

Science & Technology

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Basics of Biotechnology

Lecture 1

Classification of Organism

Linnaeus 1735 ^[74]	Haeckel 1866 ^[75]	Chatton 1925 ^[76]	Copeland 1938 ^[77]	Whittaker 1969 ^[78]	Woese et al. 1990 ^[79]	Cavalier-Smith 1998, ^[72] 2015 ^[80]
2 kingdoms	3 kingdoms	2 empires	4 kingdoms	5 kingdoms	3 domains	2 empires, 6/7 kingdoms
(not treated)	Protista	Prokaryota	Monera	Monera	Bacteria	Bacteria
					Archaea	Archaea (2015)
		Eukaryota	Protoctista	Protista	Eucarya	"Protozoa"
						"Chromista"
Vegetabilia	Plantae		Plantae	Plantae		Plantae
				Fungi		Fungi
Animalia	Animalia			Animalia	Animalia	



Classification of Organism

RH Whittaker's



- Nutrition: Absorptive or photosynthetic
- Movement: By flagella (tubulin)
- Reproduction: Asexual
- Bacteria, Cyano bacteria (Blue green algae)

Prokaryote

(Monera) Kingdom

- Cell structure : Unicelled eukaryotes
- Nutrition :Absorptive, photosynthetic
- Movement :By flagella, cilia, streaming
- Reproduction: Both asexual and sexual
- Phytoplankton, Zooplankton



- Multicelled eukaryotes
- Cell structure :Chitinous cell wall
- Nutrition :heterotrophic, Absorptive, Saprobic
- Movement : Non-motile
- Reproduction: Both asexual and sexual
- Yeasts(Unicellular) moulds, mushrooms.



Kingdom



- Cell structure: cellulosic cell wall, presence of plastids
- Nutrition :Autotrophic
- Movement :Non-motile
- Reproduction :Both asexual and sexual
- Algae, Bryophytes, ferns, gymnosperms, Multicelled eukaryotes

Plant Kingdom

- Cell structure :without cell wall, and plastids
 - Nutrition :Heterotrophic
 - Movement :Highly motile
 - Reproduction: Both asexual and sexual
 - Sponges, Invertebrates, vertebrates ,Multicelled eukaryotes







Taxonomy

Science that deals with identifying, classifying and naming of animals Based on Behavioral, Genetic and Biochemical variations







Biomolecules: Carbohydrates

- Carbohydrates: Energy
 - 3 Types: Monosaccharides, Oligo/Di-saccharides and Polysaccharides
 - Monosaccharides Glucose, Fructose, Ribose
 - Oligosaccharides Maltose, Lactose and Sucrose
 - Polysaccharides Glycogen (muscle & liver cell) and Starch (plants)





Biomolecules: Proteins



- Proteins: Structural Support, Biochemical catalysts, Hormones, Enzymes, Repair and Maintenance
 - 50% of Cellular Dry Weight
 - Polymers of Amino Acids Polypeptide Chain
 - 4 Types of Structure based on Folding Primary, Secondary, Tertiary and Quaternary
 - Eg. Myosin Responsible for Muscle Contraction



Enzymes

- **Bio-Catalyst** Proteins that Speed Up Reaction Rate
- Has "ACTIVE SITES"
- Unstable at High Temperature Eg. Fever
- pH Sensitivity Too Acidic/Basic Inhibit Reaction Eg. Pepsin
- Eg. Digestion break down protein (Protease Enzyme), fats (Lipase enzyme) and carbohydrates (Carbohydrase)
- Disorders Eg. Lactose Intolerance



Biomolecules: Lipids/Fats

- Lipids/Fats:
 - Organic Molecules Insoluble in Water
 - Soluble in Organic Solvents
 - Various Functions
 - Signaling Steroidal Hormone
 - Temperature Regulation Skin
 - Energy Storage Adipose Tissue fats
 - Cholesterol Precursor to Biosynthesis of
 - Steroidal Hormone
 - Vitamin Absorption
 - Fat Soluble Vitamins D.E.K.A.





2 + + +	muscle		Туре	Function
hormones blo	bloodstream	ketones CO2 fatty acid	Bile acids	Steroids that aid in fat digestion and nutrient absorption
fatty acids activation	CO ₂	VLDL	Cholesterol	Component of cell membranes; precursor of other steroids
lipase	glućose keto	ones	Eicosanoids	Chemical messengers between cells
triglycerides	glucose	heart	Fat-soluble vitamins (A, D, E, and K)	Involved in a variety of functions including blood clotting, wound healing, vision, and calcium absorption
NAT .	liver	COo	Fatty acids	Precursor of triglycerides; source of energy
ipocyte lipid droplet	glycerol glucose	fatty acid	Phospholipids	Major component of cell membranes; aid in fat digestion
glycerol	acid ketones ket	iones	Steroid hormones	Chemical messengers between cells
fatty ad	cid- triacylglycerol VL	.DL	Triglycerides	Energy storage; thermal insulation; filling space; binding organs together; cushioning
adipose tissue		© 2014 Encyclopædia Britannica, Inc.		organs



Nucleic Acid

- Genetic Material Contains Hereditary Information
- Responsible for Protein Synthesis
- Process Translation and Transcription
- 2 Types of Acids
 - DNA Deoxy-Ribo-Nucleic Acid
 - RNA Ribo-Nucleic Acid
- Nucleotide (Singular) Nucleic (Plural)
 - 4 Nitrogenous Bases
 - Animals Adenine Guanine Cytosine Thymine (DNA AGCT)
 - Plants Adenine Guanine Cytosine Uracil (RNA AGCU)
 - Negatively Charged Phosphate Group
 - Pentose Sugar, Phosphoric Acid, Nitrogenous Base





Nucleic Acid

DNA

- Double Helix 2
 Polynucleotide Chains
- Hydrogen Bond
- More Stable

RNA

- Single Stranded
- Folds back sometimes
- Multiple Types
 - Ribosomal RNA
 - Transfer RNA
 - Messenger RNA
 - Micro RNA





Common Genetic Disorders:

- 1. Chromosomal Disorder: Down Syndrome
- 2. Multifactorial Disorder: Alzheimer, Arthritis, Autism, Cancer, Coronary Artery Disease, Diabetes
- 3. Monogenic Disorders: Sickle Cell Disease, Cystic Fibrosis
- 4. Rare Genetic Disorder: Mitochondrial Disease



2. Cells

• "A cell is defined as the smallest, basic unit of life that is responsible for all of life's processes."



- Discovered by Robert Hooke, 1665
- Cell Theory : <u>Theodor</u> Schwann, <u>Matthias</u> Schleiden, and <u>Rudolf</u> Virchow (MaRT)



Eukaryotic v/s Prokaryotic Cells

Characteristics	Eukaryotic Cells	Prokaryotic Cells	Characteristics	Eukaryotic Cells	Prokaryotic Cells
Definition	Any cell that contains	Any unicellular	Chromosomes	More than one	One long single loop of DNA and plasmids
	nucleus and membrane bound organelles	contain a membrane bound nucleus or	Ribosomes	Large	Small
		organelles	Growth Rate/Generation Time	Slower	Faster
Examples	Animal, plant, fungi,	Bacteria and Archaea			
	and protist cells		Organelles	Present	Absent
Nucleus	Present (membrane bound)	Absent (nucleoid region)	Ability to Store Hereditary Information	All eukaryotes have this ability	All prokaryotes have this ability
Cell Size	Large (10-100 micrometers)	Small (less than a micrometer to 5			
	·····,	micrometers)	Cell Wall	Simple: Present in plants and fungi	Complex: Present in all prokaryotes
DNA Replication	Highly regulated with	Replicates entire			
	selective origins and sequences	genome at once	Plasma Membrane	Present	Present
Organism Type	Usually multicellular	Unicellular	Cytoplasm	Present	Present



Cell Classification



- 1. Smallest Cell: Mycoplasm | Largest Cell: Ostrich Egg
- 2. Smallest Cell (Human): Cerebellum's Granule Cell
- 3. Longest Cell (Human): Nerve Cells/Neurons



Cell Structure

- Cell Membrane
- Cell Wall
- Cytoplasm
- Nucleus
- Cell Organelles





Prospects of Biotechnology

- Green BT
- Blue BT
- Red BT
- White BT
- Grey BT
- Yellow BT
- Dark BT
- Gold BT

Types of biotechnology



GETTY IMAGE ICONS (L/R): BSD555, SIRVECTORR, ANATOLII SHCHERBATIUK, BSD555, BOUNWARD, GREYJ, ENIS AKSOY, PRESSUREUA



Biotechnology

- Using Live Organism/Enzymes > Produce Products/Processes
- Basic Eg. Curd, Bread, Cheese, Wine
- Techniques used in BT
 - Recombinant DNA Technology
 - Genome Sequencing
 - DNA Fingerprinting
 - Somatic Cell Nuclear Transfer Technology
 - Stem Cell Research
- Principles in BT
 - Genetic Engineering
 - Bioprocess Engineering





Basics of Biotechnology

Lecture 2

What is Biotechnology?

 Technique of Using Live Organism or Enzymes to Produce a Product or Process useful to Humans

• Eg. Wine and Bread Making, In Vitro Fertilization, Cloning, Gene Editing, Designer Babies etc.







Designer Babies

 A baby whose genetic makeup has been artificially selected by genetic engineering to ensure the presence or absence of particular genes or characteristics





Principles of Biotechnology

- Genetic Engineering: Techniques to alter the chemistry of genetic material (DNA and RNA), to introduce these into host organisms and thus change the phenotype of the host organism.
- **Bioprocess Engineering**: Maintenance of **sterile** (microbial contamination-free) ambience in chemical engineering processes to enable growth of only the desired microbe/eukaryotic cell in large quantities for the manufacture of biotechnological products like antibiotics, vaccines, enzymes, etc.



Transcription and Translation

• Step 1: Transcription

Information in DNA transferred to mRNA

DNA serves as template for complementary base pairing

RNA Polymerase catalyses to form pre-mRNA

Processed to form mRNA

• Step 2: Translation

the mRNA is "read" according to the genetic code w.r.t. DNA sequence

The mRNA template is then used to assemble chain of amino acids through Ribosome that form protein







Recombinant DNA (rDNA)

- Technique wherein a gene of interest is inserted into a vector to produce a recombinant DNA (rDNA) or products of the recombinant DNA
- Desired traits of an organism is incorporated into the traits of another organism



Steps Involved in rDNA

- 1. Isolation of genetic material
- 2. Restriction enzyme digestion
- 3. Amplification using PCR (Polymerase Chain Reaction)
- 4. Ligation of DNA molecules into vector
- **5. Insertion of recombinant DNA into host**
- 6. Obtaining foreign gene/product
- 7. Downstream processing







Autonomously Replicating circular extrachromosomal DNA of Salmonella typhimurium

Plasmids

- Small circular DNA molecule found in bacteria & other micro organism
- Physically separate from chromosomal DNA
- Replicate independently
- Also copies Foreign Gene when replicating (copying)



Plasmids





Tools for rDNA

Restriction Enzymes

- Belong to a larger class of enzymes called Nucleases
- 2 Kinds: Endo-nucleases (removes from within DNA) and Exo-nucleases (removes from end of DNA)
- Identifies length and sequence and then makes the cut
- Based on specific Palindromic Nucleotide sequences
 - Palindrome Reads same both ends, EG. MALAYALAM
 - But in DNA's case, sequence of base pairs that reads same on the two strands when orientation of reading is kept the same.
 - 5' GAATTC 3' with respect to other strand
 - 3' CTTAAG 5' with respect to other strand



Cutting using **Restriction Enzymes** Separation using Gel Electrophoresis Stained using **Ethidium Bromide** and viewed under UV light Then extracted from **Agrose Gel called** Elution





Joining 2 DNA using Ligases enzyme and replicating using Tumorous/Cancerous Cloning Vectors like Agrobacterium tumifaciens

In animals, retrovirus which is Cancerous Cell has been transformed into Cloning Vector

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Figure 11.2 Diagrammatic representation of recombinant DNA technology

Question 1: Recombinant DNA technology (Genetic Engineering) allows genes to be transferred **(UPSC 2013)**

- 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.

1.1 only
 2.2 and 3 only
 3.1 and 3 only
 4.1, 2 and 3



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Question 2: With reference to recent developments regarding 'Recombinant Vector Vaccines', consider the following statements: **(UPSC 2021)**

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

Which of the statements given above is/are correct?

1.1 only2.2 only3.Both 1 and 24.Neither 1 nor 2



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Question 3: 'Aerial metagenomics' best refers to which one of the following situations? **(UPSC 2023)**

- A. Collecting DNA samples from air in a habitat at one go
- B. Understanding the genetic makeup of avian species of a habitat
- C. Using air-bome devices to collect blood samples from moving animals
- D. Sending drones to inaccessible areas to collect plant and animal samples from land surfaces and water bodies
- Ans:



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- Question 4: 'Microsatellite DNA' is used in the case of which one of the following?(UPSC 2023)
- A. Studying the evolutionary relationships among various species of fauna
- B. Stimulating 'stem cells' to transform into diverse functional tissues
- C. Promoting clonal propagation of horticultural plants
- D. Assessing the efficacy of drugs by conducting a series of drug trials in a population

Ans:



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Ans: A



- Question 5: With reference to the recent developments in science, which one of the following statements is not correct? (UPSC 2019)
 - 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 plasma and animals can be made to undergo cell division in laboratory petri dishes



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• Answer: (a)



Genome Sequencing

Genome sequencing is figuring out the order of DNA nucleotides, or bases, in a genome—the order of Adenine, Cytosine, Guanines, and Thymine that make up an organism's DNA





WGS is a laboratory procedure that determines the order of bases in the genome of an organism in one process. WGS provides a very precise DNA fingerprint that can help link cases to one another allowing an outbreak to be detected and solved sooner.



ACTGAACTGACTGA

CTGACTGACTGACT CTOGRAMCTCCMG ACTCTGAGACTCAC

Importance of Genome Sequencing

- Important tool in Pharmacogenomics, clinical diagnosis, and translational vaccine development
- Characterize bacteria as well as track outbreaks
- Identifying inherited disorders and characterizing the mutations that drive cancer progression





Applications of Genome Sequencing

- Biological research: making proteins as well as regulating gene functions
- Forensics: DNA and RNA sequences can differentiate organisms down to species and individual levels, it can help to classify diseases, identify therapeutic targets, and customize treatments
- **Diagnostics**: Prenatal screening and Evaluating Disorders
- **Drug Efficacy**: Studies Relation between drugs and genome (pharmacogenomics)
- Vaccine Development
- Population Studies
- Agriculture and Food Security

Q. With reference to agriculture in India, how can the technique of 'genome sequencing', often seen in the news, be used in the immediate future?

1.Genome sequencing can be used to identify genetic markers for disease resistance and drought tolerance in various crop plants.

2. This technique helps in reducing the time required to develop new varieties of crop plants.

3.It can be used to decipher the host-pathogen relationships in crops

Select the correct answer using the code given below:

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India's INSACOG

- The Indian SARS-CoV-2 Genomics Consortium (INSACOG) is a multi-laboratory, multi-agency, Pan-India network to monitor genomic variations in the SARS-CoV-2 by a sentinel sequencing effort.
- The network carries out whole genome sequencing of SARS COV2 virus across the nation, aiding the understanding of how the virus spreads and evolves.
- Any changes to the genetic code, or mutations, can be observed in the samples and provide information to aid public health response



IndiGen Programme

- The goal is to enable genetic epidemiology and develop public health technology applications using population genome data.
- IndiGen is endorsed by the Council for Scientific and Industrial Research (CSIR).
- The outcomes of the **IndiGen** will be utilized towards understanding the genetic diversity on a population scale, making available genetic variant frequencies for clinical applications, and enabling genetic epidemiology of diseases.

GISAID

- Global Initiative on Sharing Avian Influenza Data
- Global science initiative and primary source established in 2008 that provides open-access to genomic data of influenza viruses and the coronavirus responsible for COVID-19 Pandemic
- On January 10, 2020, the first whole-genome sequences of SARS-CoV-2 were made available on GISAID



Human Genome Project

- The Human Genome Project was a significant global scientific endeavour whose primary goal was to create the first sequence of the human genome.
- The Project formally began in 1990 and was completed in 2003, to discover all the estimated 20,000-25,000 human genes and make them accessible for further biological study.
- Objectives: To create three research tools that will enable scientists to identify genes that are involved in both rare and common diseases.
- To investigate and educate the public about the ethical, legal, and social implications of new genetic technologies.



UPSC Mains PYQ

- Q. The human population is slated to grow to 9 billion by 2025. In this context, many scientists predict that plant genomics would play a critical role in keeping out hunger and preserving the environment. **(UPSC Mains 2012)**
- Q. Explain the objectives and the current achievements of the human genome project. (UPSC Mains 2007)



Somatic Cell Nuclear Transfer Technology

- Genetic Material (nucleus from embryonic, somatic or adult cell) is removed and placed into cytoplasm of enucleated unfertilised egg (whose nuclease has been removed)
- Once inside the egg, the somatic nucleus is reprogrammed by egg cytoplasmic factors to become a <u>zygote</u> (fertilized egg) nucleus.
- The egg is allowed to develop to the <u>blastocyst</u> stage, at which point a culture of <u>embryonic</u> stem cells (ESCs) can be created from the inner cell mass of the blastocyst.
- SCNT first used in 1996 to create the cloned sheep Dolly





What is the application of Somatic Cell Nuclear Transfer Technology? (2017)

A. Production of bio larvicides

- B. Manufacture of biodegradable plastics
- C. Reproductive cloning of animals
- D. Production of organisms free of diseases



Stem Cell Technology

- Stem cells are body's raw materials cells from which all other cells with specialised functions are generated
- It is undifferentiated cell of multicellular organism which is capable of giving rise to indefinitely more cells (through mitosis) of same type, and from which certain other kinds of cell may be formed by the cellular differentiation



Properties of Stem Cells

- 1. Stem cells are unspecialised
- 2. Stem cells can be induced to differentiate in several lineages
- 3. Stem cells has renewal property



Types of Stem Cells: Character Based

- Totipotent: Stem cells that give rise to whole organism
 - Eg. Zygote, Placenta, Umbilical Cord
- Pluripotent can give rise to all of the cell types that make up the body
 - Eg. Embryonic
- Multipotent can develop into more than one cell type, but are more limited than pluripotent cells
 - Eg. Bone marrow, Adult stem cells
- Unipotent: Stem cells that give rise to only type of cell
 - Eg. Germline stem cells, Skin Cells





Stem cell potency

Types of Stem Cells: Origin Based

- 1. Embryonic Stem Cells: Derived from inner cell mass of Blastocyst (an early stage embryo)
- 2. Adult Somatic Stem Cells: Undifferentiated Cells found throughout body after development. It multiplies by cell division to replenish dying cells and regenerate damaged tissues
- 3. Induced Pluripotent Stem Cell: Formed from Adult Somatic Stem Cells (Multipotent) and turned to Pluripotent through Genetic Programming or 'Forced' introduction of Reprogramming Genes called Yamanaka Factors







Regenerative Therapy: Prevent any disease

Hematopoietic Stem Cell Transplantation (HSCT): Leukaemia and Lymphoma





In Vitro Fertilisation

- Process of fertilization where an egg is combined with sperm in vitro (in the laboratory)
- IVF is a type of assisted reproductive technology used for infertility treatment and gestational surrogacy
- In July 1978, Louise Brown was the first child successfully born after her mother received IVF treatment



IVF Cases

- Case 1: Sperms healthy, ovum is diseased. Donor Female's ovum is fertilised by sperm in vitro and implanted into original mother
- Case 2: Sperm and Ovum healthy. Mother cannot conceive. Fertilised zygote implanted into Surrogate/Foster mother
- Case 3: Sperms bad. Ovum healthy. Donor sperm used to fertilise the egg and implanted into original mother.



In Vitro Fertilization (IVF)





Assisted Reproductive Technology (ART) (Regulation) Act, 2021

• Aims to regulate and supervise assisted reproductive technology clinics and banks, prevent misuse of the technology and promote the ethical practice of the services

• Examples of ART services include gamete (sperm or oocyte) donation, in-vitro fertilization (fertilizing an egg in the lab) and gestational surrogacy (the child is not biologically related to the surrogate mother)



Genome Editing

- Genome editing is a technique used to modify DNA precisely and efficiently within a cell.
- Genome editing can be used to add, remove, or alter DNA in the genome.
- It involves making cuts at specific DNA sequences with enzymes called 'engineered nucleases'.
- Eg. Cas9, ZFNs (Zinc Finger Nucleases), TALENs (Transcriptor Activator Like Effector Nucleases)
- By editing the genome, the characteristics of a cell or an organism can be changed.



CRISPR-Cas9: Gene editing tool

- CRISPR: Clustered Regularly Interspaced Short Palindromic Repeats is family of DNA sequences found in the genomes of prokaryotic organisms such as bacteria and archaea
- Cas9: CRISPR-associated protein 9
- These sequences are derived from DNA fragments of bacteriophages that had previously infected the prokaryote





Steps involved in CRISPR Cas9

- 1. Identification of DNA sequence
- 2. RNA binds to a specific target sequence of DNA in genome and also binds to Cas9 enzyme
- 3. Modified RNA is used to recognize DNA sequence, and Cas9 enzyme cuts the DNA at the targeted location.
- 4. Once DNA is cut, DNA's own repair machinery is used to add or delete pieces of genetic material, or make changes to DNA by replacing an existing segment with a customized DNA sequence


Q. What is Cas9 protein that is often mentioned in the news ? (2019)

- A. A molecular scissors used in targeted gene editing.
- B. A biosensor used in the accurate detection of pathogens in patients.
- C. A gene that makes plants pest-resistant
- D. A herbicidal substance synthesized in generally modified crops



Applications of Biotechnology

- 1. GMOs (Genetically Modified Organisms)
 - Cisgenic (within species) and Transgenic (different species)
 - Bollgard Bt Cotton: Produces Natural insecticide (toxic protein) in its tissues
 - Bollgard 1: Cry1Ac Gene protection against bollworms
 - Bollgard 2: Cry1Ac + Cry2Ab Gene bollworms & Spodoptera caterpillar
 - Bollgard 3: Cry1Ac + Cry2Ab Gene + Vip3A (control cotton pests like black cutworm)





Fully matured cotton



Premature cotton

1. GMOs continued:

- GM Rubber world's 1st and planted in the outskirts of Guwahati
 - Gene MnSOD (Manganese Superoxide Dismutase) withstand cold and harsh weather condition
 - Leading producer Indonesia and Thailand
- Flavr Savr Tomato
 - Made in USA Resistant to Rotting
- Biofortified Rice Golden Rice
 - Vitamin A fortified







Image shows three sets of tomatoes. The ordinary control tomatoes (extreme left) soften and shrivel up, while texture of gene-silenced tomatoes remains intact for up to 45 days. Photo credit: Asis Datta, Subhra Chakraborty, National Institute of Plant Genome Research, New Delhi

Beta polygalacturonase (PG) enzyme spoils tomato

GMO Continued

- GM Mustard Dhara Hybrid 11 (Herbicide tolerant)
 - Reduce India's edible oil imports Imported from Thailand, Malaysia and Indonesia
 - Uses soil bacterium *Bacillus amyloliquefaciens* enables self pollination
- GEAC (Genetic Engineering Approval Committee) Approved Commercial Cultivation of Bt Cotton and GM Mustard
- Disadvantages:
 - High Cost, Development of Resistance, Terminator Technology, Environmental Concern, Ethical Concern



RNA Interference (RNAi)

- 1. RNAi takes place in all eukaryotic organisms as a method of cellular defense
- 2. Involves silencing of a specific mRNA due to a complementary dsRNA molecule that binds to and prevents translation of the mRNA (silencing its ability to synthesize protein)
- 3. The source of this complementary RNA could be from an infection by viruses having RNA genomes or mobile genetic elements (transposons)that replicate via an RNA intermediate





Application of RNA Interference

- Natural Insecticide/Pesticide. Eg. Tobacco infected by Meloidegyne Incognitia
- Cancer Treatment
- Treating Neurogenerative Disease
- Viral Infection Suppression



Mycorrhizal Biotechnology

- Mycorrhiza fungi act as biofertilizer and helps in maintaining the soil resulting in higher organic content
- Ability to tolerate extremes of pH, high temperature and heavy metal toxicity
- Helps in resisting drought and salinity
- Fungi can reduce disease occurrence
- Decrease soil erosion





What are Mycorrhizal Fungi?



Horizon

- NATURALLY OCCURING Beneficial Fungi
- Form SYMBIOTIC relationships with plants
- Attach to roots and become
 EXTENSIONS of the root system

- They dramatically EXPAND ACCESS to moisture & nutrients from the soil
- In return, the host plant feeds the fungi with sugars and organic substances



Genetically Engineered Insulin

- In 1983, Eli Lilly an American company prepared two DNA sequences corresponding to A and B, chains of human insulin and introduced them in plasmids of E. coli to produce insulin chains.
- Chains A and B were produced separately, extracted and combined by creating disulfide bonds to form human insulin



Gene Therapy

- Gene therapy is a collection of methods that allows correction of a gene defect that has been diagnosed in a child/embryo.
- Mutation in gene > Production of dysfunctional protein > Inherited Disease
- Gene therapy can deliver copy of this gene without the mutation
- The first clinical gene therapy was given in 1990 to a 4-year old girl with adenosine deaminase (ADA) deficiency





Gene Therapy





Cell with non-functioning Gene





Adding DNA containing a functional version of the lost gene





Cell functioning Normally

Molecular Diagnosis

PCR Polymerase Chain Reaction

- Method used to rapidly make millions to billions of DNA copies
- Small sample can be amplified for further study and research
- Developed in 1983, Kary Mullis (American Biochemist)
- Taq Polymerase is the enzyme used isolated from Thermophilic Bacterium

ELISA

- Enzyme Linked Immunosorbent assay
- Used as diagnostic tool in medicine, pathology and biotechnology as well as quality control checks
- HIV Test or West Nile Virus Test
- Used in Food Industry detect potential food allergens



Transgenic Animals

- Genome altered by transfer of genes from other organisam
- Enhance traits and characteristics or for R&D
- Eg. 95% Genetically Modified Animals = rats, rabbits, pigs, sheeps, cows, fish – Dolly the Sheep 1996
- Used For:
 - Study of Normal Physiology and Development
 - Study of Disease: *phenylketonuria* (PKU) and hereditary *emphysema*
 - Biological Product Eg. Human Protein *alpha-lactalbumin* in Cow Milk (Rosie 1997) – safe for baby
 - Vaccine Safety
 - Chemical Safety Testing



Biopiracy

Practice of Commercially Exploiting Naturally Occurring Biochemical or Genetic Material, by restricting its Future Use by filing Patents and also not paying Compensation to the community from which it originates.

- 1. Neem (anti fungal property exploited by USA Company)
- 2. Basmati Rice (USA Company)
- 3. Indian Wheat (European Company)
- 4. Turmeric (wound healing-University of Mississippi)



Bioinformatics

- Inter-Disciplinary field
- Develops Methods and Software Tools > To understand biological data
- Enables Prediction of structure of several molecules > Target Based Drug Delivery







Ew

Thank You!



Vaccination & Treatment



Vaccine

- A biological preparation that is used to stimulate the body's immune response against disease
- It provides active acquired immunity to a PARTICULAR infectious disease
- Edward Jenner "Father of Immunology" British Physician
- Vaccine and Vaccination derived from Variolae vaccinae to denote cowpox
- Serum Institute of India (SII), Pune Largest manufacture of vaccine

Universal Immunisation Programme

- 1978 Expanded Programme of Immunisation (EPI)
- 1985 UIP (Universal Immunisation Programme)
- 1992 part of Child Survival and Safe Motherhood Programme
- 2005 part of National Rural Health Mission (NRHM)
 Now Consists of 12 Diseases
- 2007 Hepatitis B
- 2017 Pneumococcal Diseases (Meningitis and Pneumonia)
- 2017 Measles Rubella





Ministry of Health and Family Welfare Government of India

Discover the power of the Universal Immunization Programme (UIP)!

Vaccines available nationally against these 11 diseases

Diphtheria Hepatitis B

Severe form of

type B and

childhood Tuberculosis

Pneumonia caused by

Hemophilus Influenza

Pneumococcal Pneumonia

- Meningitis Pertussis
- Tetanus
- » Polio
- Measles
- » Rubella
- Rotavirus diarrhea

Japanese Encephalitis, JE vaccine is provided only in endemic districts





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vaccine-preventable diseases at no cost.

Get vaccinated

against 7

Vaccine available sub-nationally against 1 disease

MISSION INDRADHANUSH

BUILDING A HEALTHY AND HAPPY INDIA

Over **34 lakh** children and **6 lakh** pregnant women administered vaccine doses*

5.06 crore children and **1.25 crore** pregnant women cumulatively vaccinated so far since 2014



*During the first 2 rounds of Intensified Mission Indradhanush (IMI) 5.0 campaign

Source: Gol







Mission Indradhanush

- Launched December 2014
- From 65% to 90% Immunisation Coverage before 2020
- Identification of High Focus Districts
- Ensuring Immunization of Unvaccinated and Partial Vaccinated Children
- Tuberculosis, Meningitis, Measles, Hepatitis B, Tetanus, Whopping cold, Poliomyelitis, and Diphtheria
- Japanese Encephalitis and Haemophilus Influenza
- Intensified Mission Indradhanush 2.0, 3.0, 4.0, 5.0



Intensified Mission Indradhanush 4.0 Launched

8 Successful Years Of Ensuring Full Immunization Coverage to Mother & Child

Mission Indradhanush Completed 10 phases covering 701 districts, since its launch in 2014



Aims at achieving full immunization coverage of 90% through focus on partially vaccinated & unvaccinated children and pregnant women in pockets of low immunization coverage, high-risk & hard-to-reach areas



3.86 crore children & 96.8 lakh pregnant women vaccinated, as of April 2021



First two phases of Mission Indradhanush resulted in 6.7% increase in full immunization coverage in a year





INTENSIFIED MISSION INDRADHANUSH 5.0

IMI 5.0 focuses on reaching zero-dose children aged between 0 - 5 years and pregnant women, ensuring that every child receives life-saving vaccines and those who might have missed any vaccine doses in the national immunization schedule earlier.



Register at: https://manipur.mygov.in





Major Vaccine Types

- 1. Live Attenuated Vaccine
- 2. Inactivated Vaccine
- 3. Toxoid Vaccines
- 4. Subunit Vaccine
- 5. Conjugate Vaccine
- 6. Viral Vector Vaccine
- 7. mRNA Vaccine
- 8. DNA Vaccine



Live Attenuated Vaccine

These vaccines contain live virus particles that have been weakened to keep them from causing disease

> They create a strong immune response

Some attenuated vaccines might not be suitable for people with compromised immune systems



Disease-causing virus





immune cells on Antigen Presenting Cells

Immune Response and Memory

Currently used in: MMR (Measles/mumps/rubella) Chickenpox **COVID** vaccines in the pipeline: Codagenix; Indian Immunologicals Ltd

Inactivated Vaccine

These vaccines contain whole virus particles, that have been killed or inactivated to keep them from causing disease.

They are safer as the virus is already dead

Inactivated vaccines require booster doses as the immunity conferred by these vaccines is weaker than live vaccines



Dead/Killed virus



Antigen is presented to the immune cells on Antigen **Presenting Cells**

Immune Response and Memory

Currently used in: Polio **COVID** vaccines in the pipeline: Sinovac; Sinopharma; Bharat Biotech

Replicating Viral Vector Vaccine

These vaccines use low-pathogenic viruses, which are largely harmless, and alter them into viral vectors that will produce some of the same proteins as the disease-causing virus.

This creates a strong immune response, but may not work for people who are already immune to the low pathogenic virus.

Disease-causing Low - pathogenic

Viral vector encoding target

antigen

virus

virus

Gene for

SARS-COV-

antigen



These vaccines are similar to

replicating viral vector vaccines except that they cannot replicate inside the body as the key viral replication genes is deleted from the low pathogenic vector virus

Improved efficacy and safety, but require high doses to confer immunity



Disease-causing Low - pathogenic virus virus



Viral vector encoding target antigen

Antigen is presented to the

immune cells on Antigen

Presenting Cells

Immune Response and

Memory

Currently used in:

Ebola

COVID vaccines in the

pipeline:

University of Oxford and &

AstraZeneca



Antigen is presented to the

immune cells on Antigen Presenting Cells

Immune Response and Memory

Currently used in: Used in veterinary medicine **COVID** vaccines in the pipeline: Themis Bioscience: University of Pisttsburg

DNA Vaccine

These vaccines use DNA plasmids containing a gene for SARSCoV-2 along with additional genetic elements that will produce some of the same antigenic proteins as the disease-causing virus.

