as 'carriers'. They do not show signs and symptoms of the condition.
- Most of the nerve cells that control muscles are located in the spinal cord, which accounts for the word spinal in the name of the disease.
- SMA is muscular because its primary effect is on muscles, which don't receive signals from these nerve cells.
- Atrophy is the medical term for getting smaller, which is what generally happens to muscles when they're not stimulated by nerve cells.
- SMA involves the loss of nerve cells called motor neurons in the spinal cord and is classified as a motor neuron disease.

34 CAR-T (CHIMERIC ANTIGEN RECEPTOR-T) CELL THERAPY

CONTEXT: The Central Drugs Standard Control Organization (CDSCO) has issued market authorisation to CAR-T (Chimeric Antigen Receptor-T) cell therapy, a breakthrough treatment for treating relapsed/refractory (r/r) B-cell lymphomas and leukaemia, paving the way for its commercial launch of indigenous NexCAR19 in the country. ImmunoACT – an IIT Bombay incubated company – developed the treatment.

About

- The therapy, called NexCAR19, has been approved for relapsed-refractory B-cell lymphoma and leukemia by the Drug Controller General of India (DCGI).
- For treating relapsed-refractory B-cell lymphoma and leukemia, Mumbai-based Immunoadoptive Cell Therapy Private Limited (ImmunoACT) announced the approval of India's first chimeric antigen receptor (CAR) T-cell therapy by the Central Drugs Standard Control Organization (CDSCO) on October 13, 2023.
- Called NexCAR19, it is an indigenously developed CD19-targeted CAR-T cell therapy. CD-19 is biomarker for B lymphocytes and can be utilised as a target for leukemia immunotherapies.
- Chimeric Antigen Receptor (CAR)-T cells are a patient's own immune cells which are engineered in the laboratory to fight cancer.
- The evidence generated so far suggests that it is mostly effective in blood cancer and lymphoma, though studies are being conducted in several countries to assess its role in solid tumours and auto-immune diseases such as lupus and multiple sclerosis as well.
- As of now, the therapy is usually offered as a second-line of treatment for late-stage leukemia and lymphoma when patients are either not responding to conventional treatments such as chemotherapy and bone-marrow transplant, or have a case of relapsed cancer.

35 WORLD ALZHEIMER'S DAY

CONTEXT: Every year on September 21, World Alzheimer's Day is celebrated to raise awareness about the disease.

The **Dementia in India report 2020** estimates that there are 5.3 million people over the age of 60 years living with dementia in India, with the prevalence projected to increase to 14 million by 2050.

About the Disease:

- It is a neurological disorder which causes brain cells to degenerate and die. This leads to loss of memory, problems with words in speaking or writing, poor judgment, changes in mood and personality, confusion with time or place, etc.
- At the first stage, these symptoms are mild but they become more severe with time.
- Alzheimer's is the **most common cause of dementia** among older adults.
- Alzheimer's disease is thought to be caused by the abnormal build-up of proteins in and around brain cells. One of the proteins involved is **called amyloid**, deposits of which **form plaques around brain cells** and the **other protein is called tau.**

Tau is a protein that when it occurs in tangled formations in the **brain of Alzheimer patients**, disrupts the ability of neurons to communicate with one another in the brain.

- Alzheimer's is an incurable disease, as the death of brain cells cannot be reversed.
- Women have a higher risk of having Alzheimer's disease than men.

Treatment:

There is currently **no known cure** for Alzheimer's disease. Treatment addresses several areas:

- Helping people maintain brain health.
- Managing behavioral symptoms.
- Slowing or delaying symptoms of the disease.

36 GNB1 ENCEPHALOPATHY

CONTEXT: Researchers from India, Israel, US trying to develop drug to treat rare disease 'GNB1 Encephalopathy'.

About the disease:

- GNB1 Encephalopathy is a kind of **brain disease** or **neurological disorder** which affects individuals in the foetus stage.
- **Symptoms:** Delayed physical and mental development, intellectual disabilities, frequent epileptic seizures, is among the early symptoms of the disease.
- **Cause:** A single nucleotide mutation in the GNB1 gene that makes one of the G-proteins, the "**Gβ1 protein"** causes this disease.
- **Effects:**
  - This mutation affects the patient since they are a foetus.
  - Children born with GNB1 mutation experience **mental and physical developmental delay**, epilepsy (abnormal brain activity), movement problems.
- **Occurrence:**
  - To date, less than a hundred cases have been documented worldwide.
  - However, the actual number of affected children is probably much greater as diagnosis is not widely available since it requires a sophisticated and expensive procedure.

37 NIEMANN-PICK DISEASE

CONTEXT: Families of two children diagnosed with the rarest of rare diseases — Infantile Hypophosphatasia and Niemann Pick — are struggling to get these genetic disorders included under the Centre's National Policy for Rare Diseases (NPRD).