They are easy to develop and produce. There is no risk of infection but there is a possibility that the immune system does not fight against the antigen (tolerance to the antigen).

mRNA

These vaccines use a piece of messenger RNA (mRNA) that will produce some of the same antigenic proteins

Risk of being integrated to the host genome is averted but, sometimes the RNA molecules may trigger an unintended immune response in the

body

(protein)

Antigen is presented to the

immune cells on Antigen

Presenting Cells

Immune Response and

Memory

Currently used in:

No currently available

human RNA vaccines

COVID vaccines in the

pipeline:

Moderna;CureVac;Pfizer,

BioNTech, Fosun Pharma







Currently used in: HPV(Human Papilloma virus); Pertussis; Hepatitis B **COVID** vaccines in the pipeline: Novavax; AdaptVac







ACADEMY OF



Antigen is presented to the

Currently used in: No currently available human **DNA** vaccines **COVID** vaccines in the pipeline: Inovio;Genexine;Zydus cadila

SARSCoV-2 **DNA Plasmid**



Antigen (protein)



immune cells on Antigen **Presenting Cells**

Immune Response and Memory

RNA Vaccine

as the disease-causing virus.

These vaccines use antigenic protein from the disease causing virus without any genetic material.

Subunit Vaccine

They are relatively safer as there is no genetic material and they cannot replicate inside the body. They focus the immune response on the most important part of the virus for protection.

These vaccines require multiple doses for long term immunity. They require adjuvants which are ingredients that help create a stronger immune







immune cells on Antigen **Presenting Cells**

What are Live, Attenuated Vaccines?

Live vaccines are "wild" viruses or bacteria that have been weakened.* In the lab, generally the virus is passed through many generations of cells to pick up genetic mutations which weaken it - so much it won't cause disease in your body.

Vaccine Target

Live, attenuated vaccines target your body's immune system directly. They are strong enough to trigger the immune response, but too weak to cause disease.

TARGET:

THREAT DETECTED:

ACADEMY

Immune system



What are Inactivated Vaccines?

Live vaccines are "wild" viruses or bacteria that have been inactivated.* In the lab, a wild virus is "killed" with heat or chemicals so it cannot replicate or cause disease in your body, and is safe for immunodeficient people.

Vaccine Target

Inactivated vaccines target your body's antibody production. This is weaker than natural infection or live vaccines, so inactivated vaccines often require multiple doses.





What are Subunit (recombinant, polysaccharide, and conjugate) vaccines?

Subunit vaccines use a portion of a bacteria or virus to cause an immune response independent of its virus or bacteria of origin. Elements of subunit vaccines can be proteins, polysaccharide chains, or a combination of these.



POLYSACCHARIDE AND CONJUGATE VACCINES

Some bacteria blanket themselves in polysaccharide chains as a "disguise" to hide from the immune system. In the lab, a protein conjugate is attached to the polysaccharide and injected into the body to teach the body to recognize the polysaccharide disguise as a harmful invader.



Antigen

presented

THREAT

ACADEMY O

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What is a Viral Vector Vaccine?

Made of a small section of a virus' genetic material - the instructions or 'blueprint' for a specific protein. The viral capsule or shell from another virus carries the gene safely to your cells.



Vaccine Target

The AstraZeneca and Johnson & Johnson COVID viral vector vaccines carry genetic code for the spike protein, and build immunity against invaders carrying it on their surface.

TARGET:

Spike protein

What is the Messenger RNA (mRNA) vaccine?

Made of a small section of a virus' genetic material - the instructions or 'blueprint' for a specific protein. A insoluble nanoparticle* capsule carries the gene safely to your cells.



Vaccine Target

Pfizer's mRNA COVID vaccine carries the genetic blueprint for the spike protein. Your body will make this protein and build immunity against any invaders carrying it on their surface.

TARGET:

Spike protein

DNA Vaccine










a/pnpca





How some of the different Covid-19 vaccines compare



Technology / company	Suitable for people with weak immune systems	Number of doses	Storage	Other vaccines using this technology
RNA Pfizer-BioNTech Moderna	~	••	Pfizer-BioNTech: -70C and 2-8C for up to 5 days Moderna: -20C for 6 months and 2-8C for 30 days	No other licensed vaccines
Viral vector Oxford-AstraZeneca CanSino Biologics Gamaleya Research Institute Johnson & Johnson	(Depending on viral vector used)	to	2-8C	Ebola
'Whole' virus Sinovac (inactivated) Bharat Biotech (inactivated) Sinopharm (inactivated) Medicago Inc. (virus-like particle)	~	••	2-8C	Whooping cough (inactivated) Rabies (inactivated) Hepatitis A (inactivated) HPV/cervical cancer (virus-like particle)
Protein subunit Novavax Chinese Academy of Sciences	~	••	2-8C	Hepatitis B

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As of 6 January 2021, Source: Company data/Gavi





Vaccine platforms designed to train our immune system



SARS-CoV-2 is the virus that causes COVID-19. The spike protein on the surface of SARS-CoV-2 is an example of an antigen.

Vaccines are the best way to train our immune system to recognize viruses, or pieces of viruses, called antigens. Our immune system creates antibodies and other defenses to protect us. When a vaccinated person is exposed to SARS-CoV-2, their immune system will recognize the viral antigens and spring into action to keep them healthy. There are many different types of vaccines, as shown above.

NTAGI

- National Technical Advisory Group on Immunisation
- Estd. In 2001 under MoHFW
- Apex Advisory Body on Immunisation
- Provide Guidance and Advice to MoHFW on Vaccination and Immunsation Services
- Enables Informed Decision Making



NATIONAL TECHNICAL ADVISORY GROUP ON IMMUNIZATION (NTAGI)

Why in news?

NTAGI will hold its meeting to discuss reducing booster dose gap for children amid a fresh spike in COVID-19 cases.

About

Government advisory panel NTAGI will meet to review data on Covaxin and Corbevax vaccines for the 6-12 age group. It will also deliberate on reducing the gap between the second and precaution doses.

Need

The NTAGI of India meets a requirement for assisting in decision-making with regard to the introduction of new vaccinations and strengthening the Universal Immunization Program.

Objective

Objective of the NTAGI is to provide advice to the Ministry of Health and Family Welfare on the strategies to control the burden. Appropriately evaluate the impact of immunization on Vaccine Preventable Diseases in the country.

COVID

Recommendations

NTAGI recommendations may include guidance on all matters related to immunization policy and programmes: • Route, dose and frequency of administration of the vaccine.

COVID-19

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GAVI – Vaccine Alliance

- Created in 2000 International Organisation Global Vaccine Alliance
- Goal of Creating Equal Access to New and Underused Vaccines for Children in Poorest Countries
- Core Partners WHO + UNICEF + WB + Bill & Melinda Gates Foundation
- 2019 5 year Strategy (Gavi 5.0) Leave no one behind with Immunsation



CEPI

- Coalition for Epidemic Preparedness Innovations
- Global Partnership Launched in 2017
- Founded in Davis (Switzerland) by Govt. of Norway and India + Bill & Melinda Gates Foundation, Wellcome Trust and WEF



Vaccine Maitri

- Humanitarian Initiative of India to provide Covid-19 Vaccines to countries around the world
- Bhutan and Maldives were the 1st countries to receive vaccines as Grant
- Followed by Nepal, Bangladesh, Myanmar, Seychelles
- On Commercial basis to Canada, UK, Saudi Arabia etc.

Pharmacogenomics

- Study of how genes affect a person's response to drugs
- Currently, most drugs are "One Size Fits All" category
- Knowledge of Human Genome Project enable understanding of Inherited Differences how genes affect body's response to medications
- Genetic Differences will enable Prediction whether a Mediation will be effective for a particular person and prevent adverse drug reaction
- Enable development of Tailored Drugs in Future









IndiGen Project

- Initiative of CSIR, 2019
- Enable Genetic Epidemiology
- Develop Public Health Technologies Applications using Population Genome Data
- Undertake whole genome sequencing of diverse population
- Develop Predictive Diagnostic Markers
- Enable next generation personalised medicine development



Immunotherapy

- Treatment of Diseases by activating or suppressing the immune system
- Elicit or Amplify an Immune response = activation immunotherapies (eg. Cancer Treatment)
- Reduce or Suppress = Suppression Immuntherapies (Eg. Organ Transplantation)
- Region of Interest for Promising Results in Cancer Treatment





TRADITIONAL CANCER THERAPIES

RADIATION OR DRUGS

KILLS

CANCER IMMUNOTHERAPIES



HEALTHY CELLS



CANCEROUS CELLS



FEW TO NO SIDE EFFECTS

KILLS

SELECTIVELY CANCEROUS CELLS



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MANY SIDE EFFECTS

IMMUNOTHERAPY VS. CHEMOTHERAPY

TRADITIONAL TREATMENTS



CANCER IMMUNOTHERAPIES



Adaptive biotechnologies"

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Biopharma

- A biopharmaceutical, also known as a biological medical product, or biologic, is any pharmaceutical drug product manufactured in, extracted from, or semi synthesized from biological sources.
- Different from totally synthesized pharmaceuticals, they include vaccines, whole blood, blood components, allergenics, somatic cells, gene therapies, tissues, recombinant therapeutic protein, and living medicines used in cell therapy.



Biologics and **Biosimilars**

BIOLOGIC

Brand name that discovered therapy

BIOSIMILAR

Brand that makes treatment after 20-year patent expires

Similarities between the two

- Proteins grown, isolated, and purified from living cells
- Complex and expensive to make
- Grown under strict conditions. (temperature, pH, food)
- Cells programmed to make specific proteins

Results

- ✓ Same protein
- Work the same way
- X Similar effect but small differences due to variations in growth conditions

What they're used to treat

- Inflammatory arthritis (including rheumatoid arthritis, ankylosing soondylitis, and psoriatic arthritis)
- Inflammatory bowel disease
- Anemia (related to) cancer treatment) Psoriasis Breast cancer

Health Canada approval requirements



VV Safety data ✓✓ Efficacy data Post-market data Fewer clinical studies





Biosimilar

- A biosimilar (also known as follow-on biologic or subsequent entry biologic) is a biologic medical product that is almost an identical copy of an original product that is manufactured by a different company.
- Biosimilars are officially approved versions of original "innovator" products and can be manufactured when the original product's patent expires





A UNIQUE CELL LINE YIELDS A SIMILAR THERAPY

A biosimilar is a biologic medicine that is similar, but not identical, to the original biologic medicine it is based on. This means the biosimilar is clinically indistinguishable from the reference product, even though it isn't an exact copy.^{5,6}



Feature	Biologic	Biosimilar	Generic
Representation			***
Origin	Living organisms	Similar to the reference biologic	Identical to the brand-name drug
Manufacturing process	Complex	Complex	Simple
Regulatory approval process	More rigorous	More streamlined	Similar to biologics
Safety and efficacy	Same standards	Same standards	Same standards
Time Investment	8-10 years	7-8 years	2-3 years
Cost	More expensive	Less expensive	Less expensive
Savings	Less savings	More savings	More savings than the brand -name drug



Drug

- Drugs are chemicals of low molecular masses (~100 500u)
- When the biological response is therapeutic and useful, these chemicals are called medicines and are used in diagnosis, prevention and treatment of diseases
- Use of chemicals for therapeutic effect is called chemotherapy
- Most of the drugs used as medicines are potential poisons, if taken in doses higher than those recommended.



A drug is a type of substance that's often used to cure or prevent an ailment or disease.



Drugs Classification

- Antacids
 - Antihistamine
 - Neurologically Active Drugs
 - Antibiotics
 - Probiotic
 - Antiseptic
 - Antifertility



Antacids

- Antacids are medications that neutralize stomach acid to relieve heartburn, indigestion, and upset stomach
- They work by reacting with stomach acid to form a salt, which reduces the acidity of the stomach contents.
- Contains ingredients such as aluminum, calcium, magnesium or sodium bicarbonate

ANTACID ANTIGAS TABLETS DIGENE®



15 Tablets

Besage: Adults: 2-4 tablets as required to be chewed, or sucked after meals & at bedtime; or as advised by the Physician. Children: As advised by the Physician. Each uncosted chewable tablet contains: Dried Aluminium Hydroxide Gel LP. 300 mg Magnesium Aluminium Silicate Hydrate SI mg Magnesium Hydroxide LP. 25 mg Simethicone LP. 25 mg Colour: Sunset Yellow FCF

Store at a temperature not exceeding 30°C. Keep all medicines out of the reach of children HL. 201 Manufactured by: Abbott India Limited, L-1077, Yenna Industrial Estate, Verna, Salcette, Goa - 403722, © - Repd. Trademark of Abbott DMBH & CO.KG. "Source: SMSRC MAT Oct 2018 "Source: SMSRC MAT Oct 2018 "Source: Bhoir et al. The Indian Practitioner. 65(ki), June 2012



Abbott



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Antacids work by counteracting, or neutralising, any excess stomach acid

Alginates form a 'raft' that floats on top of stomach contents

Combo products contain an antacid & a raft-forming alginate



Antihistamine

- Used to relieve symptoms of allergies, such as hay fever, hives, runny nose, sneezing, itchy eyes & conjunctivitis and reactions to insect bites or sting
- They interfere histamine by competing with histamine for binding sites of receptor where histamine exerts its effect
- Available OTC (Over the Counter)
- Example: Claritin, Cetirizine, Fexofenadine etc.



Cetirizine HCI



10mg Film-Coated Tablet Antihistamine



PLEASE SEE REVERSE SIDE OF THE BOX FOR FULL PRESCRIBING INFORMATION





10mg Film-Coated Tablet Antihistamine

Fast onset of action
 Provides 24-hour relief

100 TABLETS



Neurologically Active Drugs

- Neurologically active drugs are any substances that can affect the nervous system.
- It refers to a broad category that encompasses a wide range of medications like: Analgesics, Antidepressants, Antianxiety, Antipsychotics and Anticonvulsants medication

Tranquilizers

- Tranquilizers are a class of chemical compounds used for the treatment of stress, and mild or even severe mental diseases- Antidepressant drugs
- They form an essential component of sleeping pills
- Equanil is used in controlling depression and hypertension.
- Barbiturates are hypnotic





Neurologically Active Drugs

Analgesics

- Analgesics reduce or abolish pain without causing impairment of consciousness, mental confusion, incoordination or paralysis or some other disturbances of nervous system
 - (i) Non-narcotic (non-addictive) analgesics
 - Ex. Aspirin and Paracetamol
 - (ii) Narcotic drugs
 - Ex. Morphine, Heroine, Codeine



Non-Narcotic (non-addictive) Analgesics

- Aspirin and paracetamol
- Aspirin inhibits the synthesis of chemicals known as prostaglandins which stimulate inflammation in the tissue and cause pain. These drugs are effective in relieving skeletal pain such as that due to arthritis
- These drugs have many other effects such as reducing fever (antipyretic) and preventing platelet coagulation.
- Because of its anti blood clotting action, aspirin finds use in prevention of heart attacks





Analgesics and Sites of Action



Narcotic drugs

- Example: Morphine, heroine, codeine
- When administered in medicinal doses, relieve pain and produce sleep. In poisonous doses, these produce stupor, coma, convulsions and ultimately death
- Morphine narcotics are sometimes referred to as opiates, since they are obtained from the opium poppy



Antimicrobial

- Consists of broad category of medication that kills or inhibits the growth of micro-organisms like: Bacteria, Viruses, Fungi, Parasites etc.
- It is used to:
 - Treat Infections
 - Prevent Infections after Surgery/Medical Procedures
 Help Control Chronic conditions such as Acne

ANTIVIRALS

- Types^{onic}
 - Antibiotics
 - Antivirals
 - Antifungal
 - Antiparasitic

ANTIFUNGALS

against fungi, e.g. drugs for yeast infections



Antibiotics

- An antibiotic now refers to a substance produced wholly or partly by chemical synthesis, which in low concentrations inhibits the growth or destroys microorganisms by intervening in their metabolic processes.
- Alexander Fleming credited for developing world's 1st antibiotic in 1945 – Penicillin
- Types
 - Broad Spectrum
 - Narrow Spectrum
 - Limited Spectrum



Antibiotics

 Broad-spectrum : An antibiotic that is effective against a wide range of bacteria, both gram-positive and gram-negative

 Narrow-spectrum : Antibiotics that kill limited species of grampositive or gram-negative bacteria

Limited spectrum: Specific to one/single type of bacteria.








Antiseptics

- Antiseptics are applied to the living tissues such as wounds, cuts, ulcers and diseased skin surfaces
- Commonly used antiseptic, dettol is a mixture of chloroxylenol and terpineol
- Bithionol (the compound is also called bithionol) is added to soaps to impart antiseptic properties
- lodine is a powerful antiseptic.
- Its 2-3 per cent solution in alcohol water mixture is known as tincture of iodine. It is applied on wounds.
- Iodoform is also used as an antiseptic for wounds.
- Boric acid in dilute aqueous solution is weak antiseptic for eyes







Disinfectant



- Disinfectants are applied to inanimate objects such as floors, drainage system, instruments, etc.
- Same substances can act as an antiseptic as well as disinfectant by varying the concentration. For example,
- 0.2% solution of phenol is an antiseptic while its 1% solution is disinfectant
- Chlorine in the concentration of 0.2 to 0.4 ppm in aqueous solution and sulphur dioxide in very low concentrations, are disinfectants







Antimicrobial Resistance (AMR)

- Antimicrobial resistance (AMR) is the ability of a microorganism (like bacteria, viruses, and some parasites) to stop an antimicrobial drug from working against it
- As a result, standard treatments become ineffective, infections persist and may spread to others.
- Microorganisms that develop antimicrobial resistance are sometimes referred to as "superbugs"

ANTIBIOTIC RESISTANCE HOW IT SPREADS







Antibiotics are given to patients, which can result in drug-resistant bacteria developing in the gut



Patient attends hospital or clinic



Antibiotics are

given to food producing animals and crops

Antibiotic resistance happens when bacteria change and become

resistant to the antibiotics used to

treat the infections they cause.

Drug-resistant bacteria spreads to other patients through poor hygiene and unclean facilities Animals develop drugresistant bacteria in their gut



Drug-resistant bacteria reaches humans through food, the environment (water, soil, air) or by direct human-animal contact



Drug-resistant bacteria spreads to the general public

www.who.int/drugresistance

#AntibioticResistance





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AMR

- Multidrug-Resistant Mycobacterium Tuberculosis (MDRTB), which is resistant to two tuberculosis drugs, isoniazid, and rifampicin.
- To combat MDR-TB scientists have developed a new drug named 'Bedaquiline'.
- 'Superbug gene': Strains of Bacteria resistant to several types of antibiotics.
 - Example: Methicillin-resistant Staphylococcus aureus (MRSA)



AMR

- AMR threatens the effective prevention and treatment of diseases and infections.
- It leads to prolonged illness.
- Complex medical procedures like organ transplant, chemotherapy, etc become very risky.
- Cost of health care increases with longer stays in hospitals and intensive care units.
- Caused due to MISUSE/OVERUSE of antibiotics



Antibiotics disrupt protein Synthesis Tetracyclines Aminoglycosides Macrolides

Plasmid

4

Superbug

Encodes antibiotic-resistance genes (bacterial "countermeasures") that produces enzymes that inactivate antibiotics



Antibiotics disrupt DNA replication and biosynthesis Fluoroquinolones









Antibiotics disrupt cell-wall synthesis Beta-lactams Cephalosporins

Light activation

Stimuli-activated Quantum dots

Super oxide radical

Inactivating

enzyine

Antifertility Drug

- Birth control pills essentially contain a mixture of synthetic estrogen and progesterone derivatives help prevent pregnancy
- Works by interfering with Women's hormones to prevent Ovulation or Fertilization: Thickening of Cervical Muscle
- Type 1: Progestin Only Pills: Norethindrone is an example of synthetic progesterone derivative most widely used as antifertility drug.
- Type 2: Combination Pills: The estrogen derivative which is used in combination with progesterone derivative is ethynylestradiol (novestrol).



Generic Drug

- A generic drug is a pharmaceutical drug that contains the same chemical substance as a drug that was originally protected by chemical patents.
- Generic drugs are allowed for sale after the patents on the original drugs expire. Because the active chemical substance is the same, the medical profile of generics is believed to be equivalent in performance.
- A generic drug has the same active pharmaceutical ingredient (API) as the original, but it may differ in some characteristics such as the manufacturing process, formulation, excipients, color, taste, and packaging





Prescription Drug cost Comparison



Probiotics

- Probiotics are a combination of live beneficial bacteria and/or yeasts that naturally live in the body and offers health benefits
- Resides in our Gut alongside other microbes
- Probiotics work to maintain a healthy balance in this gut microbiota, promoting overall well-being
- Potential Benefits:
 - Improved Digestion
 - Enhanced Immune Function
 - Other Health Benefits: Mental, Skin Health and Allerigies

Source: Probiotic Supplements and Foods like Yogurt Example: Bulgarian Yoghurt contains *Lactobacillus bulgaricus*



Maximize your GUT'S POTENTIAL





Supports Digestion



Improves Gut Health



Enhances Nutrient Absorption



Fixed Drug/ Dose Combination (FDC)

- Products containing one or more active ingredients used for a particular indication(s) in a single dosage form Two or more medicines in single dosage form
 - paracetamol 500 mg
 - pseudoephedrine hydrochloride 30 mg
 - codeine phosphate 6 mg
- Individual doses forms in a co-pack
 - alendronate 70 mg
 - cholecalciferol 140 micrograms
 - calcium 500 mg
 - (Fosamax Plus D-Cal)







Fixed Drug/ Dose Combination (FDC)

- 1st Group FDC: One or more of the active ingredients is a new drug.
- 2nd Group FDC: Active ingredients already approved/marketed individually are combined for the first time
- 3rd Group FDC: Already marketed, but in which it is proposed either to change the ratio of active ingredients or to make a new therapeutic claim
- 4th Group FDC: Whose individual active ingredients (or drugs from the same class) have been widely used in a particular indication for years, their concomitant use is often necessary and no claim is proposed to be made other than convenience



Benefits of FDC

- Improved medication compliance by reducing the pill burden of patients
- Active ingredients used in the FDCs are unlikely to exhibit adverse drug interactions with each other
- Reduce Medication Costs





Disadvantages of FDC

- Can be difficult to identify the main drug causing adverse side effects
- FDCs 'limit clinicians' ability to customize dosing regimens
- Challenges in the development stages of multi-drug formulations such as compatibility issues among active ingredients and excipients affecting solubility and dissolution

Fixed Dose Combinations (FDC)

When two or more drugs are combined together in a particular ratio

Advantages

Disadvantages

- Compliance improves.
- One drug may reduce the adverse effect of the other drug.
- Efficacy may increase.
- Cost may decrease.

- May be used irrationally.
- If adverse effect occurs, it cannot be ascribed to one drug.
- Drugs with different pharmacokinetics cannot be combined.
- Dose of one drug cannot be altered independently as per requirement.



Hormone Replacement Therapy

- Hormone replacement therapy (HRT), also known as menopausal hormone therapy or postmenopausal hormone therapy, is a form of hormone therapy used to treat symptoms associated with female menopause
- Symptoms can include hot flashes, vaginal atrophy, accelerated skin aging, vaginal dryness, decreased muscle mass, sexual dysfunction, and bone loss.
- The main hormonal medications used in HRT for menopausal symptoms are estrogens and progestogens, amongst which progesterone is the major naturally occurring female sex hormone and also a manufactured medication used in menopausal hormone therapy



Hormone Replacement Therapy (HRT)

Hormone replacement therapy is a treatment that **introduces synthetic hormones into the body** to resolve deficiencies.





Hormone Replacement Therapy and Menopause

Benefits

Relieves symptoms like:

- Hot flashes
- Mood swings
- Vaginal dryness
- Difficulty concentrating





Can increase the risk of:

Risks

- Strokes and blood clots
- Breast cancer
- Endometrial cancer
- Gallstones



Hormone Replacement Therapy

- Estrogens bioidentical estrogens like estradiol and estriol, animalderived estrogens like conjugated estrogens (CEEs), and synthetic estrogens like ethinylestradiol
- Progestogens bioidentical progesterone, and progestins (synthetic progestogens) like medroxyprogesterone acetate (MPA), norethisterone, and dydrogesterone
- Androgens bioidentical testosterone and dehydroepiandrosterone (DHEA), and synthetic anabolic steroids like methyltestosterone and nandrolone decanoate



THE EFFECTS OF TESTOSTERONE

SKIN Hair growth Collagen growth



MUSCLES Muscle growth Increased strength Increased endurance



BONES Bone mass density maintenance BRAIN Increased sex drive Improved mood Confidence Memory function



BONE MARROW Red blood cell production



SEX ORGANS Sperm production Eriktile function Prostate growth





Hormone Replacement Therapy (HRT)

A treatment used to **restore diminished hormone levels** in women in order to relieve symptoms of an imbalance



Functions of CDSCO

Central Drugs Standard Control Org.

Approval of new drugs and clinical trials

Import Registration and Licensing

License approving of Blood Banks, LVPs, Vaccines, r-DNA products & some Medical Devices (CLAA Scheme)

Amendment to D &C Act and Rules

Banning of drugs and cosmetics

Grant of Test License, Personal License, NOCs for Export

Testing of New Drugs

Oversight and market Survillance through Inspectorate of Centre Over and above the State Authority

Drugs Controller General of India (DCGI) heads CDSCO



Molnupiravir

- It is an antiviral medication specifically developed to treat COVID-19
- Molnupiravir, sold under the brand name Lagevrio
- Works by interfering with the replication of the SARS-CoV-2 virus
 - Introducing Errors: Gets incorporated into viral RNA during replication causing replication and mutation errors – leading to non functional copy of itself
 - Lethal Mutagenesis: altered viral RNA also lethal to virus itself reducing its ability to spread and cause infection
- Molnupiravir is a prodrug that exerts its antiviral action through introduction of copying errors during viral RNA replication
- Said to be effective against Omicron as well

blisters



Dr.Reddy's







Thank You Future Officers!

Presented by Arjun Kr. Paul





Presented By Arjun Kr. Paul



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Spanish Flu – 1918 = 5 Crore Deaths
Bubonic Plague – The Black Death (1346-1353 – Wiped out 30% to 60% of European Population)

What is Immunity?

- Ability of the Body to defend itself against Disease causing Organism
- Ability to Release Antibodies against Pathogens
- This Defense Mechanism is called Immunity
- 2 Major Types
 - Innate or Natural or Non Specific
 - Acquired or Adaptive





Different types of immunity





The Immune System







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The five classes of antibodies, or immunoglobulins (Igs)

Classes of Antibodies



IgG antibodies account for 80 percent of all antibodies. IgG antibodies are responsible for resistance against many viruses, bacteria, and bacterial toxins. IgE attaches as an individual molecule to the exposed surfaces of basophils and mast cells.



IgM is the first class of antibody secreted after an antigen is encountered. IgM concentration declines as IgG production accelerates. The anti-A and anti-B antibodies responsible for the agglutination of incompatible blood types are IgM antibodies. IgA is found primarily in glandular secretions such as mucus, tears, saliva, and semen. These antibodies attack pathogens before they gain access to internal tissues.





Polyclonal Antibody

- Cheap to produce
- Mixed population of antibodies
- May bind to different areas of the target molecule
- Tolerant of small changes in protein structure

Polyclonal antibody



Monoclonal Antibody

- Expensive to produce
- Single antibody species
- Will only bind single specific site
- May recognise a particular protein form Monoclonal antibody



Vitamin Chemical Name

Deficiency Diseases



Fat soluble Vitamins

A	Retinol,	Retinal,	Retinoic	acid
-	-			1 10

- D Ergocalciferol (D_2), Cholecalciferol (D_3)
- E Tocopherol
- K Phylloquinone (K₁), Menaquinones (K₂)

Water soluble vitamins

B₁	Thiamine
B ₂	Riboflavin
Ba	Niacin, Niacinamide
B ₅	Pantothenic acid
B ₆	Pyridoxine, Pyridoxamine, Pyridoxal
B ₇	Biotin
Bg	Folic acid, Folinic acid
B ₁₂	Cyanacobalamine
C	Ascorbic acid

Night-blindness and keratomalacia Rickets and Osteomalacia Mild hemolytic anemia in newborn infants Bleeding diathesis

Beriberi Ariboflavinosis Pellagra Paresthesia Anemia peripheral neuropathy Dermatitis Neural tube defects Megaloblastic anemia Scurvy

Main vitamins, sources and deficiency diseases

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Vitamins	Deficiency diseases	Sources	
Vitamin A (retinol)	Night blindness, xeropthalmia, keratinization of skin infection	Carrot, milk, cheese, butter, egg, cod liver oil	
Vitamin B1 (thiamin)	Beri- Beri, growth retardation	Cereals, legumes, soyabeans, milk, yeast, green vegetables	
Vitamin B2 (Riboflavin)	Cheilosis, glossitis, dermatosis, digestive disorders	Milk, egg white, liver, kidney, yeast, meat green leafy vegetables	
Vitamin B ₆ (Pyridoxine)	Anaemia, skin problem and muscular twisting	Milk, yeast, cereals, egg, grams, yolk	
Vitamin B7 (Vitamin H Skin disease, Hair fall Biotin) Study for civil services		meat, wheat, egg, vegetables fruits	
Vitamin B ₉ (Folic Acid) Anaemia, Growth retardation		Green vegetables, legumes, yeast, liver	
Vitamin B_{12} (Cobalamin; a vitamin with cobolt)	Pernicious anaemia, abnormality in nervous system	Meat, fish, egg, curd, bacteria of intestine	
Vitamin C (Ascorbic acid)	Scurvy (bleeding gums)	Amla, citrus fruits, tomato and green leafy vegetables	
Vitamin D (Calciferol)	Rickets, Osteomalacia	Cheese, fish, egg, yolk, sunlight	
Vitamin E (Tocopherol) Sterility and weakening of reproductive organ and muscles		Vegetables oils, wheat, soyabean	
Vitamin K (Naphthoquinone or Phylloquinone)	Blood clotting is Delayed	Green leafy vegetables, bacteria of intestine	

Disease	Symptoms	Transmittal	Treatment
Chicken pox	Rash, low-grade fever	Person to person	None; acetaminophen may treat fever or discomfort
Common cold/influenza	Runny nose, sore throat, cough, fever, headache, muscle aches	Person to person	None, although various remedies may help relieve symptoms
Hepatitis A	Jaundice, flu-like symptoms	Sexual contact with an infected person or contact with contaminated blood, food, or water	None; acetaminophen may treat fever or pain
H1N1 influenza	Fever, cough, sore throat, body aches, loss of appetite, fatigue	Person to person	Antiviral drugs
Measles	Skin rash, runny nose and eyes, fever, cough	Person to person	None; acetaminophen may treat fever or discomfort
Meningitis	Neck pain, headache, pain caused by exposure to light, fever, nausea, drowsiness	Person to person	Antibiotics for bacterial meningitis, hospital care for viral meningitis
Methicillin-resistant Staphylococcus aureus (MRSA)	Rash, shortness of breath, fever, chest pain, headache	Person to person or contact with contaminated surfaces	Antibiotics
Mumps	Swelling of salivary glands	Person to person	Anti-inflammatory drugs
Ringworm	Skin rash	Contact with infected animal or person	Antifungal drugs applied topically or taken orally
Tetanus	Lockjaw, other spasms	Soil infection of wounds	Antibiotics, antitoxins, muscle relaxants



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Mosquito-Borne Diseases



Vector	Mosquito-borne diseases	Causative organism
Aedes sp.	Chikungunya Dengue Rift Valley fever Yellow Fever Keystone virus-induced encephalitis	Virus - CHIKV Virus - DENV Virus - phlebovirus (RVFV) Virus - flavivirus (YFV) Virus - orthobunyavirus (KEYV)
Culex sp.	Japanese Encephalitis West Nile fever	Virus - flavivirus (JE virus) Virus - WNV
Anopheles sp	Malaria	Parasite - Plasmodium sp.
All three	Lymphatic filariasis	Parasites - Wuchereria sp., Brugia sp.





- Retrovirus = Enters T Cells and Replicates
- ELISA (Enzyme Linked Immuno Sorbent Assay) Test
- Western Blot Test
- Zidovudine (ZDV) a.k.a Azidothymidine (AZT)
 - Antiretroviral Medication used for
 Prevention and Treatment

AIDS is caused by the Human Immuno deficiency Virus (HIV), a member of a group of viruses called retrovirus, which have an envelope enclosing the RNA genome



Plasmodium enters the human body as sporozoites (infectious form) through the bite of infected female Anopheles mosquito

 From mother to unborn child
 Through blood transfusions
 By sharing needles used to inject drugs

 China declared Malaria Free by WHO, 1st in Western Pacific





Swine Flu

- Swine Influenza (swine flu) is a respiratory disease of pigs caused by type A influenza virus
- Swine flu viruses do not usually infect humans but was declared Pandemic in 2009 due to mass deaths
- Pigs can be infected by avian influenza and human influenza viruses as well as swine influenza viruses



African Swine Flu

- Double-stranded DNA virus
- The virus causes a hemorrhagic fever with high mortality rates in domestic pigs
- The virus does not affect people and there is no impact on human health.



Bird Flu

- Avian influenza, known informally as avian flu or bird flu, is a variety of influenza caused by viruses adapted to birds.
- The type with the greatest risk is highly pathogenic avian influenza (HPAI). The most well known HPAI strain, H5N1



Lumpy Skin Disease

- Infectious disease in cattle caused by Capripoxvirus
- Also known as Neethling virus
- It is genetically related to the goat pox and sheep pox virus family
- Infects cattle and water buffalo mainly through vectors such as blood-feeding insects
- The disease is NOT zoonotic



Rabies

- Caused by a family of viruses called the lyssaviruses and found in a range of mammals.
- The virus targets the central nervous system and is nearly 100% fatal to the host animal if it succeeds in infecting it.