About

- Niemann-Pick disease refers to a group of inherited metabolic disorders in which abnormal amounts of lipids (fatty materials such as waxes, oils, and cholesterol) build up in the brain, spleen, liver, lungs, and bone marrow.
- Defective or insufficient amounts of enzymes are unable to break down lipids into smaller components to provide energy for the body.
- **Symptoms may include:**
  - Ataxia (lack of muscle control during voluntary movements such as walking)
  - Loss of muscle tone
  - Brain degeneration
  - Increased sensitivity to touch

38 HUNTINGTON DISEASE (HD)

About

- Huntington disease (HD) is a progressive genetic disorder affecting the brain that causes uncontrolled movements, impaired coordination of balance and movement, a decline in cognitive abilities, difficulty in concentrating and memory lapses, mood swings and personality changes.
- It is caused by a mutation in a gene called HTT. The HTT genes are involved in the production of a protein called huntingtin.
- They provide the instruction for making the protein. When the genes mutate, they provide faulty instructions leading to production of abnormal huntingtin proteins and these form into clumps.
- The clumps disrupt the normal functioning of the brain cells, which eventually leads to death of neurons in the brain, resulting in Huntington disease.
- While it is known that the clumps formed by the abnormal huntingtin protein disrupt several cellular processes, it is not known whether they also influence the key process in the formation of other proteins in the cell.

39 ASTROCYTES

CONTEXT: In a recent research, a common characteristic has been found in the brain structure of people who died by suicide. There was a sharp fall in the density of 'Astrocytes', a particular nerve cell throughout the brain.

What is Astrocytes?

- It is a type of supportive **nerve cells**, look like the end of a frayed rope.
- They are **highly heterogeneous neuroglial cells** with distinct functional and morphological characteristics in different parts of the brain.
- They are responsible for maintaining a number of complex processes needed for a healthy **central nervous system (CNS).**

40 DEMENTIA

CONTEXT: A growing number of people are developing dementia in their 60s, 50s, 40s and even earlier.

What is Dementia?

- It is currently the **seventh leading cause of death** worldwide and one of the major causes of **disability and dependency** among **older people** worldwide.
- It is a term used to describe a **group of symptoms affecting memory, thinking and social abilities** severely enough to interfere with your daily life.
- It is caused by **damage to or loss of nerve cells** and their connections in the brain.
- It isn't a specific disease, but **several diseases can cause dementia.**

Dementia

Alzheimer's disease is the most common cause of a progressive dementia in older adults, but there are a number of other causes of dementia.

41 ZOONOSES OR ZOONOTIC DISEASE

- It is a disease that has passed into the human population from an animal source directly or through an intermediary species.
- Zoonotic infections can be bacterial, viral, or parasitic in nature, with animals playing a vital role in maintaining such infections.
- Examples of zoonoses include HIV-AIDS, Ebola, Lyme disease, malaria, rabies, West Nile fever, and the current novel coronavirus disease (COVID-19) disease.

42 CHYTRIDIOMYCOSIS OR CHYTRID

CONTEXT: For the past 40 years, a devastating fungal disease, called chytridiomycosis or chytrid, has been ravaging frog populations around the world, wiping out 90 species. This is a "panzootic" – a pandemic in the animal world.

About

- Chytrid infects frogs by reproducing in their skin, affecting their ability to balance water and salt levels, and eventually leading to death if infection levels are high enough.
- The high mortality rate and the high number of species affected make chytrid unequivocally the deadliest animal disease known to date.
- **Origin:** Chytrid originated in Asia and was unwittingly spread to other continents through global travel and trade in amphibians.

43 GLANDERS DISEASE

CONTEXT: Glanders disease spread in animals.

About

- Glanders is an infectious disease that is caused by the bacterium Burkholderia mallei.
- While people can get the disease, glanders is primarily a disease affecting horses.
- It also affects donkeys and mules and can be naturally contracted by other mammals such as goats, dogs, and cats.

44 LUMPY SKIN DISEASE

CONTEXT: Lumpy skin disease is increasingly becoming more dangerous for India's cattle population.

About Lumpy Skin Disease

- Lumpy skin disease is caused by the **lumpy skin disease virus (LSDV**), which belongs to the **genus capripox virus**, a part of the **poxviridae family** (smallpox and monkeypox viruses are also a part of the same family).
- The LSDV shares antigenic similarities with the **sheeppox virus (SPPV) and the goatpox virus** (GTPV) or is similar in the immune response to those viruses.
- It is **not a zoonotic virus**, meaning the disease cannot spread to humans.
- It is a **contagious vector-borne disease** spread by vectors like mosquitoes, some biting flies, and ticks and usually affects host animals like cows and water buffaloes.
- **Symptoms:**
  - LSD affects the **lymph nodes** of the infected animal, causing the nodes to enlarge and appear like lumps on the skin, which is where it derives its name from.
  - The cutaneous nodules, 2–5 cm in diameter, appear on the infected cattle's head, neck, limbs, udder, genitalia, and perineum.
  - The nodules may later turn into ulcers and eventually develop scabs over the skin.
  - The other symptoms include high fever, sharp drop in milk yield, discharge from the eyes and nose, salivation, loss of appetite, depression, damaged hides, emaciation (thinness or weakness) of animals, infertility and abortions.

45 BIRD FLU

CONTEXT: A devastating strain of highly pathogenic avian influenza has been sweeping through different animal species for years.

What is bird flu?

- **Avian influenza or Bird Flu** refers to the disease caused by infection with avian (bird) influenza (flu) **Type A** viruses.
- These viruses occur naturally among wild aquatic birds worldwide and can infect domestic poultry and other bird and animal species.
- It is a **zoonotic disease** that affects wild and domestic bird populations.
- **Avian flu viruses** do not normally infect humans.