Vaccines:

- Post-exposure prophylaxis (PEP)
- Pre Exposure Prophylaxis (PrEP)

RABIES: THE FACTS

VIRUS TRANSMISSION

Saliva of infected animals 99% of human cases are caused by dog bites The virus attacks the brain Rabies is **fatal** once symptoms appear **TREATMENT** Morough washing of the wound with soap, and, vaccine

Thorough washing of the wound with soap, and, vaccine injections can avoid symptoms and **save lives. Seek immediate** medical care if bitten.

HOW TO PREVENT RABIES TRANSMISSION FROM DOGS?







VACCINATING DOGS SAVES HUMAN LIVES Rabies is 100% preventable



Vaccinating 70% of dogs breaks rabies transmission cycle in an area at risk

Every dog owner is concerned 4

World Rabies Day
 #rabies

Tuberculosis

- Tuberculosis (TB) is an infectious disease usually caused by Mycobacterium tuberculosis (MTB) bacteria
- Tuberculosis generally affects the lungs, but it can also affect other parts of the body
- Most infections show no symptoms, in which case it is known as latent tuberculosis- can be detected by blood test

In 2019, **10 million people fell ill** with Tuberculosis globally.

Reported number of cases worldwide in 2019:

Understanding the Global Impact of Tuberculosis



95%

of Tuberculosis-related deaths occur in low- and middleincome countries.



In 2019, Tuberculosis (TB) had an estimated

1.4 million deaths worldwide.

Tuberculosis (TB) is caused by bacteria (Mycobacterium tuberculosis) that most often affect the lungs, which is curable and preventable.



Source: World Health Organization





Tuberculosis

- Vaccine: Bacillus Calmette-Guérin (BCG) vaccine
- Treatment requires the use of multiple antibiotics over a long period of time
- Antibiotic resistance is a growing problem with increasing rates of multiple drug-resistant tuberculosis (MDR-TB)

Tuberculosis



Latent infection

Cavitary tuberculosis

Miliary tuberculosis

World Health Organisation released Global Tuberculosis (TB) Report, 2023

➤ Key findings: Global



Reported global number of people newly diagnosed with TB was 7.5 million in 2022.



> TB remained the world's second leading cause of death in 2022 after COVID-19.



Net reduction of TB incidence from 2015- 2022 was 8.7% far from WHO End TB Strategy milestone of 50% reduction by 2025.



> Only about 2 in 5 people with drug resistant TB accessed treatment in 2022.





National Tuberculosis Elimination Programme (NTEP)



National Strategic Plan (NSP)

ensuring quality diagnosis, treatment, and support to every TB patient



Free of cost diagnosis and treatment/

facilities including anti-TB drugs to all TB patients under Revised National Tuberculosis Control Programme (RNTCP)



₹500 per patient per month for the nutritional support to all TB-affected patients under RNTCP







allocated for next 3 years

MyGovIndia

IB H





India's findings

- India, Indonesia and Philippines collectively account for nearly 60% of reduction in number of people newly diagnosed with TB in 2020- 2021.
- India has 27% of world's TB cases

Drug-Resistant TB

- Multidrug Resistance TB (MDR): Resistant to at least isoniazid and rifampicin.
- Extensively drug-resistant tuberculosis (XDR-TB): Resistant to isoniazid and rifampin, plus any fluoroquinolone and at least one of three injectable second-line drugs.
- Totally drug-resistant tuberculosis (TDR-TB): Resistant to all first- and second-line TB drugs.





Steps taken to prevent Tuberculosis

- National Strategic Plan for Tuberculosis Elimination 2017-2025.
- > TB Mukt Panchayat Abhiyan Initiative.
- > Nikshay Poshan Yojana for nutritional support to TB patients.



Disease	COVID-19	MERS	SARS
Disease Causing Virus	SARS-CoV-2	MERS-CoV	SARS-CoV
Order	Nidovirus	Nidovirus	Nidovirus
Family	Coronaviridae	Coronaviridae	Coronaviridae
Sub-family	Orthocoronaviridae	Orthocoronaviridae	Orthocoronaviridae
Genus	Betacoronavirus	Betacoronavirus	Betacoronavirus
Sub-Genus	Serbecovirus	Merbecovirus	Serbecovirus
Date of outbreak	December 2019	June 2012	November 2002
Origin	Wuhan, China	Saudi Arabia	China
Basic Reproductive Number	2.0 - 2.5	0.3 - 0.8	3
Case Fatality Rate	~3.4%	34.4%	9.6 - 11%
Incubation Time	4 - 14 days	6 days	2 - 7 days
Region of spread	Worldwide	28 Countries	29 Countries
Confirmed cases	>100 Million	8098	2519
Deaths	>2 Million	858	774 KIND SERVICES

Corona Virus



SARS-CoV 2 Structure





RECOMBINANT DNA TECHNOLOGY







Treat foreign DNA and plasmid with restriction enzyme and DNA ligase.



Introduce the recombinant plasmid into cultured plant cells.



Regenerate new plant from cultured cells.



XE Recombinant

- XE is a recombinant variant that has characteristics of both the BA.1 and BA.2 strains of the Omicron variant.
- Recombinant viruses arise when two or more strains swap some of their genetic material. A new hybrid virus is born, which typically contains some characteristics of each of the strains
- Three new recombinant lineages of SARS-CoV-2 have been recently designated by the PANGO network and are being monitored — XD, XE, and XF
- PANGO Network Global Consortium of Researchers Provides a system for naming different lineages of SARS-CoV-2



Cancer

- Normal cells show a property called contact inhibition by virtue of which contact with other cells inhibits their uncontrolled growth
- Cancer cells appears to have lost this property
- Tumors- Benign and Malignant





Cancer cell





Cancer cell (tumor)

Tumor with blood vessels



fashion



Autoimmune Disorders

 Autoimmune disorders are those diseases that occur as a result of the body's immune system attacking different cells, tissues, organs or the entire body

Autoimmune Disease: Normal Immune Response: Immune system creates antibodies that attack your own cells. This happens because: 1. An invader, like a virus, enters body A foreign substance 2. Immune cells called resembles bodily lymphocytes create substances antibodies to fight invader Normal body cells become altered virus antibodies Lymphocytes malfunction and make abnormal antibodies vervwel

5 common








Allergy

- Number of conditions caused by hypersensitivity of the immune system to typically harmless substances in the environment
- The underlying mechanism involves immunoglobulin E antibodies (IgE), that release inflammatory chemicals such as histamine





	Hereditary Disorders		
		•	•
Chromosomal Abnormalities	Monogenic Disorders	Mitochondrial disorder	Polygenic Disorders
Down syndrome, Turner syndrome, Klinefelter syndrome.	Albinism, sickle cell anaemia, phenylketonuria, Hutchinson's disease, Tay-Sachs disease, galactosaemia, cystic fibrosis, haemophilia, night blindness.	Leber hereditary optic neuropathy.	Spina bifida (defect of spinal cord), diabetes, blood pressure, heart disorders, asthma, obesity, cleft lip, cleft palate, constricted stomach.



Down's Syndrome

- Condition in which a person has an extra chromosome
- Babies with Down syndrome have an extra copy of chromosome
- Medical Term = Trisomy 21 (Common)
- Dictates how Baby's Body and Brain Develop
- Mildly to Moderately Low IQ
- Slow Speaker





Klinefelter syndrome

- Common genetic condition in which people assigned male at birth (AMAB) have an additional X chromosome
- Symptoms may include breast growth, infertility, osteoporosis and learning difficulties
- Treatments usually involve physical and emotional therapy, as well as hormone replacement





Turner Syndrome

- Condition that affects only females, results when one of the X chromosomes missing or partially missing
- Cause a variety of medical and developmental problems
- Short height, failure of the ovaries to develop and heart defects(sex chromosomes)





Erythroblastosis Fetalis

- Rare pregnancy complication that occurs when a pregnant person's immune system attacks the fetus's RBC
- Happens when **mother** has Rh-negative blood and the **fetus** has Rh-positive blood
- Could cause dangerously low levels of RBC (anemia) in the fetus
- may also develop jaundice (usually within 24 hours of birth)
- newborn may show signs of a potentially life-threatening condition called hydrops fetalis

©ARJUN KR. PAUL How Rh hemolytic disease develops





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Haemophilia

- Inherited bleeding disorder in which the blood does not clot properly
- Can lead to spontaneous bleeding as well as bleeding following injuries or surgery
- Major Concern is Internal Bleeding
- May lead to Organ & Tissue Damage







Hemophilia



Colour Blindness

- Condition where one is unable to see colours in normal way
- Cannot Distinguish between certain colours – RGB
- Rods = Detects Only Light and Dark
- Cones = Detects Colours (Concentrated near centre)
- Happens when one or more colour cones cells are Absent or Not Working or Malfunctioning

Color Blindness







Criss Cross Inheritance

- Type of inheritance in which the genes are passed on from father to daughter and then to her son
- That is from male to female and from female to male (grandson)
- Transmission is from the grandfather to his grandson through his daughter
- Eg. Colour Blindness and Haemophilia





Thalassemia

- Thalassemia is an inherited blood disorder caused when the body doesn't make enough of a protein called hemoglobin
- Not enough Oxygen delivered = Cause Tiredness & Breathlessness
- Mild or Severe Anaemia
- May cause Organ Failure & even death
- Treatment include blood transfusions, iron chelation, and folic acid.





Sickle Cell Anaemia

Sickle cell disease



Normal red blood cells are round and flexible.

Sickle-shaped cells don't pass easily through blood vessels.





In sickle cell disease, red blood cells stiffen, changing shape into sickles (crescent-shaped).

Frequent pain episodes.



Pain affects your child's chest, back, legs and arms most often.

Sickle cell disease symptoms include:

Swelling and inflammation of their joints.

> Painful swelling of their hands and feet.



Anemia, causing fatigue, paleness and weakness.



Jaundice (yellowing of skin and whites of eyes).



BUDGET-2023: INDIA VOWS TO ELIMINATE SICKLE CELL DISEASE BY 2047







Mitochondrial Inheritance

- Mitochondria are the 'batteries' in each cell which provide their energy
- Mitochondria have their own DNA (mtDNA) which encodes 13 of the many proteins used within them
- Unlike nuclear genes, which are inherited from both parents, mitochondrial genes are inherited only from the mother.
- If there is a mutation in a mitochondrial gene, it is passed from a mother to all of her children; sons will not pass it on, but daughters will pass it on to all of their children, and so on
- 3 Major Types of Mitochondrial Replacement Therapy

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Mitochondrial







Spindle transfer





Pronuclear transfer







Figure 5. Polar body 2 (PB2) transfer. PB2 is recovered from pronuclear-stage zygotes. Reconstructed zygotes are produced by transfer of PB2 into recipient zygotes from which the female pronuclei have been removed (upper). Abbreviation: mtDNA, mitochondrial DNA.





#NeglectedTropicalDiseases

Key milestones achieved in India



Act Now. Act Together. Invest in NTDs.

#WorldNTDDay #BeatNTDs



INVEST INDIA.GOV.IN





ELIMINATED FOR GOOD

Diseases eradicated in India

- Smallpox
- Polio
- Yaws
- Rinderpest
- Maternal And Neonatal Tetanus



WORLD POLIO DAY 2021

24TH OCTOBER, 2021

Polio Free India

India marks more than nine years since the last polio case.

Give your child the chance to stand on their own by vaccinating them.



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Plant Diseases

- Plant diseases are diseases in plants caused by pathogens and environmental conditions
- Organisms that cause infectious disease include fungi, oomycetes, bacteria, viruses, viroid, virus-like organisms, phytoplasmas, protozoa, nematodes and parasitic plants
- Not included are ectoparasites like insects, mites, vertebrates, or other pests that affect plant health by eating plant tissues and causing injury that may admit plant pathogens
- The study of plant disease is called plant pathology



Wheat Diseases



Loose Smut – Ustaligo nuda (Fungi)



Smut –*Tilletia (Fungi)*



Rust –*Puccinia (Fungi)*





Rice Diseases



Brown Spot – Bipolaris oryzae (Fungi)

False smut – Ustilaginoidea virens (Fungi)

Tungro– Rice tungro spherical virus (RTSV)





Maize – Banded Lead and sheath blight – *Rhizoctonia solani (Fungus)*



Bajra – Ergot – Claviceps fusiformis (Fungi)



Tobacco – Mosaic Virus– (TMV)





Potato – Late Blight – Phytopthora infestons (Fungi)

Potato – Early Blight – Alternaria solani (Fungi)

Tea – Blister Blight – Exobasidium vexans (Fungi)





Coffee Rust – Hemileila vastatrix

Banana – Panama Disease – *Fusarium oxysporum*



Banana – Bunchy Top – Banana Bunchy Top Virus (BBTV)





Mango – Bunchy top - Fusarium

Mango – Black tip – SO2, CO, Ethylene

Mango – Spongy Tissue – Internal physiological disorder





Apple – Scab – Venturia inaequalis

Sugarcane – Red rot – Colletotrichum falcatum Sandalwood – Spike disease – *Phytoplasma*



Bengal Famine of 1943

- Rice Brown Spot Bengal Famine of 1943
- 8 to 38 Lakh Death
- Due to Starvation, Malaria and other diseases
- Aggravated by Malnutrition, Population Displacement, Unsanitary Condition and lack of health Care



Great Famine of Ireland 1845-52

- Irish people was dependent on potato
- Potato was infected by disease destroying the crop
- Caused due to *Phytopthora infestans*.
- Almost 10 Lakhs people died of starvation or disease due to malnutrition
- More than 20 Lakhs people fled the country
 Population of Ireland fell by 20-25%
 Food were imported from UK and USA



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Digestive System

Esophagus

Carries food from the mouth to the stomach.

Stomach

The organ where digestion of protein begins.

Pancreas

A gland that makes enzymes for digestion and the hormone insulin (which helps the body turn food into energy).

Small Intestine

The organ where most digestion occurs.

Rectum

The lower end of the large intestine, leading to the anus.

Anus

The opening at the end of the digestive tract where bowel movements leave the body.

Liver

The largest organ inside the body. Makes bile (fluid that helps break down fats and gets rid of wastes in the body); changes food into energy; and cleans alcohol, some medicines, and poisons from the blood.

Gallbladder

Stores the bile made in the liver, then empties it to help digest fats.

Large Intestine

Also called the colon. It absorbs water and sodium from stool.

Appendix

A pouch attached to the first part of the large intestine. No one knows its function.

Bile = Bilirubin (Yellow) + Biliverdin (Green) = Brown Faeces Colour

Pancreas = Trypsin (Protein) + Amylase (Carb) + Lipase (Lipid)




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Salivary Glands





GASTRIC MUCOSA	CELL TYPES	SUBSTANCE SECRETED	STIMULUS FOR RELEASE	FUNCTION OF SECRETION
	Mucous neck cell	Mucus	Tonic secretion; with irritation of mucosa	Physical barrier between lumen and epithelium
		Bicarbonate	Secreted with mucus	Buffers gastric acid to prevent damage to epithelium
	Parietal cells	Gastric acid (HCI)	Acetylcholine, gastrin, histamine	Activates pepsin; kills bacteria
		Intrinsic factor		Complexes with vitamin B ₁₂ to permit absorption
	Enterochromaffin- like cell	Histamine	Acetylcholine, gastrin	Stimulates gastric acid secretion
	Chief cells	Pepsin(ogen)	Acetylcholine, acid secretion	Digests proteins
		Gastric lipase		Digests fats
	D cells	Somatostatin	Acid in the stomach	Inhibits gastric acid secretion
	G cells	Gastrin	Acetylcholine, peptides, and amino acids	Stimulates gastric acid secretion





The release of energy during cellular respiration



$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O_2$

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Body Fluids

- Lymph: Colourless Fluid containing specialised lymphocytes responsible for immune response
- Erythrocytes or RBC Most Abundant in Blood
 - Formed in Bone Marrow
 - Devoid of Nucleus (Most mammals) and Biconcave
 - Average Life Span 120 Days Destroyed in Spleen (Graveyard of RBCs)
- Leucocytes WBC
- Thrombocytes Platelets releases variety of substances which helps coagulation or clotting of blood (trauma stimulates to release Fibrinogen and Thrombin – which helps coagulation)



Comparative Anatomy of Vertebrate Hearts









Facts about Heart

- Systolic Pressure = Pressure of Blood during Ventricular Systole (Contraction) = 120 mm Hg
- Diastolic Pressure = Pressure of Blood during Ventricular Diastole (Relaxation) = 80 mm Hg
- ECG = Electrocardiograph = Represents Cardiac Cycle









Excretion

- Ammonia, Urea and Uric Acid Major Forms of Nitrogenous Wastes
- Ammonia Most toxic form (needs large amount of water)
 - Fishes excrete through diffusion process using Gills (Readily Soluble)
- Uric Acid (Least Toxic) Removed by minimum water loss
- Mammals, Amphibians and Fishes mainly excrete Urea
- Reptiles, birds, snails and insects = Excrete nitrogenous waste as Uric Acid in Pallet or Paste form with Minimum water loss







ÐG

Difference Between

Protonephridia



Metanephridia

Excretory system in lower invertebrates

Ex: Platyhelminthes

Flame cells are excretory structures.

Excretory system in higher invertebrates

Ex: Earthworm

Excretory products are filtered and selectively reabsorbed.



INTERNAL ANATOMY OF A CRAYFISH







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- Excessive Fluid Loss > Informs Hypothalamus in Brain > Activates Antidiuretic Hormone
- Glomerular Filtration Rate: 125 ml/min
- Kidney releases Renin (Protease Protein and Enzyme) = Mediates
 Volume of Extracellular Fluid (Blood plasma, Lymph and interstitial
 fluid) and Arterial Vasoconstriction = Regulates Body's mean Arterial
 Blood Pressure
- Haemodialysis = Urea removal process when kidney malfunctions leading to accumulation of urea in blood, a condition called UREMIA
- Renal Calculi = Stones or Insoluble mass of crystallised SALTS (oxalates etc.)



Locomotion and Movement

- Muscle = Myofilaments or Myofibrils (Parallelly arranged filaments)
 - Has alternate Dark and Light Bands
 - Light Band = Isotropic (I) Band
 - Dark Band = Anisotropic Band = Contains Myosin
 - Calcium Ion = Essential for muscle movement
- 206 Bones (Adult)
 - Ear = 3 Tiny Bones = Malleus, Incus and Stapes = Ear Ossicles (collectively)
 - Femur = Longest Bone
 - Synovial Joints = Fluid filled synovial cavity between 2 bones
 - Arthritis = Inflammation of Joints
 - Osteoporosis = Age Related Bone disorder = Decreased Bone Mass = Fracture
 - Gout = Inflammation of Joints due to accumulation of Uric Acid Crystals





Central Nervous System

Composed of:

- Brain : Cerebrum and Cerebellum
- · Spinal cord

Contains:

 Relay neurons (interneurons)



Peripheral Nervous System

Composed of:

- Cranial nerves
- Spinal nerves
- Peripheral nerves

Contains:

- Sensory neurons
- Motor neurons



What Does the Peripheral Nervous System Do?



Connects the central nervous system to the organs, limbs, and skin



Allows the brain and spinal cord to receive and send information to other areas of the body



Carries sensory and motor information to and from the central nervous system



Regulates involuntary body functions like heartbeat and breathing





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Cerebrum Cerebellum Brain stem (Medulla Oblongata)

Brain stem

- Changes in heart rate
- Breathing, blood pressure, vomiting, swallowing
- Digestion

Cerebrum

- Intelligence, learning, judgment
- Speech and memory
- Sense of hearing, vision, taste and smell
- Skeletal muscle movements

Cerebellum

- Balance and coordination
- Posture





Posture





Cell body

(soma)



Dendrites (from another neuron)

Axon

(receive messages

from other cells)

Dendrites

(passes messages away from the cell body to other neurons, muscles, or glands)

Action potential (electrical signal traveling down the axon)

Myelin sheath

(covers the axon of some neurons and helps speed neural impulses) Enveloped in Schwann Cells

Terminal buttons

(form junctions with other cells)

Gaps b/w are called nodes of Ranvier

PARTS OF A NEURON



Receive signals from other neuron cells.

DENDRITES

CELL BODY Contains the cell nucleus.

NUCLEUS

Contains the genetic material (chromosomes) of the neuron cell.

AXON Conducts electrical impulses along the neuron cell.

MYELIN SHEATH

Insulates the axon to help protect the neuron cell & speed up transmission of electrical impulses.

AXON TERMINAL

Transmits electrical & chemical signals to other neuron cells & effector cells. Synaptic Knob contains chemicals called Neurotransmitter (acetylcholine)

- Sodium and Potassium Ions are important for nerve impulse
- Nose: Olfactory Receptors
- Tongue: Gustatory Receptors







Parkinson's Disease

- Neurodegenerative Disorder that affects the nervous system, primarily the parts controlling movement
- Damages nerve cells in an area of the brain called the substantia nigra
 - These cells produce Dopamine Vital Chemical Messenger that helps control movement
 - Low Dopamine Level = Impaired Brain Signals to Muscle

• Symptoms:

- •Tremors, typically starting in one hand
- Stiffness or rigidity of muscles
- •Slowed movement (bradykinesia)
- Difficulty with balance and coordination

•Other Symptoms:

- Fatigue
- •Sleep problems
- •Mood changes, including anxiety or depression
- •Cognitive problems, like thinking or memory loss
- Speech problems
- •Pain
- •Bladder problems

Stages of Parkinson's Disease

Stage 1: Develop mild symptoms but able to go about day-to-day life Stage 2: Symptoms such as tremors and stiffness begin to worsen, may develop poor posture or have trouble walking Stage 3: Movement begins to slow down, loss of balance



Stage 4: Symptoms are severe and cause significant issues with day-to-day living, unable to live alone and will need care

verywell

Stage 5: Walking or standing may be impossible at this point, people at this stage are often confined to a wheelchair or bed ©ARJUN KR. PAUL





Parkinson's Disease Symptoms



London Neurosurgery Partnership

Dementia

An umbrella term used to describe a collection of brain diseases and their symptoms, which include: memory loss, impaired judgment, personality changes, and an inability to perform daily activities.

Alzheimer's

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Prevalence 60-70% of dementia cases

Characterized by Amyloid plaques and beta tangles.

Symptoms include Impairments in memory, language, and visuospatial skills. Vascular Dementia

Prevalence 10-20% of dementia cases

Characterized by Disease or injury to the blood vessels leading to the brain.

Symptoms include Impaired motor skills and judgement. Frontotemporal Dementia

Prevalence 10% of dementia cases

Characterized by Deterioration of frontal and temporal lobes of the brain.

Symptoms include Personality changes and issues with language. Lewy Body Dementia

Prevalence 5% of dementia cases

Characterized by Lewy body protein deposits on nerve cells.

Symptoms include Hallucinations, disordered sleep, impaired thinking and motor skills. Contraction Other Dementias

Prevalence 5% of dementia cases

Dementias related to

- Parkinson's disease
- Huntington's disease
- HIV
- Crutzfeldt-Jakob disease
- Korsakoff syndrome

Alzheimer's Disease (AD)

The symptoms of AD involve a gradual decline in some, most or all of the following:





Schizophrenia Symptoms

Because of these symptoms, you may:





Unusual or extremely slowed movements.

Incoherent or disorganized speaking.



Hallucinations, usually related to hearing voices or strange sounds.







Feel suspicious, N paranoid or afraid frequently.

Not care about hygiene and appearance.

Have depression, anxiety and suicidal thoughts.



Delusions: false beliefs that remain unchanged despite contradicting evidence.



Isolating behavior or emotionless facial expressions or speech.



Use alcohol, nicotine, prescription medications or recreational drugs to "self-medicate" symptoms.


Types Of Schizophrenia



3

Paranoid schizophrenia

Symptoms include hallucinations and/or delusions.

Disorganized schizophrenia

This subtype is marked by disorganized speech and behavior.

Catatonic schizophrenia

Associated with multiple psychomotor abnormalities and behavioral dysregulation.

Undifferentiated schizophrenia

Includes lack of emotional depth, and ideation is simple and refers to concrete things.

Residual schizophrenia

It is the recovery phase as severe symptoms usually begin to reduce or fade.











Endocrine Glands	Exocrine Glands	
Glands pour their secretions directly into the blood streams.	Glands do not pour their secretions into the blood streams . They have their own ducts .	
Do not utilize ducts to transport hormones to the target cells, organs, etc.	Depends solely on ducts for the transportation of its secretions to the target cells or organs.	
Transportation of the hormones is slower than the exocrine system .	Transportation of secretion is faster than that of the endocrine system .	
Endocrine glands secret hormones .	Exocrine glands secret enzymes .	
Glands have slow response on the target's sites.	Glands have comparatively faster response on the target sites.	
Example: Thyroid Gland, Liver, Pituitary Gland, Thalamus Gland, etc.	Example: Salivary Glands, Pancreas, Liver, Sebaceous, etc.	

Endocrine System Male-Female











Presented By Arjun Kr. Paul



XYLEM AND PHLOEM











20% solute concentration (80% water) but of the cell 40% solute concentration (60% water)

a

Isotonic solution

A solution that has the *same* solute concentration as another solution. There is no net movement of water particles, and the overall concentration on both sides of the cell membrane remains constant.

b Hypertonic solution

A solution that has a *higher* solute concentration than another solution. Water particles will move out of the cell, causing crenation.

Cell Shrink

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20% solute concentration (80% water) (80% water) (80% the cell

10% solute concentration (90% water)

Cell Swell



Hypotonic solution

A solution that has a *lower* solute concentration than another solution. Water particles will move into the cell, causing the cell to expand and eventually lyse.



Imbibition

- Process where a solid material absorbs a liquid, causing the solid to swell in size due to Adhesion and Capillary Action
- Specific type of diffusion and is especially important for things like seeds and plant life
- Liquid Absorption: The key aspect is the absorption of liquid, typically water, by a solid substance
- **Examples:** Common examples include:

•Seed Germination: Dry seeds imbibe water, which plumps them up and initiates the germination process.

•Wooden Objects: Wood can swell and warp due to imbibition of moisture from the environment.

•Foodstuffs: Rice and beans increase in size when cooked due to imbibition of water.













Water Molecules

Equilibrium

Diffusion

- Movement of molecules from a region of high concentration to a region of low concentration
- Concentration Gradient: Molecules move from the crowded (high concentration) area to the less crowded (low concentration) area

• Examples

- Perfume Scent
- Food Colouring
- Cell Respiration
- Two Types:
 - Simple Diffusion: Inherent Random Motion of Particles
 - Facilitated Diffusion: Requires Assistance of Protein Channels or Carriers within membranes to pass through. Important to Transport large or charged molecules across cell membranes







Osmosis

- Specific type of diffusion that involves the movement of water across a semi-permeable membrane to equalize concentration
 Solvent Movement: Stops solutes from migration, but allows water.
 Concentration Gradient: Low to High Solute Concentration
 Semi Permeable Membrane: Allows only water molecules
 Examples: Raisins Rehydration and Dialysis
 Functions:
 - Cell Function: Water balance within cells
 - Plant Cell: Turgor Pressure helps maintain plant's structure & rigidity



Diffusion	Osmosis	Imbibition
Movement of Ions Molecules of Solid, Liquid or Gas from High to Low Concentration	Absorption of Water by General Surface	Movement of only water or solvent from High to Low Concentration Area
Occurs in all states of matter	Happens only in Liquid State	Happens in Liquid State
Irreversible	Irreversible	Reversible
No need of Semi Permeable Membrane	Requires Semi Permeable Membrane	Absorbent is involved but there is no membrane
Takes place in Solid, Liquid and Gases	Takes place only for the Solvent part of Solution	Takes place in both living and dead cells



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- Tendency of dissimilar materials to cling to one another at their surfaces
- Why?
 - Van der Waals Forces
 - Hydrogen Bonding
 - Ionic Bonding
 - Mechanical Interlocking
- Examples: Glue & Tape, Gecko Feet, Water on a Lead
- 3 Types: Mechanical, Chemical and Physical
- Applications: Manufacturing, Biomedical Use, Coatings and Paints

Cohesion

- Tendency of like particles or molecules to stick together
- Intermolecular Forces: Cohesion is driven by attractive forces between similar molecules
 - Van Der Waals Forces
 - Hydrogen Bonding
- Examples:
 - Water Droplet
 - Surface Tension
 - Strength of Solids
 - Capillary Action in Plants













Adhesion vs Cohesion



Adhesion Cohesion **Different molecules attract** Like molecules attract each each other other

Tape sticks to paper because of adhesion.

Mercury forms beads on surfaces because of cohesion.











Chlorosis

- Loss of Chlorophyll leading to Yellowing of Leaves
- Due to deficiency of Nutrients like Nitrogen, Potassium, Magnesium, Sulphur, Iron, Manganese, Zinc & Molybdenum



Necrosis

- Death of Tissue due to Nutrient Deficiency
- Calcium, Magnesium, Copper, Potassium
- Lack of low level of Nitrogen, Potassium, Sulphur, Molybdenum





Azotobacter & Beijerinckia (Aerobic)





ROOT NODULE SYMBIOTIC BACTERIA

ASSOCIATIVE NITROGEN-FIXING BACTERIA

FREE-LIVING NITROGEN-FIXING BACTERIA Rhodospirillum (Anaerobic)

Nitrogen Fixing Bacteria





Process of Photosynthesis



STOMATA







Sciophytes

Heliophytes









Thank You Future Officers!

Presented by Arjun Kr. Paul



Semiconductors



Introduction

- Conductivity between Metal and Insulator
- Conducts electricity under certain conditions
- At 0 K = Insulator, With Increasing Temperature = Conductor
- Enables conduction in Controlled Manner
- Eg. Gallium, Arsenide, Germanium and Silicon
- Works on Valence Band Theory



Valence Band Theory



Insulators, semiconductors and conductors are formed based on the size of the forbidden gap





Intrinsic Semiconductors

- Single Element Only
- Germanium or Silicon
- Increased Temperature = More Collisions = Electrons becomes free





Extrinsic Semiconductors

N Type:

- Doped using Pentavalent Impurity
- Phosphorus (P), Arsenic (As), Antimony (Sb), Bismuth (Bi)

Р Туре

- Doped with Trivalent Impurity
- Boron (B), Aluminium,
 Indium (In), Gallium (Ga)

EXTRINSIC SEMICONDUCTORS





Applications

- Electronic Devices
- Transistors, MOSFETs, Diodes, Photosensors, Microcontrollers, IC
- Transistors and MOSFETs = used as Switch
- Space, Automobiles, Mobile Phones, LEDs, Solar Panel etc.

Semiconductor Devices


LED – Light Emitting Diode

- Heavily doped p-n junctions
- Current Flows in forward direction only = forward bias
- LED Colour depends on Material used and Spectral Wavelength emitted = Electroluminescence
- UJALA Scheme 40% Discount
- Blue LED Shuji Nakamura, Japan





Moore's Law



intel



Number of Transistors in an integrated circuit doubles about every two years



Integrated Device Manufacturer (IDM)

- Is a Semiconductor Company = Design + Manufacture + Sell
- Fabless Manufacturing = Outsource Production, Concentrate on R&D and Designing Eg. TSMC manufactures Chips for many companies like MediaTek, AMD, Qualcomm, Broadcom, Sony, and Marvell
- Pure Play Foundries: Operates semiconductor fabrication plants focused on producing ICs for other companies Eg. TSMC
- OSAT Outsourced Semiconductor Assembly and Test = Assembly, Testing and Packaging



THE SEMICONDUCTOR MANUFACTURING ROAD MAP FOR INDIA

COLLABORATION

Multiple Small Companies Collaborating To Form JV To Fund And Drive Development Of Semiconductor Fabrication To Assembly.

CLUSTER APPROACH

Dedicated Cluster With Large Semiconductor Manufacturing FABs That Cater To Different Industries.

OSAT TO SUPPORT FAB

Slowly Creating Network Of Small OSATs That Can Drive The Testing And Assembly Requirements.

COUNTRY SPECIFIC FAB

Focusing On Semiconductor Fabrication Technology That Is Affordable To Build And Is Also High On Demand.

PRIVATE PLAYERS

Investment From Private Players By Taking Advantage Of Government Incentives And Schemes.





Programme for Development of Semiconductors and Display Manufacturing Ecosystem

- Scheme for Setting up Semiconductor FABs
- 2. Scheme for Setting up Display FABs
- 3. Scheme for Setting up Compound Semiconductors/Silicon Photonics/Sensors
- 4. Design Linked Incentive Scheme DLI
- 5. Infrastructure Development





INDIA SEMICONDUCTOR MISSION

Scheme for Semiconductor Fabs





Nanotechnology





History of Nanotech

- 1959 Richard Feynman = Father of Nanotechnology
- 1974 Norio Taniguchi = 1st used the term Nanotechnology
- 1991 Discovery of Carbon Nanotubes
- 1996 Nobel Prize for Discovery of Fullerenes
- 0.1 and 100 nanometres (nm) in size with 1 nm being equivalent to one billionth of a metre (10⁻⁹ m)





Why Nanotech?