Spread:

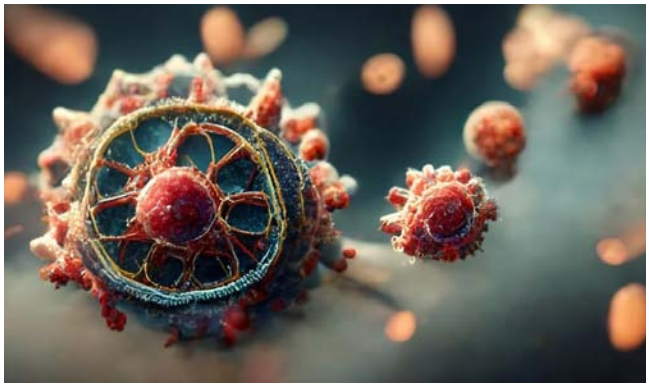
- The disease makes its presence felt particularly during winter in most of India and other parts of the globe.
- This is because, as **wintering, migratory birds arrive** and bring pathogens with them.
- **Temperature is also a factor**: the virus thrives better in cooler climes, thus enabling its spread during winter.

46 LANGYA HENIPAVIRUS (LAYV)

CONTEXT: In 2022, a research study in China reported the emergence of Langya henipavirus (LayV), a novel zoonotic henipavirus.

About novel Langya henipavirus (LayV):

- **Origin:** This newly discovered Henipavirus, may have come from animals, and is associated with some febrile cases.



- **Symptoms:** Fever, fatigue, cough, anorexia, myalgia, and nausea.
- **Treatment:** There is currently no vaccine or treatment for Henipavirus and the only treatment is supportive care to manage complications.
- **Other similar virus:**
  - Nipah and Hendra virus also belong to the same genus, henipavirus, from the Paramyxoviridae family.

Paramyxoviridae is a family of single-stranded Ribonucleic acid (RNA) viruses that cause different types of viral infections.

What makes a virus zoonotic?

- A zoonotic disease is defined as **an infectious disease** transmitted between species; either from animals to humans, or from humans to animals.
- Examples of zoonotic viruses include COVID-19, **monkeypox and Hendra virus (HeV).**

47 ANTHRAX

CONTEXT: After finding several carcasses of wild boar, Kerala health officials recently confirmed the presence of anthrax in Thrissur district.

What is Anthrax?

- Anthrax, also known as malignant pustule or **woolsorter's disease**.
- It is a rare but serious disease caused by the **rod-shaped bacteria** known as **Bacillus anthracis.**
- It occurs **naturally in soil.**
- According to the WHO, it is primarily a **disease of herbivores**, with both domestic and wild animals being affected by it.
- Anthrax is a **zoonotic disease**, meaning that it is naturally transmissible from animals (usually vertebrae) to humans.
- People can get the disease through contact with **infected animals or animal products that are contaminated with bacteria.**
- According to the WHO, **Anthrax is generally regarded as non-contagious**.
- There have been instances of person-to-person transmission, however, such instances are extremely rare.

Symptoms:

- A group of small blisters or bumps that may itch
- Swelling can occur around the sore
- A painless skin sore (ulcer) with a black center that appears after the small blisters or bumps. Most often the sore will be on the face, neck, arms, or hands.

Types of Anthrax

- **Cutaneous:** Most common form of anthrax infection, and is considered to be the least dangerous. Infection usually develops from 1 to 7 days after exposure.
- **Inhalation:** Inhalation anthrax is considered to be the most deadly form of anthrax. Infection usually develops within a week after exposure, but it can take up to 2 months
- **Gastointestinal:** Gastrointestinal anthrax has rarely been reported. Infection usually develops from 1 to 7 days after exposure.
- **Injection: This** type of infection has never been reported.

48 AFRICAN SWINE FEVER

CONTEXT: According to United Nations Food and Agriculture Organization (FAO) report has caused the deaths of more than 3.7 million pigs across a vast swathe of Asia, primarily in its east and south-east, where pork is the primary meat staple.

What is African swine fever?

- African swine fever (ASF) is a highly contagious viral disease of domestic and wild pigs, whose mortality rate can reach 100%.
- **Caused by:** It is caused by a large DNA virus of the ***Asfarviridae*** **family**, which also infects ticks of the genus
- **Similarity with classical swine fever:** Although signs of ASF and classical swine fever (CSF) may be similar, the ASF virus is unrelated to the CSF virus.
- The virus causes a **hemorrhagic fever** with high mortality rates in domestic pigs.
- **Transmission:**
  - Direct contact with infected domestic or wild pigs: This **trans-boundary animal disease (TAD)** can be spread by live or **dead pigs, domestic or wild, and pork products.**
  - Indirect contact, through ingestion of contaminated material (e.g. food waste, feed, or garbage).
  - Contaminated fomites or biological vectors (soft ticks of the genus Ornithodoros) where present.

49 LASSA FEVER

CONTEXT: The Nigeria Centre for Disease Control (NCDC) has said that about 189 deaths were recorded in the country in 2022 from Lassa fever.

About Lassa fever:

- Lassa fever is a **viral haemorrhagic disease** caused by the **Lassa virus** which naturally infects the widely distributed house rat.
  - Lassa virus is a **single-stranded RNA hemorrhagic fever virus** from the family **Arenaviridae.**

Lassa Fever virus is a **single-stranded, enveloped RNA virus** that belongs to the genus **Mammarenavirus**, of the **Arenaviridae family of viruses**. The natural reservoir for Lassa fever virus is the **Mastomys natalensis rat**.

- **Type:** animal-borne, or zoonotic, acute viral illness.
- **Transmission:** It is transmitted through the urine and droppings of infected rats found in most tropical and subtropical countries in Africa. It is endemic in parts of West Africa including Sierra Leone, Liberia, Guinea and Nigeria.
- **Communicable:** They are able to contaminate anything they come in contact with. The Lassa virus spreads through human to human contact with tissue, blood, body fluids, secretions or excretions.
- **Symptoms:** A fever is usually the first symptom followed by headaches and coughing, nausea and vomiting, diarrhoea, mouth ulcers and swollen lymph glands.
- **Treatment:** Lassa fever can be fatal, but it can be treated if diagnosed early.

50 HEPATITIS

CONTEXT: WHO announced that Egypt had made "unprecedented progress" towards eliminating hepatitis C. According to the WHO, Egypt became the first country to achieve "gold tier" status on the path to elimination of hepatitis C as per the global health body criteria.

About

- Hepatitis C is a viral infection that causes liver swelling, called inflammation. Hepatitis C can lead to serious liver damage. The hepatitis C virus (HCV) spreads through contact with blood that has the virus in it.
- Newer antiviral medicines are the treatment of choice for most people with the ongoing, called chronic, hepatitis C infection.
- These medicines often can cure chronic hepatitis C.

Hepatitis A

- Hepatitis A is an inflammation of the liver that can cause mild to severe illness.
- The hepatitis A virus (HAV) is transmitted through ingestion of contaminated food and water or through direct contact with an infectious person.
- The risk of hepatitis A infection is associated with a lack of safe water and poor sanitation and hygiene (such as contaminated and dirty hands).
- A safe and effective vaccine is available to prevent hepatitis A.

Hepatitis B

- Hepatitis B is a viral infection that attacks the liver and can cause both acute and chronic disease.
- The virus is most commonly transmitted from mother to child during birth and delivery, as well as through contact with blood or other body fluids during sex with an infected partner, unsafe injections or exposures to sharp instruments.
- Hepatitis B can be prevented by vaccines that are safe, available and effective

CHAPTER 10

OTHER DISEASE

1 RUBELLA

- Rubella is a contagious viral infection best known by its distinctive red rash. It's also called German measles or three-day measles.
- This infection may cause mild or no symptoms in most people. However, it can cause serious problems for unborn babies whose mothers become infected during pregnancy.
- The measles-mumps-rubella (MMR) vaccine is safe and highly effective in preventing rubella.
- Rubella isn't the same as measles, but the two illnesses share some signs and symptoms, such as the red rash. Rubella is caused by a different virus than measles, and rubella isn't as infectious or as severe as measles.

2 MEASLES

- Measles is a very contagious respiratory infection.
- It causes a total-body skin rash and flu-like symptoms.
- Measles is caused by a single-stranded, enveloped RNA virus with 1 serotype. It is classified as a member of the genus Morbillivirus in the Paramyxoviridae family. Humans are the only natural hosts of measles virus.

3 RARE DISEASES

- These are often serious, chronic, and life-threatening conditions.
- WHO defines a rare disease as an often debilitating lifelong disease or disorder with a prevalence of 1 or less, per 1000 population.
- However, different countries have their own definitions.
- A disease or disorder is defined as rare in India when it affects less than 1 in 2500 individuals.
- There may be as many as 7,000 rare diseases, individual diseases may be rare, and the total number of people with a rare disease is large.
- **Examples:** Lysosomal Storage Disorders (LSD), Gaucher disease, Pompe disease, cystic fibrosis, musculardystrophy, spina bifida, haemophilia, MPS 1 and 2, and Fabry disease

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CHAPTER 11

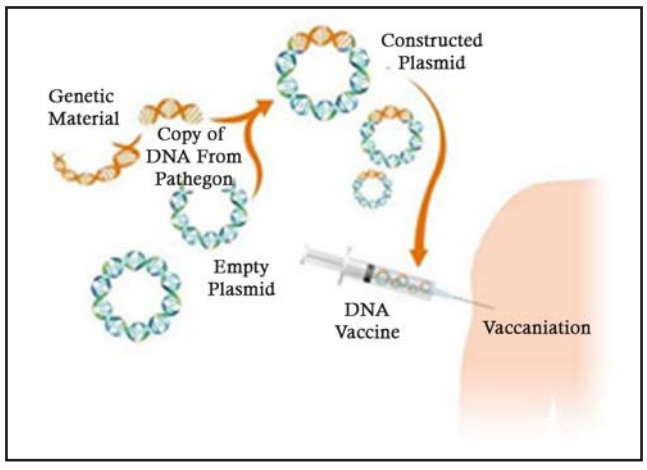
VACCINES

1 NUCLEIC ACID VACCINES

CONTEXT: The novel Nucleic acid-based vaccine candidate of the Pune-based Gennova Biopharmaceuticals was approved for funding as early as July 2022 by the Department of Biotechnology (DBT).

What is Nucleic acid-based vaccines?

- Nucleic acid vaccines use **genetic material** from a **disease-causing virus** or **bacterium (a pathogen)** to stimulate an **immune response** against it.
- Depending on the vaccine, the genetic material could be **DNA or RNA**; in both cases it provides the instructions for making a specific protein from the **pathogen**, which the immune system will recognise as **foreign (an antigen).**



- Once inserted into host cells, this genetic material is read by the cell's own protein-making machinery and used to manufacture antigens, which then trigger an immune response.
- **Advantages**: simplicity of the vector, the ease of delivery, the duration of expression, and, to date, the lack of evidence of integration.

Other COVID-19 vaccine types

- **Whole virus:** Whole virus vaccines use a weakened or deactivated version of the disease-causing virus to trigger protective immunity against it.
- **Viral vector:** Viral vector-based vaccines use a harmless virus to smuggle the instructions for making antigens from the disease-causing virus into cells, triggering protective immunity against it.
- **Protein subunit:** Protein subunit vaccines use fragments of protein from the disease-causing virus to trigger protective immunity against it.