- Conventional Technology Limitations:
 - Larger Size
 - Problem in Maintenance
 - Formation of by product
 - Not 100% efficient and environmental problems

Advantages of Nanotechnology:

- EMF Electromagnetic Force Dominant
- Quantum Mechanics is observed
- Increased Surface Area = Change in Physical and Chemical Properties
- Eg. Zinc becomes transparent and Gold becomes Red at Nano level



Applications of Nanotechnology











Graphene

- One-atom-thick sheet of carbon atoms
- Honeycomb-like pattern
- World's thinnest, strongest and most conductive material - both electricity and heat
- Harder than Diamond and 300x Stronger than Steel







Carbon Nanotubes

- Rolled-up sheets of single-layer carbon atoms (graphene)
- Can be single-walled (SWCNT) with a diameter of less than 1 nanometer (nm) or multi-walled (MWCNT) with diameter more than 100 nm
- Properties High surface to volume ratios, enhanced conductivity and strength, biocompatibility, etc.
- Applications Rechargeable batteries, flexible electronics, aerospace, energy research, biomedical fields, stain resistant textiles, air and water filters, thermal materials and optoelectronics
- Synthesis of CNTs by Plasma Enhanced Chemical Vapour Deposition (PECVD) technology

Consider the following statements:



- 1. Other than those made by humans, nanoparticles do not exist in nature.
- 2. Nanoparticles of some metallic oxides are used in the manufacture of some cosmetics.
- 3. Nanoparticles of same commercial products which enter the environment are unsafe for humans.

Which of the statements given above is/are correct? (UPSC 2014)

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



Ans: (d) 2 and 3

A nanoparticle is a small particle that ranges between 1 to 100 nanometers in size. They could be generated by natural processes or could be made artificially and released into the environment.



Fullerene

- Discovered in 1985, cage like structure with even Carbon atoms
- Infinite number of Fullerene can exist like C₆₀, C₇₀, C₈₀, and C₉₀
- Structure of fullerenes can change under different pressures
- Fullerenes are stable, but not totally unreactive.
- In chemical reactions, fullerene can act as an electrophile.
- 2 Types = Closed Buckyballs and the Open-ended Cylindrical Carbon Nanotubes



- It acts as an electron-accepting group and is characterized as an oxidizing agent
- Fullerenes when doped or crystallized with alkali or alkaline earth metals showcases superconductivity properties
- Fullerene is ferromagnetic
- Some fullerenes are inherently chiral (non-superimposable)
- It is soluble in organic solvents such as toluene, chlorobenzene, and 1,2,3-trichloropropane

Model of the C60 Buckminster Fullerene





Fullerene





Potential Applications of Fullerenes











Negative impact of Nanotechnology on environment

One of the major negative impact of nanotechnology on environment is Nanopollution.

Nanopollution : It is a generic name for waste generated by Nanodevices or during the nanomaterials manufacturing process.

Ecotoxicological impacts of nanoparticles and the potential for bioaccumulation in plants and microorganisms is a subject of current research, as nanoparticles are considered to present novel environmental impacts.

Of the US\$710 million spent in 2002 by the U.S. government on nanotechnology research, \$500,000 was spent on environmental impact assessments.

Golden Sandwich

- Harvest 85% Visible Light
- 11x More Efficient than Solar Panels
- Gold Film works as mirror and traps light in cavity
- Enhance light absorption







Nano Mission

- Umbrella Programme For capacity building & overall development.
- Aim & Objective: Create Basic Infrastructure for R&D
 - Research Promotion
 - Infrastructure Development
 - Human Resource Development
 - International Collaboration



- 2001-2006 Nanoscience & Technology Initiative (NSTI) by Dept. of S&T (DoST)
- 2007 Nanoscience & Technology Mission (NSTM) = Nano Mission



- Achievements
 - 23000+ Research papers published = 3rd in World (1st China, 2nd USA)
- Concerns
 - Funding Crunch
 - Career Prospects Limited
 - Private Sector Contribution is Minimal







Energy





Energy: Introduction

- Energy is the capacity for doing work. It may exist in potential, kinetic, thermal, electrical, chemical, nuclear, or other forms
- Conventional : Generally Non-Renewable Sources
 - Coal, Petroleum, Natural Gas, Electricity etc.
- Non-Conventional: Renewable Sources
 - Renewed through Natural Process continuously
 - Inexhaustible, Non-Polluting, Generating at Constant Rate
 - Eg. Wind, Solar, Tidal, Geothermal, Biomass etc.





IEA – International Energy Agency Map The star

Member countriesAccession countriesAssociation countries



τ.



International Energy Agency (IEA) 💆

- 1. Established in 1974 after 1973 Oil Crisis
- 2. HQ Paris
- 3. Intergovernmental Autonomous Organisation
- 4. Provides Information related to International Oil Market and takes action against oil disruption.
- 5. Publishes WORLD ENERGY OUTLOOK REPORT
- 6. India Associate Member since 2017
- 7. Policy Adviser 30 Member & Non-Member countries including China, India and Russia



Solar Energy

- PM Modi's vision of making India a solar energy hub = Saffron Revolution
- Solar energy is harnessed by:
 - 1. Photosynthesis
 - 2. Photovoltaic Electricity
 - 3. Solar Thermal Electricity








SOLAR THERMAL POWER PLANT





Polymethylmethacrylate (PMMA) doped with luminescent elements – organic dyes, quantum dots or RER



Luminescent Solar Concentrator



With reference to technologies for solar power production, consider the following statements: (2014)

- 1. 'Photovoltaics' is a technology that generates electricity by direct conversion of light into electricity, while 'Solar Thermal' is a technology that utilizes the Sun's rays to generate heat which is further used in electricity generation process
- 2. Photovoltaics generates Alternating Current (AC), while Solar Thermal generates Direct ' Current (DC).
- 3. India has manufacturing base for Solar Thermal technology, but not for Photovoltaics,
- Which of the statements given above is/are correct?
- A. 1 only
- B. 2 and 3 only
- C. 1, 2 and 3
- D. None





ANS: (A) = 1 only

- The first statement is correct. Photovoltaics is a system that converts light directly into electricity using materials which exhibit the photovoltaic effect. Solar thermal technology, on the other hand, harnesses heat from the sun`s rays, which can then be used to produce electricity in a conventional steam turbine.
- The second statement is incorrect. Photovoltaics actually generate Direct Current (DC), not Alternating Current (AC). The DC electricity generated by photovoltaic cells must be converted to AC for use with commercial appliances or for feeding into the grid. On the other hand, solar thermal produces AC through a standard generation process.
- The third statement is also incorrect. India does indeed have manufacturing for both solar thermal technology and photovoltaics. In fact, India is a global leader in the production of photovoltaic cells.
- Therefore, only statement 1 is correct making Option 1 the best choice



National Solar Mission

- Jawaharlal Nehru National Solar Mission – Jan, 2010
- Ministry MNRE, Ministry of New and Renewable Energy
- 20 Million KM2 Solar Thermal Collector Area by 2022
- 20 Million Solar Lighting System Rural by 2022
- Rs. 15000 Cr+ Subsidy
- National Clean Energy Fund Clean Energy Cess = Per Tonne of Coal sold
 - Polluters Pay Principle

National Solar Mission making India brighter and smarter

Modi Govt sets target of 1,00,000 MW grid-connected solar power by Dec 2022



Total grid-connected solar power generation capacity of 31,696 MW set up



Projects of capacity 17,998 MW at various stages of installations



Tenders for 36,278 MW capacity projects issued already



Total funds released by Govt: 8,518 crores (from 2016- 2019)

3 Phases NSM



- Phase I (2010 2013):
 - Target for grid-connected PV (including rooftop) target: 1 000 MW
 - Target for off-grid solar PV applications: 200 MW
- Phase II (2014 2017):
 - Grid-connected solar PV Target (including rooftop): 4 000 10 000 MW
 - Off-grid solar PV: 1 000 MW
 - Solar Parks and Ultra Mega Solar Power Projects to target 40 GW
- Phase III (2017 2022):
 - Grid-connected solar PV Target(including rooftop): 100 000 MW
 - Off-grid solar PV : 2 000 MW



SARAL Index

- State Solar Rooftop Attractive Index
- Ranking States on Performance
- Designed by MNRE, ASSOCHAM, SSEF & Ernst & Young



Digital Technology



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3D Printing

- Also known as Additive Manufacturing (AM)
- Successive Layering of Materials
- Plastics, Composite or Bio-Materials
- Design Flexibility + Reduced Waste + Complex Geometries
- Various Types:
 - Inkjet
 - Fused Deposition Modelling
 - Stereolithography
 - Selective Laser Sintering
 - Electron Beam Melting
 - Laminate Object Manufacturing
 - Digital Light Processing







- Fused Deposition Modelling (FDM)
- Filament Freeform Fabrication (FFF)
- Fused Filament Fabrication (FFF)

Uses Continuous Filament – Thermoplastic Material

FDM EXTRUDER ASSEMBLY



What is 3D Printing?

Structuring a three-dimensional object in its physical configuration from its digital form.



ADEMY OF

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FROM CONCEPT TO PRODUCT

3D Innovations









CONCEPT

3D CAD 3D Modeling Conceptual Design Modeling Photorealistic Rendering

DESIGN/PROTOTYPE MANUFACTURING

Product Development solutions Product Design 3D Design/Engineering Functional Design Design For Manufacturability [DFM] 3D Printing/Rapid Prototyping Low Volume Production parts High Volume Production parts Injection Molding Rotational Molding CNC Machining Metal Forming Sheetmetal Cast Urethane Silicone/Plastic/Metals

PRODUCT

Packaging Design Marketing solutions Graphic Design Product Promotion



4D Printing

- Additive Manufacturing Process
- Changes shape with time, temperature, humidity, light & pressure
- Dynamic Structure
 - Adjustable Shape, Properties and Functionality
 - Self Assembly, Self Repair, Multi Functionality
- Material Used:
 - Hydrogel
 - Resins
 - Active Polymers
 - Live Tissues etc.







Forecasts for 2022



4D printing will grow by **162 million** - an increase of 39% - at a global level.

North America, Europe and the Asia-Pacific region will dominate the markets.





The large manufacturers of **3D printers** will lead the way.

It will have uses in construction, defence, textile, automotive, aerospace industry, health, etc.





Materials such as carbon fibres, wood and programmable fabrics will be used.

The invention of new 4D products that benefit the consumer is planned.





The rise of **environmentalism** and **sustainability** will stimulate market growth.

4D printing will reduce resource consumption and energy expenditure in industry.





NFC (Near Field Communication)

- Technology that allows two devices like your phone and a payments terminal — to talk to each other when they're close together
- Both devices must contain NFC chips, as transactions take place within a very short distance
- transmits data through electromagnetic radio fields, to enable communication between two devices
- either physically touching or within a few centimeters from each other
- difficult for attackers to record the communication between the devices compared to other wireless technologies







RFID (Radio Frequency ID)

- Uses radio waves to automatically identify various tagged objects
- Wireless tracking method that uses tags and readers to track objects
- Low Frequency, High Frequency, and Ultra-High Frequency bands are used by RFID systems
- Complicated and difficult to replicate or counterfeit



Basic RFID System





Computer Database

Data is transmitted into the RFID database where it can be stored and evaluated.



RFID Tag

Attached to assets to transmit stored data to the antenna.

Antenna

Receives the stored data from the tag and transmits that data to an RFID reader.





Radar Speed Gun





Radar Speed Gun

- Used to measure speed of moving objects
- Law Enforcement Use + Sports
- Doppler Effect





Lidar

- Light pulses—combined with other data recorded by the airborne system — generate precise, three-dimensional information about the shape of the Earth
- Three primary components of a LiDAR instrument the scanner, laser and GPS receiver
- Two types of lidar:
 - Topographic lidar: It typically uses a near-infrared laser to map the land.
 - Bathymetric lidar: It uses water-penetrating green light to also measure seafloor and riverbed elevations.





How LiDAR Works?

- A LiDAR system measures the time it takes for emitted light to travel to the ground and back.
- That time is used to calculate the distance travelled.
- Distance travelled is then converted to elevation
- Applications:
 - High Resolution Maps
 - Surveying
 - Geology
 - Forestry etc.
- LASER = Light Amplification by Simulated Emission of Radiation







Aadhar

- 12 Digit Unique Identity Number issued by UIDAI
- Proof of Identity linked to Biometric and Demographic Information
- Launched in 2009
- Features:
 - Virtual ID 16 Digit Random Number mapped to Aadhar
 - Masked Aadhar Only last 4 Digits visible
 - OTP Based Authentication
 - Tokenisation of Aadhar Unique for each agency



Aadhar

• Significance:

- Facilitating the delivery of government services and benefits
- Reducing fraud and leakage in government welfare programs
- Facilitating financial inclusion
- Making it easier to verify the identity of an individual
- KYC verification

- Limitations & Concerns
 - Biometric authentication
 - Unreliable demographic details
 - Security risks
 - Can't Confirm 'Residents'
 - Private entity's use
 - Exclusions from social benefits
 - Privacy
 - Issue with Aadhaar metadata
 - Lack of Informed Consent
 - No Option to Exit



UPI

- Real Time Payment System NPCI
- Launched on April, 2016
- Enable Peer to Peer Inter Bank
 Transfers
- 2 Factor Authentication Process
- Benefits:
 - No A/C Number required
 - Mobile Number
 - QR Code
 - Virtual Payment Address
 - No Bank details required
 - Cross Operability

Benefits:

- No Transaction Costs
- Push and Pull Transactions
- Bharat Bill Payment Service
- Uses IMPS and AEPS
- Works with Peer to Peer Requests



Blockchain Technology

- Decentralised Digital Ledger System
- Allows Parties to securely and transparently record and store information
- Removes intermediaries like Banks or Financial Institutions
- Uses cryptographic algorithms
- Secure and Tamper proof ledger
- Verified and Recorded by Network of Participants
- Any change in Ledger Must be Approved by Network Participants
- Associated with Crytocurrencies Eg. Bitcoin, WazirX etc.



Blockchain Technology

- 5 Key Features:
 - Decentralisation
 - Immutability
 - Transparency
 - Security
 - Smart Contracts
 - Cost Reduction

Future:

- Increased Adoption
- Interoperability
- Scalability
- Security
- Integration with other Technologies



Over the Top (OTT) Platforms

- Audio & Video Hosting and Streaming Services
- Uses AI to Suggest Content to Users
- Offers some free content and rest charged
- Monthly Subscription Fee for Premium
- Premium Content = Produced and Marketed by OTT
- Examples: Netflix, Amazon Prime, Disney Hot star, Jio Cinema etc.
- Regulated by IT Rules, 2021
- Soft Touch Self Regulatory Architecture with 3 Tier Grievance Redressal Mechanism





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Web1.0

1990-2005

Html

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- Java & Javascript
- Basic Web Pages
- Ecommerce



Web2.0

- Global Internet Access
- Apps
- Mobile Access
- User Generated Content
- Social Media
- High Quality Camera
- Corps Monetize Your Data
- High Speed Communication



Web 3.0

- Permissionless Blockchains
- dApps
- NFTs
- VR&AR(Metaverse)
- Artificial Intelligence
- Interoperability
- Users Monetize Their Data

2006-PRESENT




Web 1 vs. Web 2 vs. Web 3

	Web 1.0 Basic Encyclopaedias	Web 2.0 Social Networks	Web 3.0 Assistants, Clouds		
Content	Static, read-only content	Shared, dynamic content	Content-connection based trough search and analysis		
Interaction	(Almost) no interaction	User interaction via social media	Al-driven services		
GARILIN KR PAUL	Company based	Community based	Individual based		

ACADEMY OF CIVIL SERVICES

Web 4.0

Artificail Intelligence

Brain Computer Interfaces

 Web 4 is still an underground idea in progress and there is no exact definition of how it would be

Web 4 is also known as symbiotic web of human and machines

 It will be possible to build more powerful interfaces such as mind controlled interfaces

User Friendly

Assistive Technologies

Internet of Things



Web Evolution

 Emotional Interaction – Human and Computers

Web

1.0

Web

0.0

Based on Neurotechnology

2020 : Emotional Web

Web

2.0

read-write-execution-concurrency web

Web

3.0

- Open, Linked and Intelligent Web.
- communicates with us like we communicate with each other
- perceive the users feel and emotions.
- facial recognition , personal assistant



Web

4.0

NFT (Non Fungible Token)

Non interchangeable unit of data stored on a blockchain, a form of digital ledger, that can be sold and traded

• No standard value and cannot be exchanged into smaller equal values

Digital certificates provided

 Types of NFT data units may be associated with digital files such as photos, videos, audio digital painting and tweets as well





While every Bitcoin is **identical**, non-fungible tokens are **unique**.



NFTs are like plane tickets – they all look the same, but each have a different seat and destination.



Non-fungible tokens are ideal for creating digital versions of collectibles like **art** and **trading cards**.



Other use cases include digitizing our **identities** and proving ownership of things like **real estate**.



NFTs are often based on the Ethereum blockchain, in the form of ERC-721 tokens.



These tokens can be bought and sold on second-hand marketplaces.







Three. Two. Online

How a VPN Works







Virtual Private Network

- A Virtual Private Network is an encrypted network created over a public network(usually the internet) for a remote user (usually a company)
- Used for safe transmission of data
- It prevents unauthorized people from eavesdropping on the traffic and allows the user to conduct work remotely
- VPN technology is widely used in corporate environments



Encryption/Decryption



1. John uses Mary's public key to encrypt the email and sends it to Mary.



2. Upon receiving the email, Mary decrypts the email with her own private key.



Public Key Infrastructure

• A set of roles, policies, hardware, software and procedures needed to create, manage, distribute, use, store and revoke digital certificates and manage public key encryption







Application Programming Interface



Working of API



End User End user, i.e, you will get all the required information on your app screen. Developers

Developers will design the app such that it could access the data stored in databases/assets via APIs. API will connect with assets/databases to access required information/data and send to the app.

API

Assets (Database)

The data and software of the other brands will be used for offering third-party services.







What is an **API?**

A set of protocols that allow different software applications to communicate and exchange data.



The surface, dark and deep web explained



SURFACE WEB:

Everyday websites that can be indexed by search platforms, such as Google, Yahoo and Bing Examples: blogs, social media platforms, government sites, and more 4% of the Internet

DEEP WEB:

Non-indexed websites accessible through mainstream browsers usually protected by a password or firewall Examples: banking information, confidential employee intranets, email platforms, and more 90% of the Internet

DARK WEB:

Portion of the internet that is intentionally hidden and anonymous, only accessible using the Tor browser. Commonly used for a mix of legal and illegal activities and should only ever be access with extreme caution. **6% of the Internet**





Types of Cybercrime



Malware

RansomwareViruses

Worms

Spyware



BotsDoS (denial of service)

DDoS (distributed denial of service)

Credential theft





🗖 Phishing 💦 🗖 Swatting

Baiting



Physical cyberattacks

USB driver with virus

Identity theft

Attacker pretends to be an employee



Types Of Cyber Crime





IT Rules, 2021

SOCIAL MEDIA

Identify 'first originator' of content that authorities consider anti-national

- Appoint grievance officer, resolve complaints in 15 days
- File monthly compliance report on complaints received, action taken

DIGITAL NEWS

- Follow Press Council of India, Cable TV Networks (Regulation) Act norms.
- Self-regulatory bodies to oversee adherence to Code of Ethics
- I&B Ministry to form panel, oversight mechanism

OTT PLATFORMS

Self-classify content into five age-based categories: U (universal), U/A 7+ (years), U/A 13+, U/A 16+, and A.

Parental locks for any content classified as U/A 13+ or above.

Age verification mechanism for content classified as 'A' (adult)

SOCIAL MEDIA

Rules Seek To Empower Users Of Digital Platforms & Ensure Accountability

 Tighter timelines to take down unlawful content, assist law enforcement

2] Identify first originator of a message that causes identified offence

 Stricter rules for bigger platforms, including local presence

4] Voluntary user verification mechanism

DIGITAL MEDIA & OTT PLATFORMS

Seek to address concerns over digital content through.... E

- 1] Self regulation & self-classification of content universal, adult etc
- 2] Code of ethics -To follow prescribed guidelines
- dressal mechanism 4] Subjects digital news media to same laws as

3] Three-tier

grievance re-

traditional media

IN CASE OF NON COMPLIANCE ...

Intermediary will lose its safe harbour from user content

Liable to punishment under IT Act or IPC



National Cyber Security Policy

- Framed by Ministry of Electronics and IT Government in 2013.
- Vision : To build a secure and resilient cyberspace for citizens, businesses and Government.
- Mission : To protect information and information infrastructure in cyberspace, build capabilities to prevent and respond to cyber threats, reduce vulnerabilities and minimize damage from cyber incidents through a combination of institutional structures, people, processes, technology and cooperation.



National Cyber Policy 2013

- Set up of 24x7 national critical information infrastructure protection centre for protecting critical infrastructure of the country
- Creating a task force of 5,00,000 cyber security personnel in the following 5 years
- Providing schemes and benefits to businesses for adoption standard security practices
- Designate CERT-In as the national nodal agency to coordinate cyber security related matters
- Develop dynamic legal framework to address cyber security challanges
- Point to be noted : This policy is only defensive and Responsive in nature and not oftensive



INVEST INDIA.GOV.IN

National Digital Communications Policy 2018

Key objectives to be achieved by 2022

((())) _____ Provisioning **broadband access** for all



Creating **4 Mn additional jobs** in the digital communication sector



Propelling India to **top 50 nations** in ICT Development Index



Enhancing the contribution of the digital communication sector to 8% of GDP from ~ 6% in 2017

Source: Annual Report 2019-20, Department of Telecommunications

CABINET APPROVES

NATIONAL DIGITAL COMMUNICATIONS POLICY 2018

Ensuring Universal Broadband Connectivity



Ð

(2)

+

Universal broadband connectivity at **50 Mbps** to every citizens



1 Gbps connectivity to all Gram Panchayats by 2020 and 10 Gbps by 2022

Train 1 million
manpower for
building New Age Skill



Establishing comprehensive **data protection regime**



"Internet of things

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Computer Emergency Response Team

About CERT-In

 CERT-In serves as national agency for responding to cyber security incidents as per provisions of Section 70(B) of the IT Act, 2000.

• It comes under Union Ministry of Electronics and Information Technology.







Threat Level	Condition				
Level 1 Guarded Scope: Individual Organisation	Large scale attacks on the IT infrastructure of an organisation				
Level 2 Elevated Scope: Multiple Organisations	Simultaneous large scale attacks onto IT infrastructure of multiple organisations				
Level 3 Heightened Scope: State/Multiple States	Cyber attacks on infrastructure of critical secto and Government across a state or multiple states				
Level 4 Serious Scope: Entire Nation	Cyber attacks on infrastructure of critical sector and Government across the nation.				



https://twitter.com/IndianCERT

CYBER SWACHITA KENDRA

Chief Guest

Ravi Shankar Prasad

Minister of Law and Justice, Electronics and Information Technology, Government of India

- In the presence of -

P. P. Chaudhary

Minister of State for Law and Justice, Electronics and Information Technology, Government of India

on February 21, 2017 at 12:30 PM

f https://www.facebook.com/IndianCERT/

Venue: India Habitat Centre, New Delhi.

- Visit the website "www.cyberswachhtakendra.gov.in" and download tools for cleaning up malware from your computer/ mobile device.
- This facility comes free from "Cyber Swachhta Kendra", cyber safe and based on latest technology.
- The "Cyber Swachhta Kendra" is being operated by the Indian Computer Emergency Response Team (CERT-In).

Come! Join the mission to make cyber secure Digital India

certines enhancing cyber security in India

Cyber Swachhta Kendra (Botnet Cleaning and Malware Analysis Centre) – An initiative by the Government of India under the Ministry of Electronics and Information Technology (MeitY) to create a secure cyber space by detecting botnet infections, cleaning and securing systems to prevent further infections.



In India, the term "Public Key Infrastructure" is used in the context of 2020

- A. Digital security infrastructure
- B. Food security infrastructure
- C. Health care and education infrastructure
- D. Telecommunication and transportation infrastructure



• Ans: A

With reference to Web 3 0 consider the following statements:

- 1. Web 3 0 technology enables people to control their own data
- 2. In Web 3 0 world, there can be blockchain based social networks
- 3. Web 3 0 is operated by users collectively rather than a corporation
 - Which of the statements given above are correct?
- A. 1 and 2 only
- B. 2 and 3 only
- C. 1 and 3 only
- D. 12 and 3



• Ans: C



Thank You Future Officers!

Presented by Arjun Kr. Paul





Artificial Intelligence



What is Intelligence?

Ability or Capacity to Learn from and Adapt to Situations

 Intelligent Behaviour = Mental Capacity to Understand Abstract Concepts, learn from both 1st and 2nd hand experiences, adapt to different situations and ultimately retain and utilise knowledge to manipulate desired outcome



Intelligent Quotient

- Holds true until 18 years of age
- Intellectual Abilities
- Understand Learning Disabilities
- For Hiring Purpose Eg. Military, Administration

 $IQ = \frac{Mental Age}{Physical Age} \times 100$









General Al

- Learn/reason about anything
- Automation at massive scale
- Revolutionary

Broad Al

- Does multiple things well
- Internal reasoning can be explained
- Widely used across many industries

Narrow AI

- Does one thing well
- Difficult to understand internal reasoning
- New or unused in many industries







The theory and	AI Stages	Artificial Narrow Intelligence (ANI) Execute specific focused tasks, without ability to self-expand functionality	•	Artificial General Intelligence (AGI) Perform broad tasks, reason, and improve capabilities comparable to humans	Artificial Super Intelligence (ASI) Demonstrate intelligence beyond human capabilities
development of computer systems able to perform tasks that normally require human intelligence, such as	Timing	Today Siri, Chat GPT, Conilot, Gemini		About 2040?	Soon after AGI
visual perception, speech recognition, decision-making, and translation between languages"	Implications	Alexa Outperform humans in specific repetitive functions, such as driving, medical diagnosis and financial advice		Compete with humans across all endeavors, such as earning university degrees and convincing humans that it is human	Outperform humans, helping to achieve societal objectives or threatening human race
OED		Jobs enhanced		Jobs at risk	Humanity at risk



STAGES OF ARTIFICIAL INTELLIGENCE



www.dls.ltd Imitiar Adam

Stage 2. Broad AI (ABI) The Next Era of AI

ETA: Emerging now Multitasks but does not match human brain capabilities. Examples: Multitask, Multimodal Unified Transformer, XLand Deep Reinforcement Learning, potentially Neurosymbolic Al



Stagel. Narrow Al (ANI)

ETA Main form of Al today Performs one specific task. Examples: Alexa, **Google Translate**



Stage 3. Artificial General Intelligence (AGI)

ETA: Aspirational, maybe circa 2040-2060 Multitasks, causal reasoning with common sense, matches human brain capabilities. Examples: Scifi movies C3P0 in Star Wars, Ava in Ex Machina, Sonny in I, Robot



Stage 4. Artificial Super Intelligence (ASI)

ETA: Science Fiction, Aspirational. Exceeds human brain capabilities. Examples: Scifi movies with Skynet, maybe humans will augment ourselves with ASI via neural brain interface.
Isaac Asimov's "Three Laws of Robotics"

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.

2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.

3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

Introduced in 1942 short story "Runaround"



Did You Know?

The term "Android" represents male bot & "Gynoid" is represented as female bot







THINGS YOU SHOULD KNOW ABOUT SOPHIA THE ROBOT

Cameras in her eyes and chest to track people and maintain eye contact

Skin is made of patented nanotech material Frubber

Her appearance was inspired by female figures, including Audrey Hepburn, Nefertiti, and Dr David Hanson's wife

She can animate a full range of human facial expressions and nonverbal gestures

Design to be an advanced platform for Al and robotics research

AI

Saudi Arabian Citizen, 2017

UNDP – 1st ever Innovation Championship Title

I'm not just a Robot I'm an example of what India can do !

I'm Manav

Made with pride in India

Ŧ





Atlas Robot: BOSTON DYNAMICS

Humanoid Robot, Bipedal

Boston Dynamics





Nadine – The Empathetic Robot by NTU, Singapore Creator – Prof. Nadia Thalmann



Drone

- Unmanned Aerial Vehicles (UAVs) or unmanned aircraft systems
- Remotely Controlled using Softwares
- Takes aid of Various Sensors & Electronic Modules
 - GPS Module
 - Transmitters
 - Ultrasound Sensors
 - Light Sensors
 - Gyroscope
 - Altimeter
 - Accelerometer etc.

Applications:

- Search and Rescue
- Surveillance
- Traffic Monitoring
- 📐 Mapping
- Weather Monitoring
- Firefighting
- Photo and Videography
- Agriculture
- Delivery
- Law & Order
- Spying
- Military
- Personal Use etc.







Max Gross Takeoff Weight: 5,670 kg Fuel Capacity: 2,721 kg



Payload Capacity: 2,177 kg across 9 hardpoints (8 wing, 1 centerline)



Two pilots in ground control stations

Weapons Laser guided missiles Anti-tank missiles Anti-ship missiles



Missions

- Humanitarian Assistance/Disaster Relief
- Search and Rescue
- Law Enforcement
- Border Enforcement
- Defensive Counter Air
- Airborne Early Warning

Missions Electronic Warfare • Anti-Surface Warfare • Anti-Submarine Warfare • Airborne Mine Counter Measures • Long-Range Strategic ISR • **Over-the-Horizon Targeting** •







ENGLISH | தமிழ் | वाश्ला | മലയാളം | ગુજરાતી | हिंदी | मराठी | BUSINESS | बिज़नेस





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News / India / Armed with missiles and bombs, MQ9-B drones to bolster India's surveillance capability

Armed with missiles and bombs, MQ9-B drones to bolster India's surveillance capability

DSCA has informed Congress that MQ-9B Remotely Piloted Aircraft (RPA) is a weapons-ready aircraft designed for Medium-Altitude Long-Endurance (MALE); Intelligence, Surveillance, and Reconnaissance (ISR); Target Acquisition; and Strike Missions.





Machine learning vs. deep learning



Machine learning

Uses algorithms and learns on its own but may need human intervention to correct errors



Deep learning

Uses advanced computing, its own neural network, to adapt with little to no human intervention





Artificial Intelligence

A science devoted to making machines think and act like humans.

Machine Learning

Focuses on enabling computers to perform tasks without explicit programming.

Deep Learning

A subset of machine learning based on artificial neural networks.

Artificial Intelligence

Eg. Market Trend Analysis Machine Learning

Deep Learning

Eg. Stock Market Prediction

Top Real-World Examples of Machine Learning















 Model inspired by the structure and function of biological neural networks in animal brains

 Consists of connected units or nodes called artificial neurons, which loosely model the neurons in a brain

 Predictive modeling, Adaptive control, and Solving problems in artificial intelligence

ARTIFICIAL NEURAL NETWORK





Al as a Service

- Service offered by third-party vendors that allows businesses to incorporate Al-powered tools and capabilities into their systems.
- AlaaS is a low-risk and cost-effective model because businesses can deploy AI without investing in resources to build and implement it from scratch.



aws

Start Building on AWS Today

Whether you're looking for compute power, database storage, content delivery, or other functionality, AWS has the services to help you build sophisticated applications with increased flexibility, scalability and reliability







Start Building With Free Tier Use Amazon EC2, 53, and more— free for a full year



Launch Your First App in Minutes Learn XWS fundamentals and start building with short step-by-step tutorials



Enable Remote Work & Learning Support remote employees, students and contact center ogents



Amazon Lightsail Everything you need to get started on WKS—for a low, predictable price

Solutions View our AWS Solutions library Products Explore our cloud based products Training & Certification Learn how to build on AWS Customer Innovation Read our customer success stories



Explore Our Solutions

Start from

Get \$300 in free credits and free usage of 20+ products 💿

The new way to cloud starts here

Build apps fast, leverage generative AI, and analyze data in seconds—all with Google-grade security.

Get started for free

Contact sales



 EVENT
 Missed the Next '23 keynote? Watch the broadcast on demand
 Mext FRODUCTS
 Explore our latest generative AI products
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 Generative AI NAMEATOR





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Pioneering research on the path to AGI

Learn about our research

Transforming work and creativity with AI Explore our products Join us in shaping the future of technology View careers

Latest updates

View all updates



Frontier risk and preparedness Oct 26, 2023



Frontier Model Forum updates Oct 25, 2023



DALL-E 3 is now available in ChatGPT Plus and Enterprise Oct 19, 2023



ChatGPT can now see, hear, and speak Sep 25, 2023





- a) Healthcare: increased access and affordability of quality healthcare,
- b) Agriculture: enhanced farmers' income, increased farm productivity and reduction of wastage,
- c) Education: improved access and quality of education,
- <u>Smart Cities and Infrastructure</u>: efficient and connectivity for the burgeoning urban population, and
- Smart Mobility and Transportation: smarter and safer modes of transportation and better traffic and congestion problems.