2 INDIA'S FIRST MRNA BASED OMICRON-SPECIFIC BOOSTER VACCINE

CONTEXT: India's first indigenous mRNA vaccine for the Omicron variant, GEMCOVAC-OM, developed by Pune-based Gennova Biopharmaceuticals Ltd, was approved under emergency use guidelines by the Drug Controller General of India.

About

- The vaccine is the first booster Covid-19 vaccine developed in India against the highly transmissible Omicron variant
- The vaccine is a **lyophilised (freeze dried) vaccine**, stable at two to eight degrees Centigrade.
- The vaccines could be administered into the skin via a **"needle-free" PharmaJet system.**

What are mRNA vaccines?

- The mRNA vaccines use mRNA's function as a protein

information carrier to prompt the body to make specific proteins.

- In the case of COVID-19 vaccines, the mRNA instructs the cells to produce the spike protein found on the outside of the SARS-CoV-2 virus.
- When the body's immune system detects these foreign proteins, it produces antibodies and other immune cells to fight what looks like an infection.
- Then, if the immune system encounters that protein again in the future, it's primed to mount a rapid response.

About messenger RNA (mRNA)

- Messenger RNA (mRNA) is a molecule that contains the instructions or recipe that directs the cells to make a protein using its natural machinery.

3 ASSISTED REPRODUCTIVE TECHNOLOGY

CONTEXT: Lok Sabha passed the Assisted Reproductive Technology Regulation Bill, 2020, which makes provisions for the safe and ethical practice of assisted reproductive technology (ART) services in the country.

Need for the initiative:

- The growth of ART clinics in India is among the highest in the world, and these are a key part of medical tourism.
  - These offer gamete donation, **intrauterine insemination, in-vitrofertilisation, intracytoplasmic sperm injection, and pre-implantation genetic diagnostic**. India does not have standard protocols of ART clinics yet.

Key-highlights of the Bill

- Assisted Reproductive Technology Regulation Bill, 2020 seeks to provide for the regulation of Assisted Reproductive Technology services in the country.
- **What is ART?** The Bill defines ART to include all techniques that seek to obtain a pregnancy by handling the sperm or the oocyte (immature egg cell) outside the human body and transferring the gamete or the embryo into the reproductive system of a woman.
- **Examples** of ART services include
  - **gamete (sperm or oocyte) donation**
  - **in-vitro-fertilisation (fertilising an egg in the lab)**
  - **gestational surrogacy (the child is not biologically related to surrogate mother)**
- ART services will be provided through:
  - ART clinics, which offer ART related treatments and procedures
  - ART banks, which store and supply gametes

ART bank is an organisation set up to **supply sperm or semen, oocytes, or oocyte donors** to ART clinics or their patients.

What are the other safeguards?

- **NATIONAL BOARD**: It will advise the Centre on policy matters. It will review and monitor rules and regulations, and recommend any changes.
- **NATIONAL REGISTRY**: It will have a central database on all clinics and banks in the country, including nature and types of services provided, and the outcome of these services.
- **REGISTRATION AUTHORITY**: It will have the chairperson, who will be an officer above the rank of Joint Secretary in the Health Department.

The registration authority's functions will include:

- To grant, suspend, or cancel the registration of ART centres.
- To enforce the standards and supervise implementation of the law.
- To investigate complaints of any breach of provisions.
- To take legal action against the misuse of ART and initiate independent investigations.
- To recommend to the National and State Boards on modifying the regulation with changes in technology and social conditions.

4 PNEUMOSIL

CONTEXT: The Government launched the country's first pneumococcal conjugate vaccine ''Pneumosil'' developed by Serum Institute of India in collaboration with the Bill and Melinda Gates Foundation.

What is Pneumonia?

- It is a form of acute respiratory infection that affects the lungs.
- In pneumonia, the alveoli (air sacs in lungs) are filled with pus and fluid, which makes breathing painful and limits oxygen intake.
- Pneumonia is the single-largest infectious cause of death among children under five years, worldwide.

Causative agents

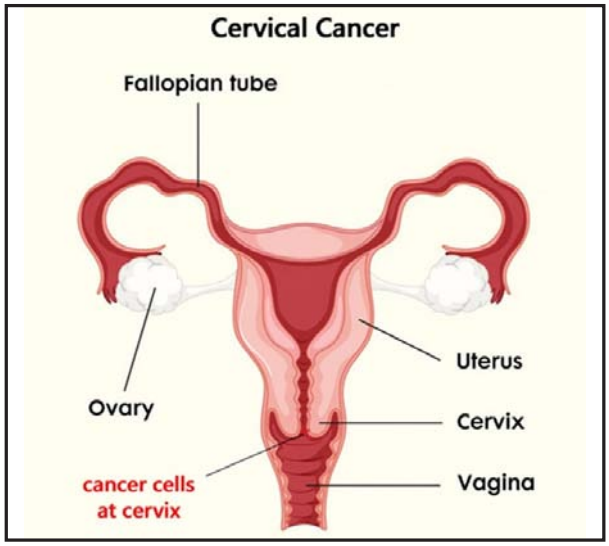
- **Bacteria:** *Streptococcus pneumonia*, *Haemophilus influenzae* type b, *Mycoplasma pneumonia*, etc.
- **Virus:** influenza virus, rhinovirus), Respiratory syncytial virus (RSV)
- **Fungi:** *Pneumocystis jirovecii*

5 CERVAVAC VACCINE

CONTEXT: Recently the scientific completion of Cervavac, India's first indigenously developed quadrivalent human papillomavirus (qHPV) vaccine for the prevention of cervical cancer has been announced.

About:

- Cervical cancer is a **prevalent sexually transmitted** infection.



- It's a type of cancer that occurs in the cells of the cervix, the lower part of the uterus that connects to the vagina.
- It is mostly caused by long-term infection with particular forms of HPV.
  - **Human papillomavirus (HPV)** is a viral infection that is passed between people through skin-to-skin contact.
- It is the second most prevalent cancer form and the second leading cause of cancer death in women of reproductive age.
- According to the WHO, cervical cancer is the **fourth most common cancer** among women globally.

New qHPV vaccine:

- Cervavac was developed by the Pune-based Serum Institute of India in coordination with the Government of **India's Department of Biotechnology (DBT).**
- Cervavac received market authorisation approval from the **Drug Controller General of India** in July 2022.
- It is the first indigenously developed Human Papillomavirus Vaccine.

Types of HPV Vaccines:

- The HPV vaccine can prevent most cases of cervical cancer if the vaccine is given before girls or women are exposed to the virus.
- **Quadrivalent vaccine (Gardasil**): It protects against four types of HPV (HPV 16, 18, 6 and 11). The latter two strains cause genital warts.
- **Bivalent vaccine (Cervarix):** It protects against HPV 16 and 18 only.
- **Non-valent vaccine (Gardasil 9):** It protects against nine strains of HPV.

6 CAR-T (CHIMERIC ANTIGEN RECEPTOR-T) CELL THERAPY

CONTEXT: The Central Drugs Standard Control Organization (CDSCO) has issued market authorisation to CAR-T (Chimeric Antigen Receptor-T) cell therapy, a breakthrough treatment for treating relapsed/refractory (r/r) B-cell lymphomas and leukaemia, paving the way for its commercial launch of indigenous NexCAR19 in the country. ImmunoACT – an IIT Bombay incubated company – developed the treatment.

About

- The therapy, called **NexCAR19**, has been approved for relapsed-refractory B-cell lymphoma and leukemia by the **Drug Controller General of India (DCGI).**
- For treating relapsed-refractory B-cell lymphoma and leukemia, Mumbai-based **Immunoadoptive Cell Therapy Private Limited (ImmunoACT)** announced the approval of India's first chimeric antigen receptor (CAR) T-cell therapy by the **Central Drugs Standard Control Organization (CDSCO)** in 2023.
- Called NexCAR19, it is an indigenously developed CD19-targeted CAR-T cell therapy. **CD-19** is biomarker for **B lymphocytes** and can be utilised as a target for leukemia immunotherapies.
- **Chimeric Antigen Receptor (CAR)-T cells** are a patient's own immune cells which are engineered in the laboratory to fight cancer.
- The evidence generated so far suggests that it is mostly effective in blood cancer and lymphoma, though studies are being conducted in several countries to assess its role in solid tumours and auto-immune diseases such as lupus and multiple sclerosis as well.
- As of now, the therapy is usually offered as a second-line of treatment for late-stage leukemia and lymphoma when patients are either not responding to conventional treatments such as chemotherapy and bone-marrow transplant, or have a case of relapsed cancer.

7 ZYCOV-D

CONTEXT: Ahmedabad-based ZydusCadila has been approved to Central Drugs Standard Control Organisation (CDSCO), the national drugs regulator, seeking emergency use authorisation (EUA) for ZyCov-D uses.

About the ZyCov-D vaccine or DNA vaccine

- ZyCov-D is a **"plasmid DNA". These DNA are engineered to show the desired results.**
- The plasmids used in the vaccine are coded with the instructions to make the **spike protein of SARS-CoV-2.**

Plasmid

- A **plasmid** is a small, circular, double-stranded DNA molecule that is distinct from a cell's chromosomal DNA.
- **Plasmids** naturally exist in bacterial cells, and they also occur in some eukaryotes.
- Often, the genes carried in **plasmids** provide bacteria with genetic advantages, such as antibiotic resistance

- Vaccination gives the code to cells in the recipient's body, so they can begin making the spiky outer layer of the virus.
- The immune system is expected to recognize this as a threat and develop antibodies in response.
- ZyCov-D will be given in three doses, with an interval of 28 days between the first and second and second and third shots.
- No needle is used to deliver the vaccine; instead, a spring-powered device delivers the shot.
- ZyCov-D has been developed with the support of the central government's **Department of Biotechnology** and the **Indian Council of Medical Research (ICMR).**

8 ANTICANCER MRNA VACCINE

CONTEXT: A new experimental approach to treating pancreatic cancer is progressing to the next step in making it available to more patients. After results from a small study, a phase 2 clinical trial has now opened to test the effectiveness of using messenger Ribonucleic Acid (mRNA-4157/V940) vaccine to fight one of the deadliest cancers.