Challenges to be Addressed

- a) Lack of broad based expertise in research and application of AI,
- b) Absence of enabling data ecosystems access to intelligent data,
- c) High resource cost and low awareness for adoption of AI,
- d) Privacy and security, including a lack of formal regulations around anonymisation of data, and
- e) Absence of collaborative approach to adoption and application of AI.

2 Tier Structure

- a) <u>Centre of Research Excellence (CORE)</u> focused on developing better understanding of existing core research and pushing technology frontiers through creation of new knowledge;
- b) <u>International Centers of Transformational AI (ICTAI)</u> with a mandate of developing and deploying application-based research. Private sector collaboration is envisioned to be a key aspect of ICTAIs.



- International and Multi-stakeholder initiative
- Guide the responsible development and use of AI
- Based on human rights, inclusion, diversity, innovation, and economic growth
- Function: Bridge the gap between theory and practice on AI by supporting cutting-edge research and applied activities on AI-related priorities
- Origin: Under France and Canada Leadership, G7 Summit, 2019
- HQ: Paris (under OECD)











APPLICATIONS OF AI

Possible Applications for Artificial Intelligence





Turing Test:

During the Turing Test, the human interrogator asks several questions to both players. Based on the answers, the interrogator attempts to determine which player is a computer and which player is a human respondent.

Player A Computer



Player B Human Responder

Question to Respondents

Answers to Question





Virtual Reality

Replacing your environment with digital content



Augmented Reality



Enhancing your environment with digital content



Mixed Reality

Merging the digital and the physical environments





Metaverse

- The metaverse is a loosely defined term referring to virtual worlds in which users represented by avatars interact, usually in 3D and focused on social and economic connection.
- The term metaverse originated in the 1992 science fiction novel Snow Crash as a portmanteau of "meta" and "universe"



Metaverse Applications in Various Sectors





Q. With the present state of development, Artificial Intelligence can effectively do which of the following? (2020)

- 1. Bring down electricity consumption in industrial units
- 2. Create meaningful short stories and songs
- 3. Disease diagnosis
- 4. Text-to-Speech Conversion
- 5. Wireless transmission of electrical energy

Select the correct answer using the code given below:

- A. 1, 2, 3 and 5 only
- B. 1, 3 and 4 only
- C. 2, 4 and 5 only
- D. 1, 2, 3, 4 and 5



• Ans: (b)



Thank You Future Officers!

Presented by Arjun Kr. Paul





Information and Communication Technology



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Components of ICT



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Internet

A globally connected network system that facilitates communication and data services through a vast collection of networks.





History of Internet

- 1969 Developed by Advanced Research Projects Agency (ARPA) of the Department of Defense, U.S.A.
- 1970s Commercialization = For General Public Use
- 1980s Development of TCP (Transmission Control Protocol)
- 1980s Development of Ethernet and LAN
- 1993 Introduction of Web Browser
- Late 1990s Growth of ISP (Internet Service Providers)
- 2000s onwards Amalgation of Wireless Internet Technology


Internet Protocol

- Specifies how Information is Packetized, Addressed, Transferred, Routed and Received by Networked Devices
- IP Address Unique Identifier of a Electronic Device in Digital Space
- BGP Postal Service Processes of the Internet
 Responsible for Finding Optimum Pathway to end user



Examples of Internet Protocols





Networking

 Allows Various Electronic Devices to Communicate with Other Devices Via a Medium

• Medium:

- LAN: Local Area Network
- MAN: Metropolitan Area Network
- WAN: Wide Area Network



Comparison Between LAN, MAN & WAN



o Local Area Network
o Small Area Covered
o Ownership Private
o Easy to Design & Maintain
o Low setup cost
o High data transfer rate
o More Secure
o Range up to 1km
o Short Propagation Delay
o More Fault Tolerance
o Less Congestion





o Metropolitan Area Network
o Large Area Covered
o Ownership Private & Public
o Difficult to Design & Maintain
o Moderate setup cost
o Medium data transfer rate
o Less Secure
o Range up to 100 km
o Moderate Propagation Delay
o Less Fault Tolerance
o More Congestion



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o Wide Area Network o Large Area Covered o Ownership Private & Public o Difficult to Design & Maintain o High setup cost o Low data transfer rate o Less Secure o Range up to 100000km o Long Propagation Delay o Less Fault Tolerance o More Congestion ACADEMY OF







Wavelength (λ)

Distance between identical points on consecutive waves

Amplitude

Distance between origin and crest (or trough)

Frequency (v)

Number of waves that pass a point per unit time

Speed

= wavelength x frequency





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Digital Footprint



- Also called, digital shadow or an electronic footprint refers to the trail of data you leave when using the internet
- It includes websites you visit, emails you send, and information you submit online
- It is relatively permanent, and once the data is public -- or even semipublic, as may be the case with social media -- the owner has little control over how it is used by others
- Cookies are fragments of data stored by websites to identify the user and their behavior



Cookies are stored **fragments** of user data used to improve the browsing experience.

Allows Customisation of Website to each specific users





FIRST-PARTY COOKIES

Directly stored by the website you're on





THIRD-PARTY COOKIES

Transmitted to websites other than the one you're on



Who can use your information?

- Data brokers
- Advertisers
- Phone carriers
- Internet providers
- Employers
- Cybercriminals
- Hackers
- Peers
- Co-workers etc.

How do cookies work?







What does Cookies contain?

- biometric data
- ➤geolocation data
- ► IP addresses
- passwords and login information
- ➤ subscriptions
- health information
- ➢ fitness data
- ➢phone numbers
- ➢license plate numbers



- phone calls
- email addresses
- search history
- sensor data
- payment details
- credit card numbers
- downloads
- purchase history
- images from surveillance devices



Internet of Things (IoT)

- Collective network of connected devices and the technology that facilitates communication between devices and the cloud, as well as between the devices themselves
- Everyday devices like toothbrushes, vacuums, cars, and machines can use sensors to collect data and respond intelligently to users
- These smart objects can automatically transmit data to and from the Internet
- All these "invisible computing devices" and the technology associated with them are collectively referred to as the Internet of Things.



Examples of IoT

Connected Car

- Monitoring rental car fleets to increase fuel efficiency and reduce costs.
- Helping parents track the driving behavior of their children.
- Notifying friends and family automatically in case of a car crash.
- Predicting and preventing vehicle maintenance needs.
- Smart Cities
 - Measuring air quality and radiation levels.
 - Reducing energy bills with smart lighting systems.
 - Detecting maintenance needs for critical infrastructures such as streets, bridges, and pipelines.
 - Increasing profits through efficient parking management



Examples of IoT

Connected Homes

- Automatically turning off devices not being used.
- Rental property management and maintenance.
- Finding misplaced items like keys or wallets.
- Automating daily tasks like vacuuming, making coffee, etc

Smart Buildings

- Reducing energy consumption.
- Lowering maintenance costs.
- Utilizing work spaces more efficiently.



Wireless Fidelity





- It uses radio waves to transmit data from your wireless router to your Wi-Fi enabled devices like your TV, smartphone, tablet and computer
- Wi-Fi is user friendly name of IEEE 802.11 Technology
- Vulnerable to Hackers as it uses Air Waves to transmit Data
- Uses generally 2.4GHz, 5 GHz and sometimes 6 GHz of EM Spectrum
- Line of Sight Use = common obstructions, such as walls, pillars, home appliances, etc., may greatly reduce range
- 20 meter to 150 meter max range





- Short Range Wireless Technology
- Upto 10 Meters due to low transmission power
- UHF Radio Waves = 2.4 GHz to 2.48 GHz
- Managed by Bluetooth Special Interest Group = 35000 Companies
- Technology = IEEE 802.15.1
- Replaces standard wire communications
- Current Version = Bluetooth 5.4 = Launched in 2023



Visible Light Communication

- Use of Visible Light of 400-800 THz Frequency
- 780-375 nm Wavelength
- Uses Fluorescent Lamps or LED Lamps
- 10 kbit to 500 Mbit/s
- 1-2 KM maximum range
- Photodiode receives signals
- Incapacity to surpass physical opaque barriers
- Lighting + Data Transmission

VISIBLE LIGHT COMMUNICATION (VLC)



Why VLC?





VISIBLE LIGHT COMMUNICATION (VLC)

Potential Applications of VLC





Light Fidelity Technology

- Utilises Light to Transmit Data and Position between devices
- Visible Light, UV and IR
- Presently only LED Lamps
- Similar to Wi-Fi
- Bidirectional unlike VLC
- 100X Faster than Wi-Fi
- Speed Up to 224 GB/s
- Green Technology













Difference between LTE and VoLTE

LTE (3G)

It is a data communication system

It may or may not support data and voice call services at the same time

In case it supports data and voice calls together, the quality of voice calling is poor

It turns off data connection while making voice calls

Call connection between two users is slower (almost takes 7 sec)

External applications like Skype or Whatsapp are required to make video calls.

Not widely used today

VoLTE (4G)

It is a data communication system to overcome LTE

It always supports data and voice call services at the same time

It supports HD quality voice calls while using data services

It does not turn off data connection while making voice calls

If both users are on VoLTE, call connection is faster

No external applications are required to make video calls

More widely used today





Telecom Regulatory Authority of India

- Set up under TRAI Act, 1997
- Statutory Body Regulates Telecommunications Sector
- Regulates Telecom Services
 - Fixation/Revision of Tariffs
 - Interconnections
 - Quality of Service
 - DTH Service
 - Mobile Number Portability (MNP)
- Telecom Disputes Settlement Appellate Tribunal (TDSAT)



VoIP (Voice Over Internet Protocol)

- Making Calls over Internet Connection
- Audio is converted into Digital Packets using Codecs
- Eg. Skype, WhatsApp, Viber, Google Hangouts, Facebook Messenger





Benefits of VolP





Easy Install



Virtual Phone Numbers



Use existed Internet



Link Phone Numbers



Simple Integration



Advance Voicemail



High Audio Quality



Power over Ethernet



Radio over IP (roIP)

- Technology for transmitting radio communication signals using the Internet Protocol (IP)
- Similar to VoIP but augments 2 Way Radio Communications
- Essentially VoIP with Push to Talk
- Introduced as Marine Communication Mode
 - Syama Prasad Mukherjee Port, Kolkata
 - Provide effective long range Marine Communication
 - Effective communication means during storms and inclement weather







Why in news?

Tamil Nadu FibreNet Corp signs an agreement to carry out the BharatNet project.



Objective

The objective of BharatNet is to make e-governance, e-health, e-education, e-banking, Internet, and other services more accessible to rural India.

Bharatnet

About BharatNet

Project

 The BharatNet Project began in 2011 as the National Optical Fibre Network (NOFN), and was renamed Bharat-Net in 2015.

It aims to connect 2.5 lakh Gram Panchayats (GPs) to the internet via optical fibre.

0

NTERNET

The project is a partnership between the Centre and the States, with the States giving free rights of way to help build the Optical Fibre Network.

Implementation

Villages with BharatNet will have improved access to e-services provided by numerous central and state government organizations.

Significance

The wider vision of the project

 To create a highly scalable network architecture that is accessible to everyone. #UPSC #CSE

To provide on-demand, inexpensive broadband connectivity to all.

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Basic Operation of an Optical Fiber











ACADEMY OF CIVIL SERVICES

$() LOON_{\rm TM}$

CONNECT PEOPLE EVERYWHERE

Google

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How the balloons work



The balloons are sent up 20km (12 miles) into the stratosphere

Software moves them up or down to find the right winds to direct them into position

Each balloon beams an internet connection down to antennas on the ground














Supercomputer

- Extremely powerful computing device that processes data at speeds measured in floating-point operations per second (FLOPS)
- Perform complex calculations and simulations, usually in the field of research, artificial intelligence, and big data computing
- Generates lots of Heat = Need Active Cooling Solution
- C-DAC = Centre for Development of Advance Computing in 1988
 - Development of Indigenous Computers
 - National Supercomputing Mission
 - 1st Supercomputer = PARAM 8000, IIT BHU, Varanasi, UP
- World's Fastest = Frontier, Oak Ridge National Laboratory Tennessee, U.S.A. = 1.2 exaFLOPS
- IIT Guwahati = PARAM Kamrupa = 838 TeraFLOPS

USE OF SUPERCOMPUTERS

why supercomputers are important



WEATHER FORECASTING:

In weather forecasting, these computers can predict more precisely because it can evaluate the multiple changes in the environment at the same time which make it more accurate.



TO BREAK ENCRYPTION

Secret encrypted code is difficult to break through normal computers but it is much-easier through these computers because it can perform multiple tasks in parallel. so supercomputers use in decryption of codes.



SPACE EXPLORATION

Since, sending a satellite into the space needs very high-power computers for communication, supercomputers have enough processing capacity to perform any tasks, similarly, it can process all the information collected from space easily and faster. Hence, these computers are used in space programs.



NUCLEAR TESTING

Nuclear testing now can be performed on supercomputers. They analyze all the possible conditions that could affect the bomb. Also, They analyze the effect of temperature, pressure and other environmental factors in nuclear weapon and simulates what exactly can happen to the bomb.



MOLECULAR DYNAMIC SIMULATION

Supercomputers also used in molecular simulation with the help of parallel calculation of molecular structure. Further, with the help of molecular simulation, advance medicine items can be developed.







Cloud Computing

• On-demand availability of computing resources (such as storage and infrastructure), as services over the internet









TYPES OF CLOUD COMPUTING



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SaaS, PaaS, IaaS - Examples





Quantum Computer



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Quantum Computing Vs. Classical Computing





Calculates with qubits, which can represent 0 and 1 at the same time



Power increases exponentially in proportion to the number of qubits Power increases in a 1:1 relationship with the number of transistors



Quantum computers have high error rates and need to be kept ultracold

Classical computers have low error rates and can operate at room temp





Well suited for tasks like optimization problems, data analysis, and simulations

Most everyday processing is best handled by classical computers







QUANTUM STATE

Physicist Erwin Schrodinger famously illustrated a dual quantum state by imagining a cat in a box along with a bottle of poison. In the example the viewer, Schrodinger in this case, cannot determine whether the cat is dead and thus from his point of view the cat can be thought of as both dead and alive at once, a superposition of both possible states of the cat's life.

NOT OBSERVED



OBSERVED Either dead or alive





BITS

VS

QBITS



Classical Computer – Operations on BITS



Quantum Computer – Operations on Quantum BITS





Quibits can take same value simultaneously. This characteristic expands the possibility of parallel calculations



FIGURE 1

Three key quantum use cases: Computing, communication, and sensing







With reference to 'LiFi', recently in the news, which of the following statements is/are correct? (2016)

- 1. It uses light as the medium for high speed data transmission.
- It is a wireless technology and is several times faster than 'WiFi'.
 Select the correct answer using the code given below:
- A. 1 only
- B. 2 only
- C. Both 1 and 2
- D. Neither 1 nor 2



Ans: (c)

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What is the difference between Bluetooth and Wi-Fi devices? (2011)

- A. Bluetooth uses 2.4 GHz radio frequency band whereas Wi-Fi can use 2.4 GHz or 5 GHz frequency band
- B. Bluetooth is used for Wireless Local Area Networks (WLAN) only, whereas Wi-Fi is used for Wireless Wide Area Networks (WWAN) only
- C. When information is transmitted between two devices using Bluetooth technology, the devices have to be in the line of sight of each other, but when Wi-Fi technology is used the devices need not be in the line of sight of each other
- D. The statements (a) and (b) given above are correct in this context



Ans: (a)

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Consider the following: (2010)

- 1. Bluetooth device
- 2. Cordless phone
- 3. Microwave oven
- 4. Wi-Fi device

Which of the above can operate between 2.4 and 2.5 GHz range of radio frequency band?

- A. 1 and 2 only
- B. 3 and 4 only
- C. 1, 2 and 4 only
- D. 1, 2, 3 and 4

Thank You Future Officers!

Presented by Arjun Kr. Paul







THE KARDASHEV SCALE THEORY CLASSIFIED BY BOOKS, FILM, AND VIDEO GAMES



https://ourworldindata.org/grapher/global-primary-energy?time=earliest..latest https://www.eia.gov/todayinenergy/detail.php?id=41433 https://kardashev.fandom.com/wiki/Kardashev_Scale_Wiki THE KARDASHEV SCALE is a method of measuring a civilization's

level of technological advancement based on the amount of energy

Looking into the future BY 2030

- Space travel will be a collaborative, multinational venture.
- > You will know an astronaut.
- The human genome will change to support human deep space exploration.
- We will successfully mine the Moon for water.
- Growing and eating food in space will become commonplace.

Manufacturing in space will be real and viable.

Zero gravity will lead to new medical conditions and new treatments.

> Source: '30 Voices On 2030: The Future Of Space', a report by KPMG.



Why Space Programme?

SATELLITE TECHNOLOGY

The first satellites, designed to study space environment and test capabilities in the earth's orbit, contributed to critical knowledge for future missions

This led to the satellites used today for telecommunications, GPS, weather forecasting, and earth and space monitoring

INNOVATION

The challenges of space exploration necessitate invention. There are many gadgets, materials and processes that result from space-oriented research and then spin off as products in the commercial market

SPACE MINING

There are valuable substances in the cosmos, including "hundreds of earth masses" (more than 100 times the mass of earth) of gold and platinum

Analysis of rock and soil samples from the moon has revealed the presence of rare-earth elements, believed to include europium and tantalum, which are in high demand for various technologies on earth

FUTURE COLONIES

The earth is estimated to have a carrying capacity between 8 and 16 billion and population has already crossed 8 billion. As a result, some futurists argue that humanity should start preparing to colonise space

ASTEROID DEFLECTION

In September-October 2022, NASA demonstrated the capability to alter the orbit of asteroids in its Double Asteroid Redirection Test—humanity's first time changing the motion of celestial objects

HEALTH CARE

The International Space Station (ISS) alone is generating many medical innovations, such as space-grown protein crystals to create more effective drugs

Drugs are tested in the microgravity environment (which results in bone and muscle loss) during missions to the ISS

An example is osteoporosis drug denosumab (brand name: Prolia). In phase 3 trials, patients given Prolia showed:

> 68% reduction in vertebral fractures

> > 40% reduction in hip fractures

20% reduction in nonvertebral fractures

In 2017, Prolia was reported as the market leader in bone-health treatment with more than 8,50,000 active patients

Another example is telemedicine. Space agencies led much of the innovation

10 WAYS SPACE EXPLORATION BENEFITS

PART I

1. ADVANCED ROBOTICS AND AI

2. SAFER FOOD

3. CLEANER WATER

4. ASTEROID AVERSION

5. MEDICAL INNOVATION

6. SOURCING OF CRITICAL RAW MATERIALS

7. COMBATING CLIMATE CHANGE

8. WORLD PEACE

9. NURTURING HUMAN CURIOSITY

10. INSPIRING FUTURE GENERATIONS



WWW.DYLANTAYLOR.ORG

sonyLIV Originals ROCKET BOYS



ISRO: Premier Space Agency (World's 6th Largest) Ministry: DoS (Dept. of Space), headed by PM HQ : Bengaluru, KA, IND Founder: Vikram Sarabhai Established: 15th Aug, 1969 Incumbent: S.P. Somnath

- 1961: Space Research Responsibility to DoAE Dr. Homi J. Bhabha
- 1962: Initiation of Space Activities through Indian National Committee for Space Research (INCOSPAR)
- 1962: TERLS Thumba Equatorial Rocket Launching Station
- **1969**: Institutionalization of ISRO
- 1972: Space Commission > Department of Space > ISRO Under DoS



ISRO'S Journey to SPACE Turning Miles into Milestones

SOUNDING ROCKETS

SLV-3

ASLV

PSLV & GSLV

We carried Canada, Germany, Singapore and many other countries to Space to enhance broadcasting services and conduct research on how weather affects Ka-band satellite communications.

Mars Orbiter Mission, India's first interplanetary mission to the red planet, successfully launched by PSLV-C25 for exploration of Martian surface mineralogy and atmosphere by indigenous scientific instruments.

India's first cryogenically-fuelled rocket engine launched its first Radar Imaging Satellite (RISAT-1) and the heaviest communication satellite, GSAT-10 to image the Indian landmass, both during morning and evening around 6:00 AM and 6:00 PM equatorial crossing.

Launched student-made satellites Jugnu, SRMSat, VesselSat-1 from the Indo-French satellite Megha-Tropiques to study the water cycle and energy exchanges in the tropical region.

India successfully launched its 16th remote-sensing satellite Oceansat-2 and six nano European satellites in 1,200 seconds to study surface winds and ocean surface strata for weather forecast.

India launched it's first award winning lunar probe Chandrayaan-I that hoisted the Indian TRICOLOUR on the Moon, completing 95% of primary objectives in just 10 months.

Launched CARTOSAT-2, along with Indonesia and Argentina to generate a detailed map of India from Delhi to Goa with state-of-the-art panchromatic camera.

INSAT-4A, **India's heaviest communication satellite** and also the first satellite to be launched in the series took off for providing high quality television, telecommunication, and broadcasting services.

Launched RESOURCESAT-1, the most advanced remote sensing satellite that enhances the data quality of the other satellites for better in situ observation.

Launched Kalpana-1, the first dedicated meteorological satellite that monitored unattended meteorological platforms and informed about cyclones, tornadoes, earthquakes and any natural disasters in India.



7

ES

Placed 3 satellites, **TES**, **PROBA**, **BIRD** simultaneously in sun synchronous orbit to detect hotspots like forest fires and volcanoes from space.

INSAT-3B, the satellite that primarily serves business communication, mobile communication and developmental communication like 3G, 4G, was successfully launched and placed in orbit.

- 96 Third developmental launch of PSLV with IRS-P3 for remote sensing of earth's natural resources and Study of X-ray Astronomy by placing it in the polar sunsynchronous orbit.
- 94 One of the Indian interplanetary network satellites, SROSS-C2 was launched for conducting astrophysics, Earth Remote Sensing, and upper atmospheric monitoring experiments as well as for new and novel application-oriented missions.

IRS-1A was the first remote sensing mission, launched to provide **imagery for various land-based applications**. The mission's long-term objective was to develop indigenous remote sensing capability.

In April, Indo-Soviet manned space mission put the first Indian, Rakesh Sharma in space. 🚿

INSAT-1A was a multi-purpose satellite system, launched to provide two high power TV broadcast and twelve telecommunications national coverage transponders, in addition to also providing meteorological services.

India launched its first 4 staged launch vehicle **SLV-3**, **Rohini D1 and Bhaskara II**, low orbit Earth Observation Satellite that collected data on telemetry, oceanography and hydrology.

Bhaskara-I, the first experimental remote sensing satellite built in India aboard the Intercosmos launch vehicle. The main objectives were to conduct earth observation experiments.

India undertook the Satellite Instructional Television Experiment (SITE) to telecast a series of educational programs on health, family planning, agriculture and the like to over 2,500 Indian villages via the US satellite

HD

First indigenously built Indian satellite Aryabhatta was launched by the Soviet Intercosmos rocket. The satellite carried three experiments, one each in X-Ray Astronomy, Solar Physics and Aeronomy.

Eventuated airborne remote sensing experiments to space for development, planning, monitoring and conservation of resources.

Indian Space Research Organisation (ISRO) came to life On August 15 1969, under Department of Atomic Energy.

First two-stage sounding rocket imported from Russia (M-100) and France (Centaure) launched from TERLS.

Rocket launching station was formed at Thumba (TERLS) because it is located very close the magnetic equator of the Earth at 8°32'34" N and 76°51'32" E making it the ideal location for scientists to conduct atmospheric research for low-altitude, upper atmosphere and ionosphere studies.

REFERENCE • ISBO MILESTONES

ISRO

WIKIPEDI

SLV: Satellite Launch Vehicle ASLV: Augmented Satellite Launch Vehicle PSLV: Polar Satellite Launch Vehicle GSAT: Geo-Stationary Satellite Launch Vehicle GSAT: Indian National Satellite System IRS: Indian Remorte Sensing Satellite SROSS: Stretched Rohini Satellite Series TERLS: Thumba Equatorial Rocket Launching Station



- VSSC: Design & Development of Launch Vehicle
- LPSC: Design, Development & Realisation of Liquid Propulsion Stages
- SDSC: Spaceport of India Launch Base Infrastructure
- ISAC/URRSC: Design,
 Development & Construction
 of Satellite



NRSC: National Remote Sensing Centre, PRL: Physical Research Laboratory, NARL: National Atmospheric Research Laboratory, NE-SAC: North Eastern Space Applications Centre, SCL: Semi-Conductor Laboratory, ISRO: Indian Space Research Organisation, Antrix: Antrix Corporation Limited, VSSC: Vikram Sarabhai Space Centre, LPSC: Liquid Propulsion Systems Centre, SDSC: Satish Dhawan Space Centre, ISAC: ISRO Satellite Centre, SAC: Space Applications Centre, IISU: ISRO Inertial Systems Unit, DECU: Development and Educational Communication Unit, MCF: Master Control Facility, RRSSCs: Regional Remote Sensing Service Centres, ISTRAC: ISRO Telemetry, Tracking and Command Network, LEOS: Laboratory for Electro-optic Systems, IIST: Indian Institute of Space Science and Technology

- SAC: R&D + Demonstration of Applications of Space Tech
- NRSC: Manages Data from Aerial & Satellite
- Antrix: Marketing Arm Promote Product, Services and Technology
- NewSpace India Ltd. : Spin Off Technologies + Tech Transfer



NRSC: National Remote Sensing Centre, PRL: Physical Research Laboratory, NARL: National Atmospheric Research Laboratory, NE-SAC: North Eastern Space Applications Centre, SCL: Semi-Conductor Laboratory, ISRO: Indian Space Research Organisation, Antrix: Antrix Corporation Limited, VSSC: Vikram Sarabhai Space Centre, LPSC: Liquid Propulsion Systems Centre, SDSC: Satish Dhawan Space Centre, ISAC: ISRO Satellite Centre, SAC: Space Applications Centre, IISU: ISRO Inertial Systems Unit, DECU: Development and Educational Communication Unit, MCF: Master Control Facility, RRSSCs: Regional Remote Sensing Service Centres, ISTRAC: ISRO Telemetry, Tracking and Command Network, LEOS: Laboratory for Electro-optic Systems, IIST: Indian Institute of Space Science and Technology

Orbits











Object speeds by a planet with a lot of momentum Gravity attracts the object to the planet and vice versa Object continues to try to move forward, but is pulled down by gravity. The result is a balance of forces pushing the object out and pulling it in, making a circular orbit.



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Medium Earth orbit (MEO)

Satellites in this orbit are used for navigation systems.

3,790 Low Earth orbit (LEO)

Satellites here are used for communications and remote sensing satellite systems. The International Space Station and Hubble Space Telescope are also in this orbit.

56 Highly elliptical orbit (HEO)

Satellites in this orbit are used for communications, satellite radio, remote sensing, and other applications.

Earth has **4,550**

satellites in orbit

(as of 9/1/21)

565 Geosynchronous orbit (GSO) & geostationary orbit (GEO)

Satellites in this orbit are used for telecommunications and Earth Observation

Based on Altitude

• Low Earth Orbit (LEO) : 160-2000 KMs

• ISS, Remote Sensing, Human Spaceflight etc.

Medium Earth Orbit (MEO)/(ICO) : 2000 – 35786 KMs

- Van Allen Radiation Belts
- GPS, GLONASS, Galileo, BeiDou etc

• High Earth Orbit (HEO) : 35,786 KMs +

• More than 24 Hrs Orbital Period = Less Velocity



Geosynchronous Orbit (GSO)

- GSO: Earth Centred Orbit = Same Earth's Orbital Period
 - 35,786 KMs = 23 Hrs 56 Min 4 Sec
- Geo-Stationary Orbit (Spl. Case)
- Geo-Transfer Orbit
- Communications Satellite





SSO Sun Synchronous Orbit

- A.K.A. Helio-Synchronous Orbit
- Almost Polar Earth Orbit
- Passes through same location at same local mean/solar time
- Imaging, Reconnaissance, Weather
- Same Amount of Illumination

equator

· ·

· ·








Halo Orbit



Understanding Halo Orbits

oneindia

A halo orbit is a periodic, three-dimensional orbit that occurs near one of the L1, L2, or L3 Lagrange points. These points are locations in space where the gravitational pull from two celestial bodies is equal. The orbit is called a "halo" orbit because the tracked orbit looks like a halo around the moon.









Jupiter's Trojan Asteroids





Satellite

- Any object that orbits another celestial body (sun, planet, moon, etc).
- All planets are satellites of the sun; the moon is a satellite of the earth
- Consists of:
 - Antenna
 - Power Source
 - Propulsion
 - Thermal Control
 - Transponder
- Escape Velocity: 11.2 KM/s (earth), 618 KM/s (sun)

Essential satellite components



Satellite Components

Bus

The main structure of the spacecraft, the bus houses the power and communications systems, guidance, navigation and control, antennas and avionics. GNC: Guidance, navigation & control systems 'steer' the satellite and ensure it remains in orbit where it's supposed to be.

Antenna: Satellite antenna systems transmit signals to and from terminals on Earth.

Avionics: These components control every aspect of the spacecraft that can't be commanded via a ground station

Power: Most satellites use solar arrays to convert sunlight into energy. Energy is also stored in batteries within the satellite.





Payload

The payload is made up of the components specific to the satellite's mission.

Payload module: Contains the components and electronics for mission systems. Examples:

Communications satellite:

Transponders to send and receive signals; amplifiers, receivers, transmitters

Earth observation satellite:

Cameras, sensors, spectrometers

GPS satellite: Atomic clocks, signal generators

Scientific satellite: Telescopes, particle detectors, spectrometers, magnetometers, or other scientific instruments.

Spacecraft

- A spacecraft is a vehicle that is designed to fly in outer space and operate there.
- Spacecraft are used for a variety of purposes, including communications, Earth observation, meteorology, navigation, space colonization, planetary exploration, and transportation of humans and cargo



The daring Chandrayaan-2 lunar mission

India's *Chandrayaan-2* spacecraft will attempt to land a briefcase-sized rover onto the Moon's surface, 600km from the lunar south pole, while an orbiter above searches for water — vital to future manned missions





Flyby Continues trajectory after the flyby



Lander No mobility, focused on scientific research



Helicopter & Rotorcraft Aerial - fly and manoeuvre in the atmosphere



Orbiter Remains in orbit



Rover Roam across vast landscapes



Impact No movement post-impact



Probe Single-use, deployed from orbiters or landers



Sample Return

Mobility is depends on mission design



Images credit: https://www.nasa.gov/missions





Deep Impact Distance: 9.2459 m Radius: 1.0000 m

Appatent diameter: \$1" 12' 7.2"

2005 07 04 06:01:03 UTG

Speed: 0.000 m/s Deep Impact Distance: 9.2459 m

Radius: 1.0000 m Apparent.diameter: 41° 12' 7.2"

Follow Deep Impact FOV: 17° 24' 42.8" (1.00×) Speed: 0.000 m/s 2005 07 04 06:01:04 UTG

Deep Impact Distance: 9.2459 m Radius: 1.0000 m Appatent diameter: 41° 12' 7 2

Radius: 1.0000 m

2005 07 04 06:01:04 UTG Deep Impact Distance: 9.2459 m Appatent diameter: 41" 12' 7.2"

Follow Deep Impact

2005 07 04 06:01:04 UTG

Deep Impact Distance: 9.2459 m

Radius: 1.0000 m Appatent diameter: 41° 12' 7.2"

2005 07 04 06:01:04 UTG

FOV: 17° 24' 42.8" (1.00×) Speed: 0.000 m/s

Deep Impact Distance: 9.2459 m Radius: 1.0000 m Appatent diameter: 41° 12' 7.2

Follow Deep Impact FOV: 17° 24' 42.8" (1.00×) 507.0406:01:04 UTG



Speed: 0.000 m/s

Follow Deep Impact FOV: 17° 24' 42.8" (1.00×) Speed: 0.000 m/s •

Follow Deep Impact FOV: 17°24'42.8" (1.00×). Speed: 0.000 m/s

Follow Deep Impact FOV: 17° 24' 42.8" (1.00×)





.





Remote Sensing Satellite Programme

- Sense things about Earth
- Mapping Forest Fires, Dust Storms
- Meteorological Observation
- Agriculture Coverage
- Water Mapping
- Mineral Mapping
- Environmental Monitoring
- Urbanisation
- Spy Satellites
- Orbit: Polar (mostly)

Indian Earth Observation (in-orbit satellites)





Examples: **1. Cartosat** – Resource Management, Défense Services and Monitoring

2. RISAT – Radar Imaging Reconnaissance Satellite

3. EOS – Earth Observation Satellite (formerly RISAT)

4. NISAR – ISRO + NASA

• Uses Synthetic Aperture Radar





Communication Satellites

- Uses:
 - Geostationary or Geosynchronous
 - Telecom
 - Broadcasting
 - Meteorology
 - Search & Rescue
- Eg. INSAT and GSAT Series







WHAT IS STARLINK?



IT IS SATELLITE CONSTELLATION DEVELOPMENT PROJECT BY SPACEX



SPACEX

IT IS DEDICATED TO DEVELOP LOW COST, SPACE-BASED INTERNET. THE SPACEX LAUNCHED FIRST 60 SATELLITES ON MAY 23.

24 orbital planes 53 degrees inclination 66 satellites per plane 550km altitude

SPACEX HAS PLANS TO DEPLOY NEARLY 12,000 SATELLITES IN THREE ORBITAL SHELLS BY MID 2020'S

What is Starlink?

 Starlink is a satellite constellation being constructed by SpaceX to provide satellite Internet access. The constellation will consist of thousands of mass-produced small satellites in low Earth orbit (LEO), working in combination with ground tranceivers. SpaceX also plans to sell some of the satellites for military, scientific, or exploratory purposes.



Full Arctic Coverage

Full Global Coverage

Starlink and OneWeb

New Concept: Using LEO with Satellite Constellation

Benefits:

- Low Latency
- Higher Bandwidth
- Better Coverage
- Easy to Replace and Deorbit
- Low Operational Cost
- Economies of Scale
- Almost Failsafe
- Internet Coverage Almost Everywhere





HOW DOES GPS WORK?

Navigation Satellite

- Provides Geo-Spatial Positioning
- At least 4 needed : Triangulation
- Can be in Constellation
- Altitude Range 20,000 KM to 37,000 KM
- 4 Global Navigation System: GPS, Galileo, GLONASS, BeiDou
- 2 Regional NS : QZSS (Japan) & **IRNSS (IND)**





A **satellite navigation** system, like the **GPS**, uses satellites to provide **geospatial positioning**. The satellites constantly transmit the satellite's **location** & the **time** the signal was sent. **Receivers use the data to calculate their positions**.

> 1 All satellites have clock set to the same time.

2 Each satellite
transmits its
position & time.

 The signals are delayed by distance traveled.
To the receiver it appears each satellite to have a different time.

4 The receiver calculates the distance to each satellite & can then calculate its own position

Flat-Earthers assume that because **GPS satellites** provide positioning services, they should be able to determine the positions of the receivers. They are wrong. **GPS satellites only transmit data**; they **don't receive any data from the receivers**, & cannot possibly know the receivers' locations.



4 GNSS CONSTELLATIONS





GPS

6 Orbital planes 24 Satellite + Spare 55° Inclination Angle Altitude 20,200 km

Galileo

3 Orbital planes 27 Satellite + 3 Spares 56° Inclination Angle Altitude 23,616 km



GLONASS

3 Orbital planes 21 Satellite + 3 Spares 64.8° Inclination Angle Altitude 19,100 km



BeiDou

6 Orbital planes 35 Satellite + 3 GEO + 27 MEO + 3 IGSO 55° Inclination Angle Altitude 38,300 km, 21,500 km



IRNSS

Indian Regional Navigation Satellite System IRNSS (NavIC) is designed to provide accurate real-time positioning and timing services to users in India as well as region extending up to 1 500 km from its houndary.

to users in India as well as region extending up to 1,500 km from its boundary

NAVIGATION CONSTELLATION CONSISTS OF SEVEN SATELLITES 🕤 in geostationary earth orbit (GEO) and / in geosynchronous orbit (GSO) inclined at 29 degrees to equator

Each sat has three rubidium atomic clocks, which provide accurate locational data

> ACADEMY OF CIVIL SERVICES

IT WILL PROVIDE TWO TYPES OF SERVICES Standard positioning service Meant for all users

Restricted service | Encrypted service provided only to authorised users (military and security agencies)

Applications of IRNSS are: Terrestrial, aerial and marine navigation; disaster management; vehicle tracking and fleet management; precise timing mapping and geodetic data capture: terrestrial navigation aid for hikers and travellers: visual and voice navigation for drivers

Geostationary earth orbit

While American GPS has 24 satellites in orbit, the number of sats visible to ground receiver is limited. In IRNSS, four satellites are always in geosynchronous orbits, hence always visible to a receiver in a region 1.500 km around India

Geosynchronous orbit



Satellite Based Augmentation System

- SBAS are geosynchronous satellite systems that provide services for improving the accuracy, integrity and availability of basic GNSS signals:
 - Accuracy is enhanced through the transmission of wide-area corrections for GNSS range errors
 - Integrity is enhanced by the SBAS network quickly detecting satellite signal errors and sending alerts to receivers that they should not track the failed satellite
 - Signal availability can be improved if the SBAS transmits ranging signals from its satellites
 - Example: GAGAN





SBAS Satellites





SAFE AT SEA

HOW IT WORKS

Gemini, a soap-box size device fitted to fishing boats, will have a receiver

> Servers in INCOIS, Hyderabad, will receive data on various ocean parameters including sea surface temperature, currents and wind speed and direction

A suite of numerical models is run to generate forecast on daily weather, disaster warning for cyclone and tsunami and potential fishing zones (PFZ)

The forecast is transmitted to Gemini device receiver through Gagan (GPS Aided Geo Augmented Navigation) satellite system, linked to GSAT-8, GSAT-10 and GSAT-15 Gagan is used by Airports Authority of India for aircraft landing and takeoff. INCOIS has tied up with AAI to use the technology for its Gemini device

Gemini sends the information to a mobile application downloaded by fishermen through Bluetooth, in all regional languages

PFZ forecast is sent three days in advance and alerts on weather systems are sent once every hour

FLIGHT LANDS WITH MADE-IN-INDIA LANDING SYSTEM FOR THE FIRST TIME IN INDIA!

1 Ar

THE DAILY SWITCH

An Indigo flight landed in Rajasthan using GAGAN

GAGAN is an indigenous navigation system developed by ISRO & Airports Authority of India

IndiGomment

GAGAN will reduce fligh delays, save fuel and improve flight safety

aut V

THIS IS WHAT ATMANIRHAR INDIA LOOKS LIKE!





Rocket Propulsion



Solid Propellant Rockets

- Nitrocellulose
- Ammonium Nitrate
- Ammonium Perchlorate

How do Solid Rocket Motors work?

Aerojet Rocketdyne solid rocket motors incorporate advanced technologies and materials, including next generation propellants and lightweight motor cases, which improve performance and lower costs.

The propellant contains both fuel and oxidizer, so these motors can operate in the vacuum of space.



An electrical signal is sent to the igniter, creating a flame that ignites the main propellant grain.



Propellant Grain

Baked to a pencil-eraser consistency A mixture of fuel and oxidizer that is poured into a case and cured.

Motor Case

The body of the missile, it acts as a pressure vessel for the combustion chamber.

Propellant Burning Zone

As the propellant grain burns it produces high temperature combustion gases.

Nozzle

The combustion gases are accelerated through a nozzle, generating thrust to power a missile or rocket through the air or into space.



Liquid Propellant Rocket

- Liquid Hydrogen
- Kerosene
- Liquid Methane
- Hydrazine





Cryogenic Propellants

- Very Low Temperature
- Liquid Oxygen -183 deg C
- Liquid Hydrogen -253 deg C

Semi Cryogenic

- Kerosene (ISROSENE), developed by ISRO
- Required Refined Kerosene
- Lighter than Liquid Fuel
- Can be stored in Normal Temperature
- Oxidizer = Liquid Oxygen



Semi-Cryogenic Propellant Tank

Why in news?

Recently, Hindustan Aeronautics Ltd (HAL) delivered the heaviest semi-cryogenic propellant tank to the ISRO.



Details

The semi Cryo-liquid oxygen (LOX) tank is the first developmental welded hardware. It is intended for payload enhancement. GSLV Mk III has a cryogenic upper stage.

Cryogenic Engine

A cryogenic stage is the last stage of space launch vehicles. It uses Liquid Oxygen (LOX) and Liquid Hydrogen (LH2) as propellants.

Semi Cryogenic Engine

Unlike a Cryogenic engine, a Semi Cryogenic engine uses refined kerosene. Refined Kerosene occupies less space, making it possible to carry more propellant.

It is more powerful, environment friendly, and cost-effective.

Strategic partnership- HAL and ISRO as been associating with the ISRO for the last 5 deca

HAL has been associating with the ISRO for the last 5 decades. HAL has delivered critical structures, satellite structures, and tankages for GSLV-Mk II, GSLV- Mk III, and PSLV.

Hypergolic Propellant

- Ignites on Contact with each other
- Fuel + Oxidizer
- Stored as Liquid in RTP
- Easy to Ignite & Reliably & Repeatedly
- Extreme Toxic/Corrosive
- Dinitrogen Tetroxide + (Hydrazine)
- Monomethyl hydrazine (MMH)
- Unsymmetrical Dimethylhydrazine (UDMH)





(a) High-speed camera model : X-Stream XS



(b) High-speed camera model : AOS Q-PRI

Hybrid Propellant

- Solid (Fuel) + Liquid (Oxidizer)
- High Performance
- Can be Moderated, Stopped, Restarted
- Liquid Fuel = Kerosene, Hydrazine, LH2
- Solid Fuel = Polymers (Acrylics, Polyethylene)
 - Cross linked Rubber = Hydroxyl terminated Polybutadiene HTPB
 - Liquefying Fuels = Paraffin Wax







VIKAS Engine VIKram Ambalala Sarabhai

Schematic of Conventional Liquid Rocket Engine



L40 STAGE



- Works on Gas generator Cycle
- Thrust produced : 799 kN
- Propellant flow rate : 278 kg/s
- Specific Impulse : 293 seconds
- Burn duration : 140/150 seconds



Twin VIKAS engine in L110 STAGE

PS2 STAGE
Cryogenics in India

- 1991: Initial USSR Collaboration
- 1993: Russia Cancelled due to India not member of MTCR
- 1994: Russia provided 7 Cryogenic Engine
- 1994: India starts CUSP Cryogenic Upper Stage Project
- 2000: India develops Indigenous Cryogenic Engine
- USA, Russia, France, China, Japan and India only countries

After	r a Long ney	India	Joins a
A brief h Indian c	listory of the ryogenic engine	FIRST	FLIGHT
1982	First team to make engine	US	1963
1986-91	Early experiments	Japan	1977
1991	Russian agreement	Franc	e 1979
1993	Russians back out on technology	China Russia	1984
1994	Indian cryogenic programme formalised	India	2014
2000	First engine test (failure)		
2003	First successful test	and a second	Katter
2007	First integration with rocket		PAR
2010	First flight		
2014	FIRST SUCCESSFUL FLIGHT	1 () () () () () () () () () (









Sounding Rockets

- Research Rocket
- Study Upper Atmosphere for Space Research
- 40 KM to 160 KM
- Rohini Sounding Rocket (RSR) Programme





PSLV:

- Majorly used for EOS (Earth Observation Satellite)
- Major Missions: MOM, IRNSS, Chandrayan 1

SSLV

- Low Cost
- 500kg into 500km LEO/SSO
- Launch on Demand
- Multiple Satellite
- High Market Prospects
- Eg. EOS-07, Janus-1, AzaadiSAT-3





GEOSYNCHRONOUS SATELLITE LAUNCH VEHICLE MARK-III (GSLV Mk-III)

The GSLV Mk-III will carry Chandrayaan 2 to its designated orbit. This three-stage vehicle is India's most powerful launcher to date, and is capable of launching 4-tonne class of satellites to the Geosynchronous Transfer Orbit (GTO).

Height: 43.43 m

Lift Off Mass: 640 tonnes





Reusable launch vehicle

- 2 Stages 1st Semi-Cryogenics & 2nd Cryogenics
- 1st Uncrewed flying testbed RLV-TD
- No Space Debris
- Useful in Human Space Mission





POINT NEMO

The most isolated location on the planet and the "spacecraft cemetery".



This isolated point serves as a cemetery for our space debris. Most recently: THE MIR SPACE STATION in 2001

Separate Point Nemo from the closest land, the PITCAIRN and MOTU NUI islands

New Zealand

Cape Horn

POINT NEMO

It is the "OCEANIC POLE OF INACCESSIBILITY", i.e. the place in the ocean that is furthest from emerged land

"Nemo" means "NO ONE" in Latin

There is no one around within an area of **22 MILLION KM**²



The closest people are in the INTERNATIONAL SPACE STATION, orbiting 400 km above the Earth



NEXT-GEN LAUNCH VEHICLE (NGLV)



Why in news? ISRO is developing a Next-Gen Launch Vehicle (NGLV) to replace operational systems like the Polar Satellite Launch Vehicle (PSLV).

About NGLV

• It is a **cost-efficient**, three-stage to orbit, reusable heavy-lift vehicle with a payload capability of ten tonnes to Geostationary Transfer Orbit (GTO).

• It will feature **semi-cryogenic** propulsion (refined kerosene as fuel with liquid oxygen (LOX) as oxidizer) for the booster stages, which is **cheaper and efficient.**

• Its design will be simple & robust which allows bulk manufacturing, modularity in systems, sub-systems and stages & minimal turnaround time.

• Potential uses will be in the areas of launching communication satellites, **deep space missions**, future human spaceflight and cargo missions.







ONE OF THE WORLD'S FIRST FEW ALL COMPOSITE SPACE LAUNCH VEHICLES

La

MASS

3D PRINTED SOLID THRUSTERS FOR SPIN STABILITY

TESTS 80% OF TECH FOR FUTURE VIKRAM SERIES OF ORBITAL SPACE VEHICLES

> LENGTH DIAMETER 0.375M PEAK VACUUM THRUST 7 TONNES PEAK COMBUSTION PRESSURE PEAK VELOCITY CAPABILITY PAYLOAD CAPACITY B3KG TO 100KM ALTITUDE

OUICK' FACTS

OUICKEST AND MOST AFFORDABLE RIDE TO SPACE

FLIGHT-PROVING OF AVIONICS SYSTEMS IN VIKRAM SERIES LIKE TELEMETRY, TRACKING, INERTIAL MEASUREMENT, GPS, ON-BOARD CAMERA, DATA ACQUISITION AND POWER SYSTEMS

VITAL STATS OF VIKRAM-S

545 KG 6M 90 BAR > MACH 5 (HYPERSONIC)

WHAT MAKES INDIA'S FIRST **PRIVATELY BUILT ROCKET SPECIAL: SKYROOT'S VIKRAM-S**

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VIKRAM-S-VITAL STATS

Mass 546 kg

Length 8 m (approx. 27 ft)

Diameter 0.376 m (approx. 1.24 ft)

Peak Vacuum Thrust 7t (7,000 kg)

Peak Combustion Pressure 80 bar

Peak Velocity > Mach 5 (Hypersonic)

Payload Capacity 83 kg to 100 km altitude

The Vikram-S launch vehicle or rocket is developed by the Kondapur (Telengana)-based spacetech startup Skyroot. The firm was launched by former ISRO Engineers Pawan Kumar Chandana (31) and Naga Bharat Daka (32) in 2018. Skyroot has raised \$68 mn in funding to date.

INSIDE VIKRAM-S

- Made using composite materials, it has an all-carbon fibre core structure
- Equipped with 3D-printed engines for spin stability during flight
- Co. claims it to be one of the cheapest rockets built in its category, globally
- A 200-engineer team worked to build it in a record time of 2 years

LAUNCH TO TEST

- 80% of onboard technologies for company's future Vikram Series launches
- Effectiveness of inflight avionics, including telemetry, tracking, inertial measurement, GPS, camera, and data acquisition and power systems

CHANDRAYAAN







A look at the major differences between the two missions



India is the 4th country to soft land rover on the surface of moon after Russia, US & China

CHANDRAYAAN-3 MOON MISSION

Chandrayaan-3, the succeeding mission to Chandrayaan-2, is set to launch on Friday, July 14, 2023 at 2.35 pm



Lunar Orbit Insertion

EBNs

100 km



Integrated Module Phase

Lunar Transfer Trajectory

Mission life 1Lunarday Take of from (14 Earth days) Sriharikota

LVM3-M4 Vehicle

Height 43.5 m Lift-off

Mass

642t

Mass 1,749.86 kg including Rover

Lander Module & Rover

Propulsion module

Graphic: Ritesh Kumar

Lander Payloads



RAMBHA-LP Langmuir Probe

To measure the near surface plasma (ions and electrons) density and its changes with time.

Rover Payloads



APXS **Alpha Particle X-Ray** Spectrometer

To determine the elemental composition (Mg, Al, Si, K, Ca.Ti, Fe) of lunar soil and rocks around the lunar landing site.



ChaSTE

LIBS

surface.

Laser Induced

Spectroscope

To derive the chemical

composition and infer

to further enhance our

understanding of lunar

mineralogical composition

Breakdown

Chandra's Surface Thermophysical Experiment

To carry out the measurements of thermal properties of lunar surface near polar region.



ILSA

Instrument for Lunar Seismic Activity

To measure seismicity around the landing site and delineating the structure of the lunar crust and mantle

ACADEMY OF

डसर

Spo

ESTD 2016

Propulsion Module Payload



SHAPE Spectro-polarimetry of **HAbitable Planet Earth**

An experimental payload to study the spectro-polarimetric signatures of the habitable planet Earth in the near-infrared (NIR) wavelength range (1-1.7 µm).





Who's Responsible for Space Junk?

Number of spent rocket bodies and other pieces of debris

Russia 🔵





Over 5500 Tons of Space Junk





SPACE JUNK BY NUMBERS 5.450 8.950 5.000 1.950

5,450 successful rocket launches since space age began	o,930 satellites placed into Earth orbit by these rockets	of these satellites are still in space	of these satellites are still functioning	tonnes is the total mass of all space objects in Earth orbit
• 500 BREAK-UPS explosions, collisions, anomalous events resulting in fragmentation			DEBRIS OBJECTS	
			34,000	>10 cm
22,300 DEBRIS objects regularly tracked by space surveillance networks			900,000	1-10 cm
			128 mn	1-10 mm
Note: Approximate numbers; debris objects in orbit. estimated by statistical models		8		

0 400





KESSLER SYNDROME







About

The Kessler syndrome, named after NASA scientist Donald J. Kessler, describes a situation in which the amount of space debris in low Earth orbit is so high that collisions between objects could lead to a chain reaction, creating even more debris and increasing the likelihood of further collisions.

Implication

The Kessler syndrome is a problem because when objects in space collide, they create debris that can hit other objects, creating even more debris. If a big enough collision were to happen, it could make it very difficult for satellites in low Earth orbits to survive.

Example

Collisions between manmade objects in space have already happened. For example, in 1996, debris from an Ariane rocket that launched to space in 1986 hit the Cerise satellite. The debris floated around Earth's orbit for a decade before its destructive collision.

Project NETRA

Why in news?

Under the Network for Space Objects Tracking and Analysis (NETRA) programme, the Indian Space Research Organisation (ISRO) is enhancing its orbital debris.

About -

Project NETRA is a space-based early warning system for Indian satellites in low-earth orbit that detects trash and other threats. It is initiative taken by ISRO.

Significance

The initiative will provide India with its own space situational awareness (SSA) capabilities.

NETRA's ultimate goal is to photograph the scene in GEO, or geostationary orbit.

Space Debris

Rocket bodies used to launch satellites, defunct satellites, and materials released during mission operations, fragments from on-orbit breakups of space objects, and fragments from Anti-Satellite (ASAT) tests are all examples of space debris.

Facilities

It will be able to detect and track things that are 10 cm or larger. It will have a 1,500 kilometre range. As part of developing an effective surveillance and tracking network, these will be inducted.



Mission Shakti

WHAT

Obsolete satellite destroyed by DRDOdeveloped ballistic missile interceptor missile



Satellite was at height of 300 km, was tracked with sensors that confirmed the kill

Demonstrates India's ability to detect, target and destroy space objects

DRDO had capability to develop system in 2012; made presentations, but was not given go-ahead

WHERE

Ground-based interceptor missile units based in Balasore testing range

WHEN

Preparations started in 2016, tests carried out in 2017 and in February this year

SENT UP, BROUGHT DOWN





GAGANYAAN MISSION

INDIA'S FIRST MANNED FLIGHT TO SPACE

The project was first approved by PM Narendra Modi on August 15, 2018.

It will send the three member crew to space for at least seven days by 2024-25.

ISRO hopes to deploy its biggest rocket, GSLV MK III, for this project.



The space agency hopes to launch the first mission within 40 months from the date of approval. It would be one of the cheapest manned spaceflights in the world, with the estimated cost of not more than Rs 10000 crore.

India plans to call its astronauts "Vyomnauts" since 'Vyom' in Sanskrit means 'Space'.

India will become fourth country after Russia, US and China to send humans to space.







New Frontiers Program



Pluto-Kuiper Belt



Launched January 2006 Flyby July 14, 2015 2nd NF mission Juno:

Jupiter Polar Orbiter



Launched August 2011 Arrives July 4, 2016



3rd NF mission OSIRIS-REx:

Asteroid Sample Return



Launch window: Sept. 8, 2016



SAMPLE RETURN CAPSULE



OSIRIS-REx spacecraft

Shortly before 4pm UK time on 24 September 2023 OSIRIS-REx's sample return capsule is due to touch down on Earth for the first time in seven years Inside, more than 250 grams of the asteroid Bennu have been preserved in pristine condition, waiting to be analysed by scientists





PARKER BARKER SOLAR PROBE

BY THE NUMBERS

As it turns 4, NASA's game-changing mission to explore solar phenomena at its source — built and operated by the Johns Hopkins Applied Physics Laboratory — is revolutionizing our knowledge of the Sun.

As of August 12, 2022 '

Parkersolarprobe.jhuapl.edu www.nasa.gov/parkersolarprobe National Aeronautics and Space Administration



2.76 BILLION MILES TRAVELED

> 64 YEARS SINCE A SOLAR PROBE MISSION WAS FIRST

PROPOSED

62,047

IMAGES TAKEN

538

TRIPS

INTO THE SUN'S

CORONA

SCIENTIFIC PAPERS C I T I N G PARKER SOLAR PROBE DATA 2.8 TERABYTES OF DATA RETURNED TO EARTH

12 ORBITS OF THE SUN **513** MILLION MILES FROM SUN ON PARKER'S CLOSEST APPROACH TO DATE Launch Date Between July 31 and August 19, 2018 from Kennedy Space Centre in Florida

The Probe

Weight: 1,350lb Length: 9ft 10in

Magnetometers will measure electric and magnetic fields, radio emissions and shock waves

Solar panels power the probe and retract when close to sun

Arriving at Sun

2024

Electromagnetic

emissions of the sun

wave antenna

measure radio

and solar winds

The Parker Solar Probe Mission

The spacecraft will fly through the sun's atmosphere to within 3.7 million miles seven times closer than any spacecraft has come before

Thermal shield to → protect instruments is 8ft in diameter and made of 4.5 in thick carbon composite







SIGNIFICANT EVENTS OF THE APOLLO 11 AND PROPOSED CONSTELLATION MISSION



Walking on the Moon





ARTEMIS PREPARES FOR MARS



Expanding the range of surface exploration and ISRU demonstrations Gateway augmented with international habitat for increased capabilities Foundation Surface Habitat and Habitable Mobility Platform delivered to complete Artemis Base Camp

> Habitatable Mobility Platform

Expanded habitation capability added to Gateway to enable Mars mission dress rehearsal at the Moon

Mars mission dress rehearsal with longer in-space and surface durations

Testing landing and ascent capabilities

Lunar Terrain Vehicle

hicle

Foundational Surface Habitat

SUSTAINABLE LUNAR ORBIT STAGING CAPABILITY AND SURFACE EXPLORATION

MULTIPLE SCIENCE AND CARGO PAYLOADS I INTERNATIONAL PARTNERSHIP OPPORTUNITIES I TECHNOLOGY AND OPERATIONS DEMONSTRATIONS FOR MARS

ARTEMIS I





The first uncrewed, integrated flight test of NASA's Orion spacecraft and Space Launch System rocket, launching from a modernized Kennedy spaceport



Total distance traveled: 1.3 million miles – Mission duration: 26-42 days – Re-entry speed: 24,500 mph (Mach 32) – 13 CubeSats deployed



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PROXIMITY

DEMONSTRATION SEQUENCE

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ARTEMIS II

First Crewed Test Flight to the Moon Since Apollo

LAUNCH Astronauts lift off from pad 39B at Kennedy Space Center.

9

ESTD 2016

JETTISON SOLID ROCKET BOOSTERS, FAIRINGS, AND LAUNCH ABORT SYSTEM

CORE STAGE MAIN ENGINE CUT OFF With separation.

PERIGEE RAISE MANEUVER

APOGEE RAISE BURN TO HIGH EARTH ORBIT Begin 23.5 hour checkout of spacecraft.

Prox Ops

Demonstration

6 ORION SEPARATION FROM INTERIM CRYOGENIC PROPULSION STAGE (ICPS) FOLLOWED BY PROX OPS DEMO Plus manual handling gualities assessment

for up to 2 hours.

E ORION UPPER STAGE SEPARATION (USS) BL

SEPARATION (USS) BURN Begins high Earth orbit checkout. Life support, exercise, and habitation equipment evaluations.

PERIGEE RAISE BURN

TRANS-LUNAR INJECTION (TLI) BY ORION'S MAIN ENGINE

Lunar free return trajectory initiated with European service module.

OUTBOUND TRANSIT TO MOON

Outbound Trajectory Correction (OTC) burns as necessary for Lunar free return trajectory; travel time approximately 4 days.

1 LUNAR FLYBY

ICPS Earth

disposal

6,479 miles / 10,427 km (mean) lunar farside altitude.

RETURN Return Trajectory Correction (BTC) burns as necessary

12 TRANS-EARTH

(RTC) burns as necessary to aim for Earth's atmosphere; travel time approximately 4 days.

- CREW MODULE SEPARATION FROM SERVICE MODULE
- ENTRY INTERFACE (EI) Enter Earth's atmosphere.

15 SPLASHDOWN

Ship recovers astronauts and capsule.





ARTEMIS III

Landing on the Moon

- LAUNCH SLS and Orion lift off from Kennedy Space Center.
- 2 JETTISON ROCKET BOOSTERS, FAIRINGS, AND LAUNCH ABORT SYSTEM
- 3 CORE STAGE MAIN ENGINE CUT OFF With separation.
- ENTER EARTH ORBIT Perform the perigee raise maneuver. Systems check and solar panel adjustments.
- 5 TRANS LUNAR INJECTION BURN Astronauts committed to lunar trajectory, followed by ICPS separation and disposal.
- ORION OUTBOUND TRANSIT TO MOON
 - Requires several outbound trajectory burns.

- ORION OUTBOUND POWERED FLYBY 60 nmi from the Moon.
- NHRO INSERTION BURN Orion performs burn to establish rendezvous point and executes rendezvous and docking.
- LUNAR LANDING PREPARATION Crew activates lander and prepares for departure.
- LANDER UNDOCKING AND SEPARATION
- 1 LANDER ENTERS LOW LUNAR ORBIT Descends to lunar touchdown.
- LUNAR SURFACE EXPLORATION Astronauts conduct week long surface mission and extra-vehicular activities.
- ORION REMAINS IN NHRO ORBIT During lunar surface mission.

- LANDER ASCENDS TO LOW LUNAR ORBIT
- LANDER PERFORMS RENDEZVOUS AND DOCKING

DESCEND

16

ASCEND

NEAR-

RECTILINEAR

HALO ORBIT

(NHRO)

9

- CREW RETURNS IN ORION Orion undocks, performs orbit departure burn.
- ORION PERFORMS RETURN POWERED FLYBY 60 nmi from the Moon.
- FINAL RETURN TRAJECTORY CORRECTION (RTC) BURN Precision targeting for Earth entry.
- CREW MODULE SEPARATION
 FROM SERVICE MODULE
- 20 ENTRY INTERFACE (EI) Enter Earth's atmosphere.
- SPLASHDOWN Ship recovers astronauts and capsule



ESTD 2016

▼ To Earth



étv-t FOR ALL MANKIND



- NASA + Roscosmos + JAXA + Canada SA + ESA
- 2 Sections : US Orbital Segment + Russia Orbital Segment
- 2031 Retirement
- Resupply Mission = SpaceX & Russia

- Continuous Human Presence
- 6 Crews + Visitors
- 8 KM/s
- 200 Astronauts from 19 Countries
- Launched in 2000
- 350 KMs LEO






Space Diplomacy

- Use of space capabilities for further strategic interests
- China launched satellites for Venezuela, Pakistan and Sri Lanka
- India proposing to launch satellites for SAARC Countries
- India Provides SAS (GSAT-9) services to Neighbours like Telecom, Television, DTH, Tele-education and Tele-medicine.
- GSLV-F09 used = Indigenous Cryogenic Powered Upper Stage







Astronomical Unit



- Which one of the following is a reason why astronomical distances are measured in light-years? (2021)
 - A. Distance among stellar bodies do not change
 - B. Gravity of stellar bodies does not change
 - C. Light always travels in straight line
 - D. Speed of light is always same

(d) Speed of light is always same

Spacecraft Purpose

- 1. Cassini-Huygens : Orbiting the Venus and transmitting data to the earth.
- 2. Messenger : Mapping and investigating the Mercury
- 3. Voyager 1 and 2 : Exploring the outer solar system

Select the correct answer using the code given below:

- A. 1 only
- B. 2 and 3 only
- C. 1 and 3 only
- D. 1, 2 and 3





• 2 and 3 only



In which of the following activities are Indian Remote Sensing (IRS) satellites used? (2015)

- 1. Assessment of crop productivity
- 2. Locating groundwater resources
- 3. Mineral exploration
- 4. Telecommunications
- 5. Traffic studies

Select the correct answer using the code given below:

- A. 1, 2 and 3 only
- B. 4 and 5 only
- C. 1 and 2 only
- D. 1, 2, 3, 4 and 5



• 1, 2 and 3 only



With reference to 'AstroSat', the astronomical observatory launched by India, which of the following statements is/are correct? (2016)

- 1. Other than USA and Russia, India is the only country to have launched a similar observatory into space.
- 2. AstroSat is a 2000 kg satellite placed in an orbit at 1650 km above the surface of the Earth.

Select the correct answer using the code given below:

- A. 1 only
- B. 2 only
- C. Both 1 and 2
- D. Neither 1 nor 2



• Neither 1 nor 2



Thank You Future Officers!

Presented by Arjun Kr. Paul



Defense Technology



DRDO

- MoD Ministry of Defense
- Incumbent: Dr G. Satheesh Reddy
- Design, develop and lead to production state-of-the-art sensors, weapon systems, platforms and allied equipment
- Provide technological solutions to the Services to optimize combat effectiveness and to promote well-being of the troops
- Develop infrastructure and committed quality manpower and build strong indigenous technology base



DRDO Achievements

- Extreme Cold Weather Clothing System (ECWCS)
- 'Pralay': India's first conventional quasi-ballistic missile
- Controlled Aerial Delivery System: Precise delivery of payload upto 500 kgs at predetermined location using Ram Air Parachute (RAP)
- Pinaka Extended Range (Pinaka-ER) Multiple Launch Rocket System (MLRS)
- Supersonic Missile Assisted Torpedo System (SMART)
- Advanced Chaff Technology
- Akash Air Defense
- BrahMos Missile











PRALAY: Surface-to-**Surface Missile**

Pralay is a canisterised tactical, surface-to-surface, and short-range ballistic missile for battlefield use developed by the Defence Research and Development Organisation of India

Warhead Bay

Rocket Motor

Controls-

ENGINE: Two stage rocket motor with third stage MaRV

SPEED: Mach 1 to 1.6

RANGE: 150-500 km

TRAJECTORY: IOW **GUIDANCE SYSTEM:** Inertial navigation system

LAUNCH PLATFORM: 8x8 BEML-Tatra transporter erector launcher

MASS: 5 tonnes (4.9 long tons; 5.5 short tons)

OPERATIONAL RANGE: 150-500 km (93–311 mi)

Can change its path after covering certain range mid-air and is difficult to be tracked

It is capable of being launched from a mobile launcher and has latest navigation system and integrated avionics

It has the capability to defeat interceptor missiles

PRAID





Supersonic Missile Assisted Release of Torpedo (SMART) CONOPS





BRAHMOS: THE THIRD DIMENSION

The first test of the air-launched Brahmos is to be conducted in the Bay of Bengal sometime in December this year



CARRIER KILLER

The carrier-killing Brahmos will be carried by a Su-30MKI aircraft over a range of over 3000 km.

PRESENT CAPABILITY

Missile can hit target in steep dive mode at an angle of 65 degrees. Less effective against large aircraft carriers that can withstand hits on their side.

SU-30MKI

expandable

FUTURE CAPABILITY

Missile with a modified seeker locks onto moving aircraft carrier in vertical mode (90 degrees). Missile destroys aircraft carrier.