About:

- It is a **personalised cancer vaccine** i.e., tailor-made for every patient.
- To build the vaccine, researchers **took samples of patients' tumors and healthy tissue.**
  - After analysing the samples to **decode their genetic sequence and isolate mutant proteins associated only with the cancer,** that **information was used to design** the vaccine.
- The personalised cancer vaccine **uses the same** m-RNA technology that was used to **produce the Covid-19 vaccine.**
- mRNA vaccines **use mRNA to teach** our cells how to **make a protein that triggers an immune response inside our bodies.**
- **Mechanism:**
  - It **allows the body's immune system** to seek and **destroy cancerous cells.**
- The personalised cancer vaccine **works in concert with Keytruda, to disable a protein called Programmed Death 1 (PD-1)** that **helps tumors to evade the immune system.**
- When injected into a patient, the **patient's cells act as a manufacturing plant, producing perfect copies of the mutations** for the immune system to recognise and destroy.
- Having been **exposed to the mutations** without the virus, the **body learns to fight off the infection.**
- **Efficacy:**
  - The vaccine showed a **44% reduction in the risk** of dying of cancer or having the cancer progress.
  - The **combination of mRNA-4157/V940 and Keytruda** was generally **safe and demonstrated the benefit compared with Keytruda alone** after a year of treatment.

9 NOBEL PRIZE IN MEDICINE 2023

CONTEXT: The 2023 Nobel Prize in Physiology or Medicine has gone to scientists Katalin Kariko and Drew Weissman, whose work enabled the development of mRNA vaccines against Covid-19.

What is mRNA?

- Messenger RNA (a mRNA) is a type of **single-stranded RNA** involved in **protein synthesis**.
- They are made from a **DNA template** during the process of transcription.
- The role of mRNA is to carry protein information from the DNA in a cell's nucleus to the cell's cytoplasm

(watery interior), where the protein-making machinery reads the mRNA sequence and translates each **three-base codon** into its corresponding **amino acid** in a growing protein chain.

- So mRNA really is a form of nucleic acid which helps the human genome, which is coded in DNA, to be read by the cellular machinery.

Contribution of Nobel Prize winner scientists:

- Karikó and Weissman realised that the problem with **lab-grown genetically engineered mRNA** is that the body's dendritic cells recognise them **as a foreign substance**, and release inflammatory signalling molecules against them.
- To investigate this, they produced **different variants of mRNA**, each with unique chemical alterations in their bases, which they delivered to dendritic cells.
- The results were striking: The inflammatory response was almost abolished when base modifications were included in the mRNA.
- This later on became the basis for development of mRNA vaccines which helped during the COVID recovery.

About mRNA vaccines:

- **Background:** This technology had been known since the 1980s, but had not been perfected enough to create vaccines at a viable scale.
- Basically, instead of putting **an inactivated virus** in the body to activate an immune response, vaccines using this technology **use messenger Ribonucleic Acid, or mRNA**, to deliver a message to the immune system.
- Genetically engineered mRNA can instruct cells to make the protein needed to fight a particular virus.
- **Working:**
  - By using this mRNA, cells can produce the viral protein.
  - As part of a normal immune response, the immune system recognizes that the protein is foreign and produces specialized proteins called antibodies.
  - Once produced, antibodies remain in the body, even after the body has rid itself of the pathogen, so that the immune system can quickly respond if exposed again.
  - Antibodies help protect the body against infection by recognizing individual viruses or other pathogens, attaching to them, and marking the pathogens for destruction.
  - If a person is exposed to a virus after receiving mRNA vaccination for it, antibodies can quickly recognize it, attach to it, and mark it for destruction before it can cause serious illness.

PRACTICE QUESTIONS

1. Consider the following statements regarding Type 2 Battens Disease:

1. It is a group of genetic disorders classified as neuronal ceroid lipofuscinoses (NCLs).
2. Battens Disease is passed down from parents to children.
3. The disease is curable.

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) All three (d) None

2. Regarding Onchocerciasis, or river blindness, consider the following statements:

1. It is an infectious disease that can cause blindness and permanent skin damage.
2. It is caused by the parasitic worm *O. volvulus.*
3. This neglected tropical disease (NTD) is transmitted through mosquito bites.

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) All three (d) None

3. With reference to the condition of 'Bipolar Disorder', consider the following statements:

1. Alternating episodes of high and low mood are symptoms of bipolar disorder.
2. Unlike simple mood swings, each extreme episode of bipolar disorder can last for several weeks.
3. The pattern of mood swings in bipolar disorder varies widely.

How many of the statements given above are correct?

(a) Only one

(b) Only two

(c) All three

(d) None

4. Osteoporosis is a medical condition characterized by:

(a) Excessive bone tissue growth.

(b) Abnormal curvature of the spine.

(c) Weakening of bones, leading to increased fragility and a higher risk of fractures.

(d) Inflammation of the joints.

5. Which of the following is the primary objective of the WHO's "25 by 25" target within the Global Action Plan for the Prevention and Control of Non-communicable Diseases (NCDs)?

(a) To decrease the global prevalence of NCDs by 25% by 2025.

(b) To promote 25 different NCD prevention initiatives by 2025.

(c) To reduce NCD-related mortality by 25% before 2025.

(d) To allocate 25% of global healthcare funding to NCDs by 2025.

6. Consider the following statements regarding Niemann-Pick disease:

1. It is a rare neuromuscular diseases that cause progressive weakness and breakdown of skeletal muscles over time
2. There is currently no cure for Niemann-Pick disease.

Which of the statements given above is/are correct?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

7. With reference to the species of Lymphatic filariasis (LF), consider the following statements:

1. It is a parasitic disease caused by microscopic.
2. It is a leading cause of permanent disability worldwide.
3. It can only be spread by the bite of mosquito.