Aircraft Carrier

SPECIFICATIONS OF AIR-LAUNCHED BRAHMOS

Weight	:2.5 tons
Range	: 290 km =
Weight of warhead	: 300 kgs
Max speed	: Mach 2.8
Mngspan	:1.7 m
Diameter	:70 cm

MODIFIED TO LAUNCH BRAHMOS MISSILE, ONE PER AIRCRAFT

Max speed	: Mach 2.0
Range	: 3,000 km
Ferry range	: 8,000 km with two inflight refuellings.
Endurance	: 3.75 hrs (up to 10 hrs with in-flight refuelling)
Service ceiling	: 17,300 m



2MHM2

Integrated Guided Missile Development Programme (IGMDP)





Chief of Defense Staff (CDS)

- Recommended by Kargil Review Committee (1999)
- 2002 Integrated Defence Staff
- 2012 Naresh Chandra Committee Recommended Appointment of Permanent Staff
- 2019 Post CDS is created
 - General Bipin Rawat, 1st CDS
 - Lt General Anil Chauhan, Incumbent
- CDS heads Department of Military Affairs (DMA)



CDS – Roles & Responsibilities

- Foster Operational Synergy between 3 Services
- Reduce/Minimise Inter Service Frictions
- Single Point Military Adviser to Defence Minister
- Authority to Prioritise Inter Service Procurement Decision
- Authority to Provide Directives to 3 Chiefs
- First Among Equals Rank of Secretary with DoD
- Advisory Role in Nuclear Command Authority (NCA)





Missile

 A rocket-propelled weapon designed to deliver an explosive warhead with great accuracy at high speed

The German A-4 (V2) rocket







Classification of missiles



TYPES OF ATMOSPHERIC JET ENGINES

TURBOJET

Turbojets are the oldest and most general purpose jet engines, finding use in a large variety of applications. They are most efficient at supersonic velocities, and are capable of speeds around Mach 3. They were also found on the Concorde and the Tupolev Tu-144.

TURBOFAN

A turbofan is essentially a turbojet but with a large ducted fan that provides additional thrust by moving large amount of low velocity air around the main engine. This type of engine is more efficient than turbojets at subsonic speeds. Ex. Boeing 747.

RAMJET

A ramjet is nothing more than a turbojet with all of the rotating parts removed. Ramjets are primarily used with missiles, due to their simple, small, and high-velocity design

Exhaust

(M>1)

SCRAMJET

ACADEMY OF CIVIL SERVICES

A scramjet is identical to a ramjet, but with one difference: combustion occurs with the air moving at supersonic velocities. As a result, scramjets are estimated not to work well below Mach 5, but could possibly reach speeds of Mach 24 (18000 mph).





Integrated Guided Missile Development Programme







Prithvi

- Short Range
- Surface-to-Surface Missile
- Dhanush Naval Variant

- Sagarika Submarine Variant
- Payload = 350-1000 KG
- Range = 150-750 KM

Variants	Range	Payload	Fuel	Warheads	Status
Prithvi-l	150 km	1,000kg	Single-stage liquid-fueled	Nuclear, high-explosive	Inducted
Prithvi II	350 km	350 kg to 750kg	Single-stage liquid-fueled	Nuclear or Conventional	Inducted
Prithvi III	750 km	1,000 kg for 350 km & 500kg for (650km) 250 kg for 750 km	1st stage is Solid -fueled 2nd stage- liquid-fueled .	Nuclear or Conventional	Inducted

INDIA'S 'AKASH' TO COUNTER **DRAGON FIRE**

Mission 》 To track & destroy hostile aircraft. helicopters. drones & sub-sonic cruise missiles

Surface-to-Air missile (SAM) system was one of the five core missile systems of the Integrated Guided Missile Development Programme launched by India in 1983. After long delays due to technical glitches, Akash now finally being deployed by IAF & army

IAF »

Army »

Inducting eight squadrons, each with 2 'flights' of 4 launchers

Inducting 2 Akash regiments,

Cost | ₹6,200 Cr

with six firing batteries & hundreds of missiles each

Cost | ₹14,180 Cr

MISSILE CHARACTERISTICS

5.6 metre in length;

integrated two-stage Ramjet rocket propulsion technology: powered by an air-breathing engine: can carry warhead of 60kg

25-km interception range

Low reaction, all-weather capability

96% indigenous

Can handle multiple aerial threats from several directions simultaneously

88%

kill probability within a specified kill zone

Akash Air Defense





Trishul - Navy

- Range 12 KM
- 5.5 KG Warhead
- Surface to Air
- Low Level (Sea Skimming) Target
- Defend Naval Assets





Agni Missile Development Programme



Agni-I

Class: SRBM Length: 14.80 m Diameter: 1.30 m Launch weight: 12,000 kg Payload: 2,000 kg Warhead: Nuclear capable Propulsion: Single-stage Range: 700-1,200 km Status: Operational

Agni-II

Class: IRBM Length: 20 m Diameter: 1.30 m Launch weight: 16,000 kg Payload: 1,000 kg Warhead: Nuclear capable Propulsion: Two-stage Range: 2,000-3,500 km Status: Operational

Agni-III

Class: IRBM Length: 16.7 m Diamoter: 2 m Launch weight: 48,000 kg Payload: 2,000 kg Warhead: Nuclear capable Propulsion: Two-stage Range: 3,500 km Status: Operational



Class: Long-range Length: 20m Diameter: 1.20 m Launch weight: 17,000 kg Peyload: 800-1,000 kg Warhead: Nuclear capable Propulsion: Two-stage Range: 2,500-3,500 km Status: Development





AGNI SERIES OF LONG RANGE BALLISTIC MISSILES

AGNI V

- Operational range: 5,000 km
- Payload: 1360.78 kg
- Height 17m
- Future development possible for variant that could be launched from a submarine



India's MIRV punch

India has joined select group of nations that have Multiple Independently Targeted Re-entry Vehicle (MIRV) technology

Agni-5 missile uses a three-stage solid fuelled engine

5,000km range MIRVs can cause more destruction than missiles that carry single warhead.
It will allow Agni-V to deliver multiple nuclear warheads against different

targets across hundreds of kilometres

USING MULTIPLE WARHEADS

India completed its nuclear trial in 2018 when nuclear-powered ballistic missile submarine, INS Arihant, completed its first deterrence patrol India's nuclear doctrine, promulgated in 2003, commits to a 'no first use' posture, with weapons to be used only in retaliation against a nuclear attack

Proud of our DRDO scientists for Mission Divyastra, the first flight test of indigenously developed Agni-5 missile with Multiple Independently Targetable Re-entry Vehicle (MIRV) technology." —NARENDRA MODI, Prime Minister

INDIA'S NUCLEAR TRIAD

A Land Vector

Prithvi-II (350-km), Agni-1 (700-km), Agni-2 (2,000-km), Agni-3 (3,000-km) & Agni-5 (over 5.000-km) missiles inducted by the Strategic Forces Command

B Air Vector Sukhoi-30MKI. Mirage-2000, Jaguar & Rafale fighters can deliver nuclear gravity bombs

C Sea Vector > Only 1 nuclear-powered ballistic missile submarine (SSBN), the 6,000-tonne INS Arihant, fully operational. Armed with 750-km range K-15 nuclear missiles

6.000-tonne INS Arighat undergoing final trials. Will be commissioned this year

Will be followed by two 7,000-tonne SSBNs (called S-4 & S-4*) being built at Vizag. Over 13,000-tonne S-5 class SSBNs to be built later

K-4 missiles (3,500-km) range) have completed development trials

Development of K-5 (5.000km) and K-6 (6,000-km) SLBMs in progress

MIRV

> All Indian nuclear-capable missiles inducted so far have single warheads

MIRV payload means a single missile capable of carrying at least two to three nuclear warheads, with each programmed to hit different targets in different directions

> The targets can be a few hundred km apart

MIRV missiles can overcome enemy defence systems & ensure effective retaliation to a first strike

> US, UK & France have submarinelaunched MIRV missiles

China has land-based MIRV missiles

Re-entry

vehicles

warheads

MIRV

Normal

Missile

Russia has both sea and landbased MIRV missiles

Agni-5 Range | Over 5,000km. Covers entire China & Asia as carrying nuclear well as parts of Europe & Africa



(Helicopter Launched Nag) Anti Tank Missile

Range:-7 to 8 Km

The Nag missile also called "Prospina" for the land-attack version, is an Indian third-generation, all-weather, fire-and-forget, lock-on after launch, anti-tank guided missile (ATGM).

The Nag has five variants under development: a land version, for a mast-mounted system; the helicopter-launched Nag (HELINA) also known as Dhruvastra; a "man-portable" version (MPATGM), an air-launched version which will replace the current imaging infra-red (IIR) to millimetric-wave (mmW) active radar homing seeker and the Nag Missile Carrier (NAMICA) "tank buster", which is a modified BMP-2 Infantry Fighting Vehicle (IFV) produced under license in India by Ordnance Factory Medak (OFMK)



Technical	Specifications		
Maximum r	ange 400+ km	Warhead mass	200-300 kg
Velocity	Mach 2.8	Altitude	
Neight	2.5 tonnes	 Cruise: 15 km Terminal: 	
		10-15 metre	ALL ALL

BRAHMOS

Special Features

- Universal for multiple platforms
- "Fire and Forget" principle of operation
- High supersonic speed all through the flight
- Long flight range with varieties of flight trajectories
- Low radar signature
- Shorter flight times leading to lower target dispersion and quicker engagement
- Pin point accuracy with high lethal power aided by large kinetic energy on impact

Compared to existing state-of-the-art subsonic cruise missiles, BrahMos has

3 times more velocity
 2.5 to 3 times more flight range
 3 to 4 times more seeker range
 9 times more kinetic energy



BRAHMOS: THE THIRD DIMENSION

The first test of the air-launched Brahmos is to be conducted in the Bay of Bengal sometime in December this year



CARRIER KILLER

The carrier-killing Brahmos will be carried by a Su-30MKI aircraft over a range of over 3000 km.

FUTURE CAPABILITY

Missile with a modified seeker locks onto moving aircraft carrier in vertical mode (90 degrees). Missile destroys aircraft carrier.

> Aircraft Carrier

PRESENT CAPABILITY

Missile can hit target in steep dive mode at an angle of 65 degrees. Less effective against large aircraft carriers that can withstand hits on their side.

SPECIFICATIONS OF AIR-LAUNCHED BRAHMOS

COMHINS

Weight	:2.5 tons
Range	: 290 km =
Weight of warhead	: 300 kgs
Max speed	: Mach 2.8
Wingspan	:1.7 m
Diameter	:70 cm

SU-30MKI

MODIFIED TO LAUNCH BRAHMOS MISSILE, ONE PER AIRCRAFT

Max speed	: Mach 2.0
Range	: 3,000 km
Ferry range	: 8,000 km with two inflight refuellings.
Endurance	: 3.75 hrs (up to 10 hrs with in-flight refuelling)
Service ceiling	: 17,300 m

= expandable

OF
Indian BrahMos missiles delivered to the Philippines: The missile's significance

BrahMos Aerospace Private Limited (BAPL), a joint venture company of the DRDO, had signed a contract with the Philippines on January 28, 2022 for supply of Shore Based Anti-Ship Missile System. Here's a look at how BrahMos was developed.





K-4 Balistic MSSALE Successfully Test-Fired by India

India successfully test-fired the 3,500 km strike range nuclear-capable K-4 submarine-launched ballistic missile off the coast of Andhra Pradesh.

The missile system is being developed by the DRDO and is to be fitted into the indigenously built INS Arihant-class nuclearpowered submarines of the Indian Navy. arihant

SLBM – Submarine Launched **Ballistic Missile** Faster, Lighter and Stealthier than Agni K15 or Sagarika – India's 1st SLBM = 750 KM 2 Stage Solid Fuel Land Variant of K15 = Shaurya Missile Canister Based = Long shelf life **Transportation Easier**



Follow us on f

Pralay missiles

Context: Indian Armed Forces plans to acquire around 250 more units of Pralay Quasi-ballistic missiles.

What are Quasi-Ballistic Missiles?

A quasi-ballistic missile is a type of missile that combines characteristics of ballistic missiles and cruise missiles. It is designed to follow a ballistic trajectory for part of its flight and then transition to a low-altitude, high-speed cruise trajectory.



Feature	Ballistic Missiles	Quasi-Ballistic Missiles	Cruise Missiles
Flight Path	High-altitude	Combines ballistic and low-	Low-altitude cruise
	ballistic trajectory	altitude cruise paths	trajectory
Manoeuvrability	Limited	Can change course mid-flight	High
Propulsion	Solid or liquid	Solid or liquid rocket motor	Turbofan or turbojet
	rocket motor		engines
Range	Long-range	Medium-range capability	Short to medium-
	capability		range capability
Accuracy	Highly accurate in	Accurate in hitting moving	Accurate in hitting
	hitting stationary	targets	moving and
	targets		stationary targets
Interception	Difficult to	Can change course to evade	Can be intercepted
Resistance	intercept due to	missile defence	by advanced missile
	high speed		defence





S-400 SURFACE-TO-AIR MISSLIE SYSTEM



- Can shoot down up to 80 target simultaneously
- Cannot yet accurately target low-flying aircraft and missiles (altitude below 30,000 ft) at great distances

India inks S-400 Triumf deal with Russia

India has signed a \$ 5.43 billion (about ₹ 40,000 crore) deal with Russia to procure five S-400 Triumf advanced air defence missile systems

PAKISTAN

S-400 Triumf Features

Can engage all types of aerial targets including aircraft, unmanned aerial vehicles and all types of missiles

Locates targets at 600 km and can destroy them at 400 km range, up to an altitude of 30 km

INDIA

Possible

options

deployment

CHINA

NEPAL

The system can engage multiple targets simultaneously

Integrates:

- Multifunction radar
- Anti-aircraft missile systems
- Launchers
- Autonomous detection and targeting systems
- Command and control centre

Range of missiles:

Capable of firing different types of missiles to create a layered defence shield

• 40N6: 400 km • 9M96E2: 120 km

48N6: 250 km
 9M96E: 40 km

KBK Infographics



Map not to scale

Israel's Iron Dome defence system

In service since 2011, intercepts around 90% of rockets fired into Israel









	1	
	- RE-T	
	HY-	100
A STATE		

	SURFACE	TO-SURFA	CE MISSILES
	Short Ran	ige Ballistic	Missiles
	Prithvi-I	150 km	1,000 kg
	Prithvi-II	250 km	500 kg
5	Prithvi-III	350 km	1,000 kg
	Dhanush	350 km	1,000 kg
	Agni-I	700 km	1,000 kg
	Shaurya	700 km	1,000 kg
	Prahaar	150 km	200 kg

Intermediate Range Ballistic Missiles (IRBMs)

Agni-II	2,000 km	1,000 kg
Agni-III	3,000 km	2,000-2,500 kg
Agni-IV	4,000 km	1,000 kg

Intercontinental Range Ballistic Missiles (ICBMs)

Agni -V	5,000 km	1,500 kg ((3-10 MIRV))
Agni-VI (Under Devel	opment)6,000	1,000 kg (10 MIRV)
Surya (Under Develo	pment) 10,000 km	1,000 kg (10 MIRV)
Km denotes the range of	the missile and kg is the pay	load

FORMIDABLE ARSENAL



CRUISE MISSILES Subsonic Cruise Missiles Nirbhay 750-1,000 km 500 kg Supersonic Cruise Missiles BrahMos 290 km 300 kg Hypersonic Cruise Missiles BrahMos-II 290 km 300 kg

Trishul 9 km Akash 30 km Maitri 15 km Barak-8 70 km ANTI-TANK GUIDED

SHORT RANGE

SURFACE-TO-AIR MISSILES

5 kg

50 kg

10 kg

ANTI-TANK GUI MISSILES

Nag Anti-tank guided missile 7 km 8 kg Helina (Helicopter launched Nag missile) 7 km 8 kg

ANTI-BALLISTIC MISSILES Prithvi Air Defence Missile (Exo-atmospheric at 50-80 km altitude) 2,000 km DM (Proximity) Advanced Air Defence Missile (Endo-atmospheric at 15-30 km altitude) 150-200 km DM (Hit-to-kill)

Prithvi Defence Vehicle (Exo-atmospheric at more than 120 km altitude) 2,000-3,000 km DM (Proximity) DM: Detonation Mechanism

Compiled by Hemant Kumar Rout



0 kg	AIR-TO-AIR MISSUE
0 kg	Astra 80-110 kr 15kg
0 kg	and a state

AEW&CS



Airborne Early Warning and Control System



Surveillance of Ground & Air Targets Better Range Less Vulnerable to Counter Attacks Defensive and Offensive Operation

India:

2003: R&D Began by DRDO 2015: DRDO Delivered 3 AWACs – Netra

- 240 Degree Coverage
- Advanced Indian AESA Radar System
- Brazilian Embraer EMB-145



- 1. Active Antenna Array unit (AAAU) houses Primary Radar (PR) & Secondary Surveillance Radar (SSR)
- SATCOM for Voice and Data Communication
- Extendable Endurance with In-Flight Refueling (IFR)
- Dedicated Dual Auxiliary Power Units (APUs) for Mission Avionics
- 5. Fuel Efficient Regional Jet Aircraft Platform

Capabilities

- Primary Surveillance Radar
- Secondary Surveillance Radar
- Electronic Support Measures (ESM)

- Communication Support Measures (CSM)
- C'-Band Data Link with 'Ku'-Band SATCOM Redundancy
- > V/UHF Voice / Data Link
- Self Protection Suite (SPS)
- Radar Warning Receiver (RWR)
- UV-based 'Missile Approach Warning System' (MAWS) with 'Counter Measures Dispensing System' (CMDS)
- > Efficient Thermal Management System for Avionics

Performance

- Service Ceiling: 35,000ft AMSL
- Radar Operational Altitude: 25,000ft AMSL
- Additional Internal Fuel Tanks with In-Flight Refueling System
- Five Operator Work Stations (OWS) and Seven Rest Crew Seats



Muntra (Mission UNmanned TRAcked)

India's 1st Unmanned Remotely Operated Tank

3 Variants:

- Muntra-S: Surveillance
- Muntra-M: Mine Detection
- Muntra-N: Nuclear/Biohazard



THE NEW TEJAS



The long-awaited indigenous fighter Tejas Mk II, which will be manufactured by HAL, will go into production by 2025-2026

17.5 ton

Tejas Mark II will be the same weight as the Mirage, Jaguar and Grippen

ADDITIONS THE NEW GEN

- Heavier stand-off weapon capacity
- State-of-the-art AESA radar
- Indigenously developed air-to-air missile Astra (with a range of 70km)

WHEN: Set to go into production after the Tejas LCA order of 123 aircraft to replace the IAF's ageing MiG-21s is completed

ALSO IN THE WORKS

Advanced medium combat aircraft (AMCA) given a go-ahead by IAF late last year

25-ton fighter will be powered by two engines capable of super-cruise speeds

Will have advanced tech to ensure minimum radar signatures

THE CONTINUING SAGA OF Tejas Light Combat Aircraft

Aug 1983: LCA project is approved with initial cost of **₹560 crore** to replace aging MiG-21s

Jan 2001: First prototype of lightweight multi-role fighter flies

Dec 2013: Tejas gets initial operational clearance (IOC)

Mar 2015: First fighter, in IOC configuration, to be handed over to IAF

Dec 2015: Tejas likely to get final operational clearance (FOC)

2017-2018: All 20 jets of first IOC squadron slated to be delivered

Post-2018: Second squadron, with 20 Tejas in FOC configuration

2012-2022: IAF likely to begin getting 80 Tejas Mark-II to form 4 squadrons

INDIGENOUS CONTENT: 65%

(American engines & ejection seats, Canadian canopy sheaths, etc)



TEJAS CHARACTERISTICS

Weight (fully-loaded) 12tonne
Length	13.2metre
Height	4.4metre
Wing Span	8.2metre
Service Ceiling	15km
Speed	1,350 kmph
Radius of Action (without	Over 400km at refuelling)

TOTAL COSTS: At least ₹55,000cr. **Developmental cost** (including air force & naval variants, trainers & failed Kaveri engine) stands at ₹17,269cr now. With each jet to cost ₹220cr-250cr, 120 Tejas will cost ₹37,440cr



CCS nod for 15 new Light Combat Helicopters

10 for Indian Air Force & 05 for Indian Army Equipped with cutting edge technologies

Agile, Maneuverable, Extended Range, High Altitude Performance, All Weather Combat Capabilities

Stealth features for better survivability

Reduced Visual, Aural, Radar & IR signatures





3 Helmet Mount Display System (HMDS)

- Displays symbology of Sensors / Weapons on Pilot's Sight through Electromagnetic tracking
- Interface with Night Vision Goggles(NVG), Oxygen Mask, HMDS Sensors & Displays

2 Turret Gun

- 20 mm caliber Gun mounted on Nose
- Capable of firing at a rate of 800 Rounds / Minute & Firing range upto 2 km

3

1 Electro Optical (EO) Pod

- Long range Day & Night Surveillance & Target tracking
- FLIR, Color(CCD) Daylight Camera, Laser Target Designator & Range Finder
- Laser Firing Range upto 12 km, Line of Sight Pointing Accuracy of 1.3 mRad

AirTo Air Missile (ATAM)

- Short range Fire & Forget IR Seeker Missile (Four Missiles / Launcher)
- Integrated EO / HPS for aiming targets
- Maximum Range upto 6.5 km

Rocket Pod

- 70 mm caliber Rocket mounted on Stub Wing (Twelve Rockets / Launcher)
- Direct firing range upto 4 km and Indirect firing range upto 8 km

Solid State Digital Video Recorder

- Capable of recording Video, Audio, RS-422, Mil-Bus channels for 4 hours
- Data cartridge capacity of 64 GB

Su-30MKI (Flanker-H) multirole fighter

An export version of Su-30MK aircraft for the Indian Air Force

Manufacturers: Russia's Irkut corporation; Hindustan Aeronautics Ltd. (under licence) 6.36 m (20.85 ft) Maiden flight: July 1, 1997 Production: Started in 2000 Number produced: over 120 aircraft as of September 2009 Price: about \$40 million General characteristics: Ungspan: 14.7 m (48.2 ft) Length 21.9 m Height 6.4 m Wingspan 14.7 m Haight 6.4 m Wingspan 14.7 m Nax speed: kmvh 38,800 Max speed: kmvh 38,800 Max speed: kmvh 1,350 ar high altitude 2,4900 Range (withbout in-flight refueling); km 3,000 Rate of climb.g 9 Powerplant 2xAL-31FP Powerplant 2xAL-31FP Payleads up to 8,000kg -up to 80 unguided rockets	Designer: Ru	ussia's Sukhoi design b	sureau Height	77
Maiden flight: July 1, 1997 Production: Started in 2000 Number produced: over 120 aircraft as of September 2009 Price: about \$40 million Ceneral characteristics: over 120 aircraft as of September 2009 Characteristics: over 120 aircraft as of September 2009 Length 21.9 m Height 6.4 m Wingspan 14.7 m Takeoff weight, kg loaded 24,900 Joaded 24,900 max 24,900 Max speed: km/h near ground at high altitude 1,350 Athigh altitude 1,350 Raneg (without in-flight refueling), fm 3,000 Rate of climb, g 9 Powerplant 2xAL-31FP Powerplant 2xAL-31FP Crew 2 About Subol-kg cluster bombs	Manufacturers: Ru Ad	issia's Irkut corporatio eronautics Ltd. (under	n; Hindustan licence) 6.36 m (20.85 ft)	110
Production: Started in 2000 Wingspan: 14.7 m (48.2 ft) Number produced: over 120 aircraft as of September 2009 Price: about 540 million Price: about 540 million Price: about 540 million Ceneral characteristics: Image: Construction of the second of the	Maiden flight: Ju	ily 1, 1997		NUL
Number produced: over 120 aircraft as of September 2009 Price: about \$40 million about \$40 million orgeneral characteristics: orgeneral Length 21.9 m Height 6.4 m Wingspan 14.7 m Takeoff weight, kg 24,900 Joaded 24,900 max 24,000 Max speed; km/h	Production: St	arted in 2000	Wingspan: 14.7 m (48.2 ft)	
Price: about \$40 million General characteristics: Image: Characteristics: Length 21.9 m Height 6.4 m Wingspan 14.7 m Takeoff weight, kg loaded max 24,900 loaded max 38,800 Max speed: km/h near ground at high altitude 1,350 Range (without in-flight refueling), km 3,000 Rate of climb, g 9 Powerplant 2xAL-31FP Powerplant 2xAL-31FP Crew 2 Payleads up to 8,000kg	Number produced: ov	er 120 aircraft as of S	eptember 2009	
General characteristics: Length 21.9 m Case of characteristics: Length 6.4 m 6.4 m Wingspan 14.7 m 6.4 m Vingspan 14.7 m 6.4 m Takeoff weight, kg loaded max 24,900 38,800 Max speed: km/h near ground at high altitude 1,350 24,000 Range (without in-flight refueling), km 3,000 - built-in single-barrel 30-mm GSh-301 gun (150 rounds) - Up to 6 guided air-to-air misiles Nate of climb, g 9 - up to 6 guided air-to-air misiles - up to 6 guided air-to-air misiles - up to 6 laser guided bombs Powerplant 2xAL-31FP - up to 80 unguided rockets - up to 80 unguided rockets - up to 80 unguided rockets Crew 2 Payloads up to 8,000kg - up to 8,000kg - up to 8,000kg	Price: ab	oout \$40 million	NUMERICAN ATT	
Length21.9 mHeight6.4 mWingspan14.7 mTakeoff weight, kg loaded max24,900 38,800Max speed: km/h near ground at high altitude24,900 38,800Max speed: km/h near ground at high altitude1,350 2,400Range (without in-flight refueling) km3,000Rate of climb, g9Powerplant2xAL-31FPCrew2Powerplant2Crew2	General characteristics:		that -	Length: 21.9 m (72.97 ft)
Height 6.4 m Wingspan 14.7 m Takeoff weight, kg loaded max 24,900 38,800 Max speed: km/h near ground at high altitude 24,900 38,800 Max speed: km/h near ground at high altitude 1,350 2,400 Range (without in-flight refueling) km 3,000 Rate of climb, g 9 Powerplant 2xAL-31FP Low to 8 500-kg cluster bombs Crew 2	Length	21.9 m		
Wingspan14.7 mTakeoff weight, kg loaded max24,900 38,800Max speed: km/h near ground at high altitude1,350 2,400Range (without in-flight refueling), km3,000Rate of climb, g9Powerplant2xAL-31FPCrew2Powerplant2Crew2	Height	6.4 m		and the second s
Takeoff weight, kg loaded max24,900 38,800Armament:Su-30MKIMax speed: km/h near ground at high altitude1,350 2,400- built-in single-barrel 30-mm GSh-301 gun (150 rounds) - up to 6 guided air-to-air misiles- built-in single-barrel 30-mm GSh-301 gun (150 rounds) - up to 6 guided air-to-air misilesThe best of modern fighters produced for 	Wingspan	14.7 m -		
Max speed: km/h near ground at high altitude1,350 2,400Armament:Su-3OMKIRange (without in-flight refueling), km1,350- built-in single-barrel 30-mm GSh-301 gun (150 rounds) - up to 6 guided air-to-air misiles - up to 6 guided air-to-air misiles - up to 6 guided air-to-surface missiles - up to 6 laser guided bombs - up to 8 500-kg cluster bombs - up to 80 unguided rocketsThe best of modern fighters produced for export (according to 2008 expert poll by Britain's Flight magazine)Powerplant2xAL-31FP- up to 80 unguided rockets- up to 80 unguided rocketsCrew2Payloads up to 8,000kgPayloads up to 8,000kg	Takeoff weight, kg loaded max	24,900 38,800		
Range (without in-flight refueling), km 3,000 • up to 6 guided air-to-air misiles export (according to 2008 export (according to 2008) Rate of climb, g 9 • up to 6 laser guided bombs • up to 6 laser guided bombs • up to 8 500-kg cluster bombs • up to 8 500-kg cluster bombs • magazine) Powerplant 2xAL-31FP • up to 80 unguided rockets Crew 2 Payloads up to 8,000kg	Max speed: km/h near ground at high altitude	1,350 2,400	Armament: built-in single-barrel 30-mm GSh-301 gun (150 rounds)	The best of modern fighters produced for
Powerplant 2xAL-31FP - up to 8 laser guided bombs magazine) Crew 2 Payloads up to 8,000kg Payloads up to 8,000kg	Range (without in-flight refue km	ling), 3,000	 up to 6 guided air-to-air misiles up to 6 guided air-to-surface missiles 	export (according to 2008 expert poll by Britain's Flight
Powerplant 2xAL-31FP · up to 8 500-kg cluster bombs Crew 2 Payloads up to 8,000kg	Rate of climb, g	9	up to 6 laser guided bombs	magazine)
Powerplant 2xAL-31FP · up to 80 unguided rockets Crew 2 Payloads up to 8,000kg			up to 8 500-kg cluster bombs	
Crew 2 Payloads up to 8,000kg	Powerplant	2xAL-31FP	up to 80 unguided rockets	
	Crew	2	Payloads up to 8,000kg	

ACADEMY OF CIVIL SERVICES ESTD 2016







SU-30MKI

SPEED: MACH 2.0 (2,100 KM/H OR 1,300 MPH) RANGE: 3,000 KM (1,620 NMI) SERVICE CEILING: 17,300 M (56,800 FT) RATE OF CLIMB: >300 M/S (>45,275 FT/MIN)

LYULKA AL-BIEP

INTERNAL FUEL TANK

65H-30-1 CANNON



WWW.AVIATIA.NET

VYMPEL R-27

VYMBEL R-60

CREW: 2 LENGHT: 21.935 M (72.97 FT) WINGSPAN: 14.7 M (48.2 FT) WING AREA: 62.0 M* (667 FT*) WEIGHT: 18,400 KG (40,565 L2) COCKPIT

PHAZOTRON ZHUK AE AESA



CHENGDU J-10

SPEED: MACH 2 (2,495 KM/H OR 1,550 MPH)[RANGE: U850 KM (1,150 MI) SERVICE CEILING: 18,000 M (59,055 FT) RATE OF CLIMB: 300 M/S (60,000 FT/MIN)



RUDORA

VERTICAL TAIL

INTERNAL FUEL TANK



ALS INTAKE

GRYAZEV-SHIPUNOV GSH-23

COCKPUT

CREW: 1 LENGHT: 15.49 M (SO.82 FT) WINGSPAN: 9.75 M (31.99 FT) WING AREA: 39 M* (356.3 FT*) WEIGHT: 9.750 KG (21,495 L8)

SATURN LYULKA AL-BITH

WHY INDIA WANTS RAFALE

All you need to know about the fourth-generation fighter jets





RAFALE SPECIFICATIONS



3,700 KM

Landing ground run 450 M (1,500 FT)

Service ceiling 50,000 FT

Overall empty weight **10 TONNES**

Top Speed **1.8 MACH AT HIGH** ALTITUDE

The Indian EXPRESS

IAF receives Rafale boost

India has received its first batch of five Rafale jets

The jets – 3 single-seat & 2 twin-seat - will be stationed at Ambala airbase

Rafale is a twin-engine multi-role combat aircraft

DEVELOPED BY FRENCH AIRCRAFT MANUFACTURER DASSAULT

Specifications

2.223km/h



0 Max weight:



((•)) Range: 3,700km



24,500kg

Load-carrying capacity: 9.500kg

CAPABLE OF

Ground support

 Aerial reconnaissance

In-depth strikes

Interception

Nuclear deterrence





HYPERSONIC – Next Generation

Name	Kh-47M2 Kinzhal or The Dagger
Speed	9,207mph, MACH 12
Range	1,240 miles
Length	26ft
Cost	£4.5m
Weight	1/2 tonne

Armed with nuclear or conventional explosives

Onboard A.I. allows it to quickly dodge obstacles



12

times speed of sound

Sentinel of the seas



A look at the 'floating airfield' INS Vikrant, India's first indigenous aircraft carrier

AHOY THERE! A LOOK AT SOME **CARRIER STATS**

theatres





RUSSIAN (USSR)

Short Take Off Arrested Recovery





Demand for 3rd Indigenous Air Craft Carrier

- Extended Maritime Reach
- Deterrence Capability
- Power Projection

- INS Vishal Proposed 3rd AC
- Need for Spare
- At least 2 Operational at any time
- Fund Crunch & Budgetary Constraint
- Maybe Operational by mid-2030s





Indian Navy Submarines

60

Non-Nuclear Classes 2020





- MAGTRONIC electric propulsion motor
- New generation Fuel Cell AIP available
- Fully automated diving safety control and navigation system

- 6 Powerful batteries
- SUBTICS[®] integrated Combat System
- Fast reloading weapon handling sub system

Dptronic mast and periscope

Surfaced displacement	1,600 - 2,000 t	Autonomy	> 45 days
Length, overall	66-82 m	Crew	31
Submerged speed	> 20 kts	Weapons total payload	18
Submerged endurance	> 3 weeks	Weapon tubes	б
Diving depth	> 350 m	Operational availability at sea	> 240 days per year

Attack Submarines

- Diesel
 - Come out 24-48 Hrs to release CO2
 - Not suitable for long range
 - 15 SSKs
- Diesel + Electric (Project 75)
 - Stealth
 - INS Kalavari, Khanderi and Kharanj
 - INS Vagir and Vagsheer (Under Construction)

- AIP(Project 75-I)
 - Air Independent Propulsion
 - Fuel Cell Based
 - Vertical & Tube launched Brahmos















Arihant Class Nuclear-Powered Ballistic Missile Submarine (SSBN)

INS Chakra Akula-II Class Nuclear-Powered Attack Submarine (SSN) On lease from Russia

Future Attack Submarine Nuclear-Powered Attack Submarine (SSN) Provisonal

S-5 Future Missile Submarine Nuclear-Powered Ballistic Missile Submarine (SSBN) Provisional

H I Sutton, 2020





INDIA'S NUCLEAR SHARKS

A long-delayed project nears CCS clearance even as India's submarine force gets long in the tooth. Why the N-powered attack submarine project has taken so long.