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) All three (d) None

8. Consider the following statements regarding Tilapia parvovirus (TiPV), recently mentioned in news:

1. TiLV is an enveloped, negative-sense, single-stranded RNA virus.
2. It is a pathogen.

Which of the statements given above is/are correct?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

9. Consider the following statements:

1. Hepatitis C virus is a blood-borne virus and can be transmitted via blood transfusion
2. Hepatitis B infection is more common worldwide as compared to Hepatitis C.
3. There is no vaccine for hepatitis C.

How many of the statements given above are correct?

(a) Only one (b) Only two

(c) All three (d) None

10. Which of the following correctly defines CAR-T cell therapy, recently mentioned in news?

(a) It is a drug therapy for acid sphingomyelinase deficiency.

(b) It is a therapy for treating relapsed/refractory (r/r) B-cell lymphomas and leukaemia

(c) It is topical gene therapy for dystrophic epidermolysis bullosa.

(d) It is a drug to treat major depressive disorder.

11. Consider the following statements regarding Macrophages:

1. They confer adaptive immunity.
2. They secrete anti-inflammatory cytokines and help mediate reparative processes.
3. Macrophages are only present in blood.

How many of the above statements are correct?

(a) Only one

(b) Only two

(c) All three

(d) None

12. Consider the following statements regarding Sickle Cell Disease:

1. It is an inherited disorders that affect haemoglobin.
2. In sickle cell disease, red blood cells become crescent and can block blood flow to the rest of the body.
3. Sickle-shaped cells last long and can lead to serious complications including pain, infections, and organ damage and failure.
4. It is a lifelong condition.

How many of the statements given above are correct?

(a) Only one (b) Only two

(a) Only three All four

13. Regarding Nipah virus consider the following statements:

1. Flying foxes are the natural host of Nipah virus.
2. A person infected with the virus can develop atypical pneumonia.
3. There are no antiviral medications to treat the virus.

How many of the statements given above are correct?

(a) Only one

(b) Only two

(c) All three

(d) None

14. Consider the following statements regarding 'Zika virus':

1. Zika virus is primarily transmitted through the bite of the Anopheles mosquito.
2. Infection with Zika virus during pregnancy can lead to microcephaly in newborns.

Which of the statements given above is/are correct?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

15. Regarding Spinal Muscular Atrophy (SMA), consider the following statements:

1. It is an acquired disease affecting the central nervous system.
2. SMA involves the loss of nerve cells called motor neurons in the spinal cord.
3. Its primary effect is on muscles.

How many of the statements given above are correct?

(a) Only one

(b) Only two

(c) All three

(d) None

16. Which of the following correctly defines CAR-T cell therapy, recently mentioned in news?

(a) It is a drug therapy for acid sphingomyelinase deficiency.

(b) It is a therapy for treating relapsed/refractory (r/r) B-cell lymphomas and leukaemia

(c) It is topical gene therapy for dystrophic epidermolysis bullosa.

(d) It is a drug to treat major depressive disorder.

17. Consider the following statements regarding Ultrasonic (high frequency) Sonic Weapons:

1. Ultrasound can cause cavitation.
2. The effects of ultrasound decrease with amplitude.
3. It is highly directional.

How many of the statements given above are correct?

(a) Only one

(b) Only two

(c) All three

(d) None

ANSWERS				
1. (b)	2. (b)	3. (d)	4. (c)	5. (c)
6. (b)	7. (c)	8. (c)	9. (c)	10. (b)
11. (b)	12. (c)	13. (c)	14. (b)	15. (b)
16. (b)	17. (b)			

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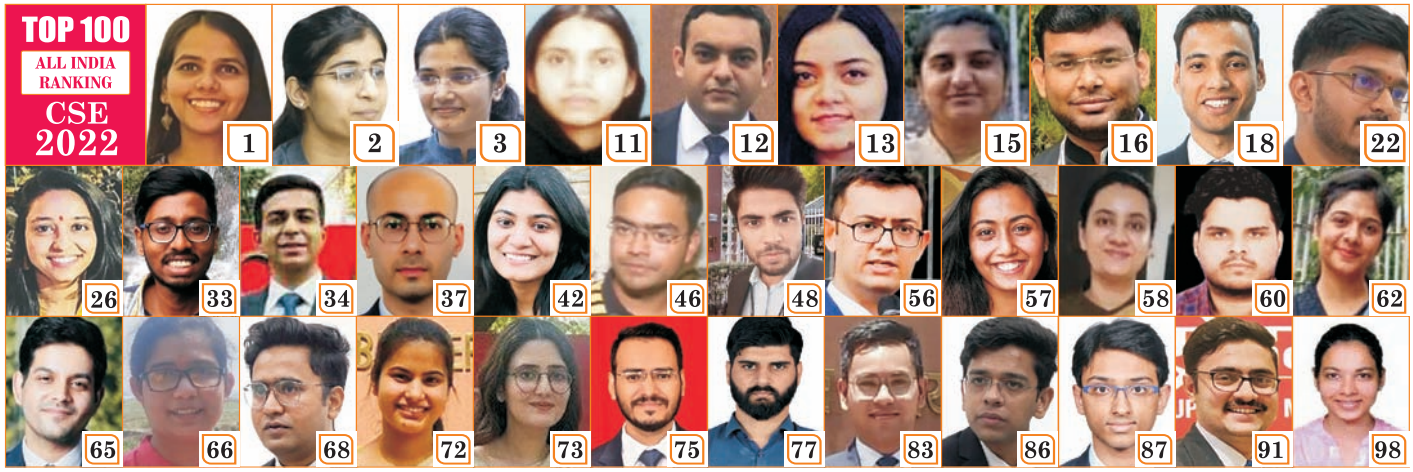

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