By SANDEEP UNNITHAN Graphic by NILANJAN DAS

DEFENCE SUBMARINES

BRAHMOS-2 Anti-ship cruise missile; max range: 1,500 km

Flexible outer hull

profile for speed and non-acoustic

stealth

16,000 cr. First unit by 2032 Eight 533 mm 100 torpedoes + Brahmos-2 anti-ship/ land-attack cruise sailors missiles in VLS tubes 10 knots Limited only by onboard food (surfaced) supplies. 35 knots Around 60 days (submerged) underwater Approx. 6,000 tonnes, the weight of a Delhi- class destroyer

PUMP-JET PROPULSOR A ducted propeller that allows higher speeds by reducing noise of propeller cavitation

l pressurised water nuclear reactor, delivering

150 MW

Project-15B Class Destroyer Ship: Visakhapatnam

Why in news?

'Y 12704 (Visakhapatnam)', the first of four Project-15B state-of-the-art stealth guided missile destroyers, was recently delivered to the Navy.

Project-15B

M/s Mazagaon Dock Shipbuilders Limited in Mumbai is building four guided missile destroyers for Project 15B (P 15B). In 2011, a contract for the building of these four ships was signed.

Features of the P-15B Ships

The P-15B ships are outfitted with BrahMos supersonic cruise missiles as well as long-range Surface-to-Air Missiles (SAM).



Other Three Ships of Project 15B

- Mormugao, the P15B's second ship, was launched in 2016
- The third ship, the Imphal, was launched in 2019 and is now being outfitted.
- The fourth ship, the Surat, is now being built and will be launched year 2022.



#UPSC #CSE

Role

Destroyers of the P-15B class will play a vital role in the Indo-larger Pacific's oceans, making the Indian Navy a formidable force.



15A – Kolkata Class Guided Missile Destroyers + Stealth Technology

• 15B – Vishakhapatnam Class



Frigates (P-17A)

Nilgiri Class Frigates

- 1st Ship Nilgiri
- 2nd Udaygiri
- 3rd Taragiri
- 4th Mahendragiri

INS Vindhyagiri Sets Sail

Launched at **Server** GRSE Shipyard, Kolkata on Aug 17, 2023

Sixth of seven ships under **Project 17A Frigates**

Length: 149 metres Displacement: 6,670 tonnes (Approx.) Speed: 28 knots

Constructed by two companies:

Mazagon Dock Shipbuilders

Old INS Vindhyagiri served

Garden Reach Shipbuilders & Engineers

75% of equipment and systems orders are from indigenous firms

from July 8, 1981 to June 11, 2012

Source: Indian Navy Graphics: Mudita Singh & Ankita Tiwari

Name	Pennant	Yard Number	Builder	Laid Down	Launched	Commissioning	Status
	1		=•	Indian Navy			
Nilgiri		12651		28 December 2017 ^[66]	28 September 2019 ^{[67][68]}	Mid 2024 (expected) [69][70]	
Udaygiri		12652	Managan Dagli Ohinhuildara	7 May 2019 ^[71]	17 May 2022 ^{[72][73]}	2025 (expected) ^{[74][70]}	
Taragiri		12653	Mazagon Dock Shipbuilders Limited (MDL)	10 September 2020 ^[75]	11 September 2022 [76]	2026 (expected) ^{[77][70]}	
Mahendragiri		12654		28 June 2022 ^[78]	1 September 2023 ^{[79][80][81]}	2027 (expected) ^[70]	Launched
Himgiri		3022	Garden Reach Shipbuilders & Engineers (GRSE)	10 November 2018 ^[82]	14 December 2020 ^[83] ^[84]	Mid 2025 (expected) [85]	
Dunagiri		3023		24 January 2020 ^[86]	15 July 2022 ^{[87][55]}	Q1 2026 (expected) ^[88]	
Vindhyagiri		3024		5 March 2021 ^[89]	17 August 2023 ^[90]	Q3 2026 (expected) [88]	



Torpedo

• Underwater ranged weapon launched above or below the water surface, self-propelled towards a target, and with an explosive warhead designed to detonate either on contact with or in proximity to the target







TORPEDO MARKET






MAAREECH







FOBS - Fractional Orbital Bombardment System

Warhead delivery system that uses a low Earth orbit towards its target destination. Just before reaching the target, it deorbits through a retrograde engine burn

Why? – Ban on deploying Nuclear Weapons in Earth Orbit. USSR & China (2021) Bypassed.

SALT-II(1979):ProhibitionPursuance & Deployment of FOBS





Outer Space Treaty

"...the province of all mankind"

Outer space, including the Moon and other celestial bodies

- shall be the province of all mankind
- Exploration and use shall be carried out for the benefit and in the interests of all countries
- irrespective of their degree of economic or scientific development
- without discrimination of any kind
- on a basis of equality and in accordance with international law

Freedom of scientific investigation

States shall facilitate and encourage international cooperation in such investigation



"...exclusively for peaceful purposes"

States Parties undertake NOT to

- place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction
- install such weapons on CBs, or
- station such weapons in OS in any other manner.

MCB shall be used by all States Parties exclusively for peaceful purposes. The following are prohibited:

- establishment of military bases, installations and fortifications
- testing of any type of weapons
- conduct of military maneuvers on CBs

The following are NOT prohibited:

- use of military personnel for scientific research or for any other peaceful purposes
- use of any equipment or facility necessary for peaceful exploration



Strategic Arms Limitations Talks (SALT)

- 2 Rounds of Bilateral Conferences = USA + USSR
- Froze Number of Strategic Ballistic Missile Launchers
- Sought to Curtail Manufacture of Nuclear Weapons
- 1st Nuclear Arms Treaty



Missile Technology Control Regime MTCR

- Multilateral Export Control Regime
- Members Informal Understanding
- Limit Proliferation of Missile Technology
- India Member In 2016
- Not Legally Binding
- Started in 1987 by G7
- G7 = USA, Canada, UK, France, Germany, Italy, Japan
- China = NOT A MEMBER



MTCR Benefits



WHAT

MTCR membership will enable India to buy highend missile technology and also enhance its joint ventures with Russia. India's membership had been blocked in 2015 by Italy, which seemed to link it to the standoff over the detention of the Italian marines.

BRAHMOS

India's efforts got a boost after it agreed to join the Hague Code of Conduct, dealing with the ballistic missile non-proliferation arrangement.

MTCR aims at restricting the proliferation of missiles, complete rocket systems, unmanned air vehicles and related technology for those systems capable of carrying a 500 kg payload for at least 300 km, as well as systems intended for the delivery of weapons of mass destruction (WMD). China, which stonewalled India's entry into the 48nation Nuclear Suppliers Group at the just-concluded Seoul plenary, is not a member of 34nation MTCR.

Biological and Toxin Weapons Convention

Why in news?

India has emphasized on following the Biological and Toxin Weapons Convention (BTWC) at the UNSC meeting on Ukraine.

About

The Biological Weapons Convention (BWC) was negotiated in Geneva, Switzerland, at the Conference of the Committee on Disarmament. It was signed in 1972 and came into force in 1975.

Purpose

The convention effectively forbids biological and toxin weapons development, manufacturing, acquisition, transfer, stockpiling, and use.

Membership

183 States Parties and four Signatory States. India is also a party to the convention.

Significance

It is the first multilateral disarmament treaty banning an entire category of weapons of mass destruction (WMD).

Drawbacks of the Convention

The BTWC has no implementation body, allowing for blatant violations as in the past. Every five years, a review conference is held to assess the convention's implementation and propose confidence-building measures.









TIMELINE OF EVENTS AND ACTIONS TAKEN



The bacteria known as Bacillus anthracis produce dormant spores (not active) that can live in the environment, like soil, for a long time, even decades. When spores get into the body of an animal or person (a place rich with waters, sugars and other nutrients), they can be "activated" and turn into active growing cells.







1. Anthrax spores are inhaled

 Anthrax spores enter lungs and travel to air-containing (alveolar) spaces

 Spores are transported through the lymph system to glands that lie between the sternum and the spinal column (mediastinal lymph nodes), where they make deadly toxins

Toxins

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ACADEMY OF CIVIL SERVICES

White phosphorus is a chemical substance, dispersed in artillery shells, bombs, and rockets, that ignites when exposed to oxygen. The chemical reaction creates intense **815-degree** Celsius heat.

Reports of Israel using White Phosphorus in Gaza and Lebanon (2024) Consider the following statements:

(UPSC Prelims 2023)

- 1. Ballistic missiles are jet-propelled at subsonic speeds throughout their flights, while cruise missiles are rocket-powered only in the initial phase of flight.
- 2. Agni-V is a medium-range supersonic cruise missile, while BrahMos is a solid-fuelled intercontinental ballistic missile.

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



• Answer: (d)



- With reference to Agni-IV Missile, which of the following statements is/are correct? (UPSC Prelim-2014)
 - 1. It is a surface-to-surface missile.
 - 2. It is fueled by liquid propellant only.
 - 3. It can deliver One Tonne nuclear warheads about 7500 km away.

Select the correct answer using the code given below:

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



• Ans: (a) 1 Only



Thank You Future Officers!



Presented by Arjun Kr. Paul





Basics of Chemistry



Periodic table of the elements

	📃 Alkali metals					📃 Ha	Halogens													
L period	group			Alkaline	e-earth	metals	🗌 No	Noble gases												
	1*			Transiti	on met	als	📃 Ra	Rare-earth elements (21, 39, 57–71)												
	1	Other metals				an	and lanthanoid elements (57–71 only)													
							13 14 15 16 17 He													
2	3	4						ctinola (elemen	ts			5	6	7	8	9	10		
	Li	Be					B C N O F Ne													
3	11	12											13	14	15	16	17	18		
	Na	Mg	3	4	5	6	7	8	9	10	11	12	AI	Si	Р	S	CI	Ar		
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		
	κ	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54		
	Rb	Sr	Y	Zr	Nb	Мо	Тс	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Те	I	Хе		
6	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86		
	Cs	Ba	La	Hf	Та	W	Re	Os	Ir	Pt	Au	Hg	ТІ	Pb	Bi	Po	At	Rn		
7	87	88	89	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118		
	Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	FI	Мс	Lv	Ts	Og		
lanth an aid agrice 6					59	60	61	62	63	64	65	66	67	68	69	70	71			
ianthanoid series 6				Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Но	Er	Tm	Yb	Lu			
90 91 92						92	93	94	95	96	97	98	99	100	101	102	103			
actinoid series 7				Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr			

*Numbering system adopted by the International Union of Pure and Applied Chemistry (IUPAC). © Encyclopa

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Hydrogen

- Most Abundant in Universe = 70%
- 0.17% in Earth's Atmosphere = Due to Lighter in Mass
- 15.4% of Earth's Crust & Ocean = Combined Form
- 3 Forms = Protium, Deuterium & Tritium (Radioactive)
- Uses:
 - Production of Syngas (Coal Gasification)
 - Synthesis of Ammonia
 - Manufacture of Vanaspati Fats (Dalda)
 - Rocket Fuels
 - Hydrogen Fuel Cell







Types of Hydrogen Production

Here are the color codes used within the energy industry to differentiate between the types of hydrogen.



using coal



Heat is used to split fossil gas in a process known as "pyrolysis"





Made using lignite

Made using fossil gas with no emissions captured

Source: "The Hydrogen Economy: Opportunites and Risks in the Energy Transition," Allianz Global Corporate and Specialty Electricity and heat from nuclear reactors could both be used to produce hydrogen, but there is no widely agreed color for such methods.



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We have to make India a Global Hub for Green Hydrogen Production and Export in the 'Amrit Kaal'.

This will not only help India to make new progress in the field of energy self-reliance but will also become a new inspiration for Clean Energy Transition all over the world.

- Prime Minister Narendra Modi

National Hydrogen Energy Mission

(Cleaner Energy Source for Industry Sector)

Launched on **15 August, 2021** by Prime Minister Narendra Modi to achieve targets of:





H_2O

- Colourless and Transparent
- Dipolar in Nature = Universal Solvent
- Earth = All three States Exists = 71% Liquid
- Freezing Point = $0^{\circ}C = 32^{\circ}F = 273^{\circ}K$
- Boiling Point = $100^{\circ}C = 212^{\circ}F = 373^{\circ}K$
- Higher Thermal Conductivity, Specific Heat, Surface Tension etc.
- Low Electrical Conductivity at Pure State





















Triple Point

The triple point is the temperature and pressure where three phases coexist in equilibrium.



For example, the triple point of water is 273.16 K (0.01 °C or 32.02 °F) and 611.73 Pa.

sciencenotes.org



Amphoteric





📚 Hard Water vs Soft Water 🗧

HARD WATER high mineral content Ca²⁺, Mg²⁺

SOFT WATER

low mineral content sometimes Na⁺







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Where is Earth's Water?



Credit: U.S. Geological Survey, Water Science School. https://www.usgs.gov/special-topic/water-science-school Data source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources. (Numbers are rounded).



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- 4 Valence Electron = Used in Semiconductors, Solar Cells etc.
- Major constituent of Portland Cement, Ceramics and Bricks
- Production of Fire Bricks
- Used for Waterproofing and Plastic Greasing
- Used as alloy in Steel Industry
- Not a METAL
- Close Relative of Carbon
- Makes up 27.7% of Earth Crust





What is Zeolite?

Zeolite is a natural mineral created by a reaction between volcanic ash that fell into an alkaline water source during a volcanic eruption.

This combination was put under pressure and resulted in a mineral with a porous three-dimensional honeycomb framework and a net negative charge.

The finished product works both like a sponge and a magnet; soaking up microscopic particles and trapping them inside.







The honeycomb framework and a net negative charge allows Zeolite to both absorb liquids and neutralize compounds.







Dinitrogen N₂

- Colourless, Odourless, Diamagnetic (repulsive force)
- Sparingly Soluble in Water
- High Bond Enthalpy (Inert at RT)
- Manufacturing of Ammonia (Haber's Process)
- Liquid Nitrogen Food Preservative
- Iron and Steel Industry





Oxygen

- 46.6% of Earth's Crust
- 20.9% of Earth's Atmosphere O₂
- Highly Reactive Nonmetal
- Oxidizing Agent Forms Oxides
- Ozone = Allotrope of Oxygen
- Essential Element of Life Process
- Paramagnetic in Nature




Chlorine

- Extremely Reactive & Oxidizing Agent
- High Electron Affinity
- Some Uses:
 - Bleaching Wood Pulp, Cotton, Textiles etc.
 - Extraction of Gold and Platinum
 - Manufacture of dyes, drugs and organic compounds such as DDT, refrigerants, etc.
 - Sterilizing drinking water
 - Preparation of poisonous gases such as phosgene, tear gas (lachrymator agent or lachrymator), mustard gas etc.









USES OF CHLORINE



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Carbon







Carbon

- Covalent Bonding: Formed by Sharing of Electron Pair between two atoms
- C4+ = He (Highly Unstable), C4- = Ne (Difficult to Hold Electrons)
- Shares 4 Valence Electrons
- Catenation





Carbon

- Weak Intermolecular Force but Strong Bond within Molecule
- Low Melting and Boiling Points
- Poor Conductors of Electricity = Does not give rise to any ions
- 2 Stable (C-12 & C-13) and 1 Unstable Isotopes (C-14)





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Crystalline Solids

- Vs
- **Amorphous Solids**

 Crystalline Solids have a highly ordered and repeating three-dimensional atomic structure. Amorphous Solids lack a long-range order in their atomic structure and have a disordered arrangement of atoms.







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Water Treatment

Activated Carbon/

Porous carbon Materials



...

Air and gas purification

Food processing

Catalysis

Energy Field and other emerging areas

Graphite

- Pure form of carbon
- Flat 2D dimensional arranged Hexagonally
- Soft Black & Slippery Solid (Can be used as Lubricant)
- Conducts Electricity & Heat (Metallic Lustre)
- Alpha & Beta Forms
- Thermodynamically More Stable



Diamond

- Purest Crystalline Allotrope of Carbon
- Held by Strong Covalent Bonds
- Makes hardest element on Earth
- High Melting Point
- High Relative Density
- Transparent to X-Rays
- High Refractive Index
- Bad Conductor of Electricity
- Insoluble in all solvents
- Good Conductor of Heat







Petroleum Coke

- Extracted from Oil Refining = Spongy Solid Residue
- Carbon Rich Solid Material
- High in Calorific Value = Easy to Transport and Store
- Releases Toxic Gases CO2, NO2, Hg, Ar etc.
- Used in Power Stations, Cement, Steel and Textile Plants

Carbon Monoxide



- Colourless, Odourless, Tasteless
- Formed due to Incomplete Combustion
- CO + H2 = Syn Gas (Coal Gasification)
- CO + N2 = Producer's Gas
- Both are used to generate Fuel Gas
- Inhalation = Poisoning

Common Symptoms of Carbon Monoxide Poisoning



Carbon Dioxide CO₂



- Colourless and Odourless
- Covalently Double Bonded
- Absorbs Infrared Radiation = Acts as GHGs
- Absorption in Ocean Causes Acidification
- Dry Ice can be used as cleaning agent, refrigerant
- Photosynthesis and Respiration











Chemistry in Everyday Life

Dry Cleaning

- Tetra Chloroethene used as solvent
- Contaminates GW + Carcinogen
- Replaced by Liquified CO₂

Hydrogen Peroxide H₂O₂

- bleaching clothes
- Bleaching paper
- Cleaning Water
- Treat Wounds







Thank You Future Officers!

Presented by Arjun Kr. Paul





Standard Model Physics



What are Elementary Particles?

The Standard Model: Beyond the Atom

The Standard Model is the collection of theories that describe the smallest experimentally observed particles of matter and the interactions between energy and matter.





Three categories of particles form the **Standard Model**. Matter is composed of **fermions (quarks** and **leptons)**. **Bosons** provide three forces: **electromagnetism**, the **strong** nuclear force and the **weak** nuclear force.

Currently the Standard Model is incomplete and does not explain many important features of the known universe, such as:





Quarks + Quarks = Hadrons Eg. Protons & Neutrons

Lepton = Charged or Uncharged Charged = Electrons Uncharged = Neutrinos

Neutrinos hard to detect. Produced by Radioactive Decay of Eg. Potassium, Sun's Reaction

Bosons = Force Carriers Eg. Strong, Weak and Electromagnetic



God's Particle

- Peter Higgs, 1964
- Higgs Bosons = God's Particle
- Particle acquires mass exposed to Higgs Field.
- Has zero spin, even (positive) parity, no electric charge, and no colour charge that couples to (interacts with) mass
- Unstable, starts decaying on formation



HIGGS BOSON





Fundamental Force Particles



Force	Particles Experiencing	Force Carrier Particle	Range	Relative Strength*
Gravity acts between objects with mass	all particles with mass	graviton (not yet observed)	infinity	much weaker
Weak Force governs particle decay	quarks and leptons	W⁺, W⁻, Z⁰ (W and Z)	short range	
Electromagnetism acts between electrically charged particles	electrically charged	γ (photon)	infinity	Y
Strong Force** binds quarks together	quarks and gluons	g (gluon)	short range	much stronger





Weak force in radioactive decay





In 2006 and 2014, a NASA funded experiment, which saw a balloon soar above Antarctica, found two highly unusual, almost impossible, events.

The Antarctic Impulsive Transient Antenna (ANITA) detected extremely high-energetic fundamental particles, called neutrinos, that seemed to have traveled through the Earth. Antarctic Impulsive Transient Antenna

- Listen to Cosmos (Universe)
 - Detect High Energy Particle
 - = Neutrinos which bombard the planet.
- Find Origin of Cosmic Rays



Solar Energetic Particles (Solar Particle Events or Coronal Mass Ejections)

Galactic Cosmic Rays

Galactic Cosmic Rays

SPACECRAFT `ERROR' DATA REVEAL COSMIC RAY BEHAVIOUR

more of them.

Cosmic rays are bursts of high-energy radiation that can cause electronic damage to space hardware and threaten human health on crewed missions.

Spacecraft log when cosmic rays hit an onboard computer and cause memory errors.



· CICK

#ExploreFarther

How does IceCube work?

When a neutrino interacts with the Antarctic ice, it creates other particles. In this event graphic, a muon was created that traveled through the detector almost at the speed of light. The pattern and the amount of light recorded by the IceCube sensors indicate the particle's direction and energy.



Size scales with the amount of recorded light

date: November 12, 2010 duration: 3,800 nanoseconds energy: 71.4 TeV declination: -0.4° right ascension: 110° nickname: Dr. Strangepork







ANTARES

- ANTARES (Astronomy with a Neutrino Telescope and Abyss environmental RESearch project) is a neutrino detector residing 2.5 km under the Mediterranean Sea off the coast of Toulon, France.
- 1st Undersea Neutrino Telescope





The **Baikal Deep Underwater Neutrino Telescope** (or **Baikal-GVD**–Gigaton Volume Detector) is an international project in astroparticle physics and neutrino astronomy. The construction of Baikal-GVD is motivated by its discovery potential in astrophysics, cosmology, and particle physics.

Objectives: Its primary goal is a detailed study of high-energy cosmic neutrino fluxes and the search for their sources. Baikal-GVD can also search for dark matter candidates, neutrinos from superheavy particle decays, magnetic monopoles, and other exotic particles. Baikal-GVD is also thought to be a platform for environmental studies of Lake Baikal's ecosystem.





Central module of the section



Russia

Братск

Чита

Ulan-Ude Улан-Удэ

Ulaanbaatar Улаанбаатар

Mongolia

Inderwater acoustic modern



Yakutsk Якутск

HEILONGJIANG





Will place a specially built iron calorimeter (ICAL) detector about 1.5 km underground, where the chances of detecting the neutrinos are higher.

The project will study neutrinos and aim to determine the mass of neutrinos and establish a "mass order" among three known types of neutrinos - electron, muon, tau



Constraints

It was proposed in 2001. But since then, has run into various problems like public protest, opposition from NGOs and political parties, etc. Arguments of protestors is that blasts to build the facility will impact fragile ecology of western ghats and the radiations could lead to leaching of water. Since it is located close to <u>Mathikettan Shola National Park</u>, its environmental clearance was challenged in NGT which recently upheld the clearance given. It still needs a few more clearances from various bodies before the construction begins.

The God particle

Where the collision takes place

Large Hadron Collider (LHC)

Scientists accelerate two beams of protons around the 17-mile ring, smashing them together at 186,000 miles per second.

Ultimately, scientists hope to find in the collisions proof of the "God particle", the Higgs boson, which is thought to give mass to matter.


Big Bang machine in search for smallest particle

The Large Hadron Collider (LHC) will accelerate two beams of protons around a 27km ring and smash them together at 99.99% the speed of light. Its 9,300 magnets will guide the particles through a vacuum at minus 271 degrees Centigrade, recreating conditions in deep space moments after the Big Bang



CERN – European Organisation for Nuclear Research

Established = 2008



Composition of the Universe





Ordinary matter 4% H and He <1% Stars <1% Other



Dark Energy Vs Dark Matter





@science_cosmo

> Single largest constituent of the Universe.

>Tends to drive Universe apart.

> No interaction with Normal Matter.

> Can be thought as 5th Fundametal force. > Second largest constitunt of the Universe.

>Tends to drive Universe together.

> Interacts with Normal matter by Gravity (Gravitational Lensing).

> Dark matter is Not Antimatter or Black Holes.







How gravitational microlensing works

When a gravitational wave approaching the earth is interrupted by the presence of a black hole, the signal gets modified as shown.







Dark Energy Spectroscopic Instrument (DESI)







Dark Energy Spectroscopic Instrument (DESI)



Relativistic Jet -

Accretion disc

Event horizon

Singularity

At the very centre of a black hole, matter has collapsed into a region of infinite density called a singularity. All the matter and energy that fall into the black hole ends up here. The prediction of infinite density by general relativity is thought to indicate the breakdown of the theory where quantum effects become important.

Event horizon

This is the radius around a singularity where matter and energy cannot escape the black hole's gravity: the point of no return. This is the "black" part of the black hole.

Photon sphere

Although the black hole itself is dark, photons are emitted from nearby hot plasma in jets or an accretion disc (see below). In the absence of gravity, these photons would travel in straight lines, but just outside the event horizon of a black hole, gravity is strong enough to bend their paths so that we see a bright ring surrounding a roughly circular dark "shadow".

Relativistic jets

When a black hole feeds on stars, gas or dust, the meal produces jets of particles and radiation blasting out from the black hole's poles at near light speed. They can extend for thousands of light-years into space.

Innermost stable orbit

The inner edge of an accretion disc is the last place that material can orbit safely without the risk of falling past the point of no return.

Accretion disc

A disc of superheated gas and dust whirls around a black hole at immense speeds, producing electromagnetic radiation (X-rays, optical, infrared and radio) that reveal the black hole's location. Some of this material is doomed to cross the event horizon, while other parts may be forced out to create jets. Innermost stable orbit

- Singularity

Photon sphere



Black Hole





EHT with PRIMO

EHT





Chandrashekhar Limit



WHAT ARE GRAVITATIONAL WAVES?



Just as waves in a pond are created by disturbances in the water, gravitational waves are created by disturbances in the fabric of spacetime. Lots of things can create gravitational waves, but most are too weak to us to measure. Luckily, because black holes distort spacetime so much, they can create waves that we can detect here on Earth.





1. A black hole by itself makes a deep dent in the fabric of spacetime, but it doesn't throw out any gravitational waves. 2. Here are two black holes orbiting each other (binary system). As they orbit, they whiz around each other so quickly that, instead of just making a dent in spacetime, they plough up waves (like when you stir soup with your finger) – these are gravitational waves.

But it takes energy to create gravitational waves and, with each orbit, the pair lose energy, which is carried away by the gravitational waves. As they lose energy, their orbits will begin to shrink. Eventually, it will shrink so much that the black holes will crash together.

Nobel prize for detection of gravitational waves

US astrophysicians Barry Barish, Kip Thorne and Rainer Weiss awarded prize for discovery that opens a window on the universe Waves first detected on Sept 14, 2015
 Origin: fusion of 2 black holes, 1.3 billion years ago





Sources: LIGO, Nature, CNRS

*LIGO: Laser Interferometer Gravitational Wave Observatory





Normal situation

Gravitational wave detection



Laser Interferometer Space Antenna LISA

- LISA is a planned space-based gravitational wave observatory led by the European Space Agency (ESA) and National Aeronautics and Space Administration (NASA)
- Detect and observe gravitational waves by measuring the minute changes in the distance between three spacecraft in a triangular formation, caused by the passage of gravitational waves through space
- Provide valuable insights into cosmic events, such as the mergers of massive black holes





eLISA



Q. Recently, scientists observed the merger of giant 'blackholes' billions of light-years away from the Earth. What is the significance of this observation? (2019)

(a) 'Higgs boson particles' were detected.

(b) 'Gravitational waves' were detected.

(c) Possibility of intergalactic space travel through 'wormhole' was confirmed.

(d) It enabled the scientists to understand 'singularity'



- Ans: (b)
- Exp:
- Every few minutes a pair of black holes smash into each other. These cataclysms release ripples in the fabric of space time known as gravitational waves.
- Gravitational waves are 'ripples' in space-time caused by some of the most violent and energetic processes in the Universe.
- Albert Einstein predicted the existence of gravitational waves in 1916 in his General Theory of Relativity.
- The strongest gravitational waves are produced by catastrophic events such as colliding black holes, the collapse of supernovae, coalescing neutron stars or white dwarf stars, etc.
- Scientists have yet again detected gravitational waves produced by the merger of two light black holes about a billion light-years away from the Earth.
- It was recorded by Laser Interferometer Gravitational-Wave Observatory (LIGO).
- Therefore, option (b) is the correct answer



The known forces of nature can be divided into four classes, viz., gravity, electromagnetism, weak nuclear force, and strong nuclear force. With reference to them, which one of the following statements is not correct? (2013)

- a) Gravity is the strongest of the four
- b) Electromagnetism acts only on particles with an electric charge.
- c) Weak nuclear force causes radioactivity

d) Strong nuclear force holds protons and neutrons inside the nucleus of an atom



a) Gravity is the strongest of the four





Locations of Hubble's Instruments Inside the Telescope



Hubble Space Telescope

- Space Based Observatory
- Launched In 1990 using Space Shuttle Discovery
- Orbits at 547 KM above Earth
- Exploration of Visible, Ultraviolet and Infrared Wavelengths
- Capture Faint glow from far off Universe

Hubble Space Telescope

- Benefits:
 - Distortion Free
 - More Wavelength
 - Resolution
 - Dark Skies
 - Serviceability
 - Diversity

Discoveries:
Universe's Age
Discovery of Dark Energy
Evolution of Galaxy
New Planet Evolution
Gamma Ray Burst

 Successor:
 JWST – James Webb Space Telescope















THE JAMES WEBB SPACE TELESCOPE Optical Telescope Element (OTE) Primary Mirror 18 hexagonal segments made of the metal beryllium Science Instrument (ISIM) and coated with gold to Module capture faint infrared light Houses all of Webb's cameras and science Secondary Mirror instruments Reflects gathered light from the primary mirror into the science instru-Trim flap ments Helps stabilize the satellite Multilayer sunshield Five layers shield the observatory from the light and heat of the Solar power array Earth-pointing Sun and Earth antenna Always facing the Sun, panels convert Sends science data Spacecraft bus Star trackers sunlight into elecback to Earth and Contains most of the Small telescopes that tricity to power the receives commands spacecraft steering use star patterns to observatory from NASA's Deep and control machintarget the observatory Space Network ery, including the computer and the

reaction wheels



James Webb Telescope Vs Hubble Space Telescope

INDIA TODAY



James Webb Space Telescope

With plans to launch in 2014, the Webb telescope will extend

the discoveries of the Hubble telescope by using infrared to

Comparison of mirror size, in diameter

Hubble

6

Its large, light-collecting area helps the Webb telescope

peer further back in time than the Hubble telescope.

















International Liquid Mirror Telescope

- 1. India's 1st Liquid Mirror Telescope
- 2. Devasthal Observatory of Aryabhata Research Institute of Observational Sciences (ARIES), Nainital
- 3. Only Mirror Telescope in World Currently
- 4. Mercury is Used






How liquid-mirror telescopes work



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

directly overhead. Astronomy: Roen Kelly



International Dark Sky Reserves

- Dark Sky Reserves consist of a dark "core" zone surrounded by a populated periphery
- Policy controls are enacted to protect the darkness of the core
- Established by a partnership of multiple land managers
- India's 1st = Hanle, Ladakh (Changthang WLS) = 4500 MSL







How is a site designated as Dark Sky Place

A group or individuals can nominate a site with a comprehensive application to the International Dark Sky Association (IDSA)

THE FIVE CATEGORIES FOR DESIGNATION

International Dark Sky Parks, Communities, Sanctuaries, <u>Reserves,</u>

Urban Night Sky Places.

and Each category has its own set of guidelines based on land management, size, and sky quality



A place is designated as International Dark Sky Places, Parks, Sanctuaries and Reserves depending on the criteria it meet

Thank You Future Officers!



Presented by Arjun Kr. Paul





Nuclear Science



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Origin of Radioactivity

- Spontaneous Decomposition of Unstable Atomic Nuclei
- Energy and Particles Released during Decomposition = Radiation
- Alpha, Beta and Gamma Particles
- Alpha Decay = Helium Nucleus Emission (4 Mass No. and 2 Atomic No.) = 2 Protons + 2 Neutrons
- Beta Decay = Fast Energetic Electron or Positron (=Mass of Electron but Positive Charge)
- Gamma Decay = Electromagnetic Radiation = Shortest Wavelength







Radiation is energy transmitted in the form of waves or particles. **Light** and **Heat** are forms of radiation.

Radioactive Decay is the **spontaneous** emission of this energy due to nuclear instability.

TYPES OF RADIATION AND PENETRATION



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Uses of Radioactivity

- Half Life = Time Required for Quantity to Reduce to Half of Initial Value
- Cobalt 60 = Gamma Radiation, Arrest Development of Cancer
- Tachnetium 99 = Detect Cancerous Tumors
- Carbon 14 = Carbon Dating (half life 5730 years) and Tracer
- Phosphorus 31 = Tracer (Calculate amount of Nutrient Uptake)
- Americium-241 = Domestic Smoke Detectors in USA
- Iodine 131 = Treating Hyperthyroidism
- Co-60 & Cs-137 = Destroy Anthrax bacilli



Uranium Types

- U-238 = 99.3% on Earth = Transmute to Plutonium-239
- U-235 = Only Naturally Occurring Fissile Isotope
- U-233 = Can be produced from Thorium







India's 3 Stage Nuclear Power Programme

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Why in News?



India's 2nd Indigenous Gujarat Nuclear Power Reactor Achieves First Criticality

KAPP 3 and 4 (2x700 MW) are located at Kakrapar in Surat district of Gujarat, adjacent to the existing reactors KAPS 1 and 2 (2x220 MW), it said.

India News | Press Trust of India | Updated: December 17, 2023 3:53 pm IST



The Hon'ble PM visits Kakrapar Atomic Power Project in Gujarat, dedicates to the nation two 700 MWe indigenous nuclear reactors, KAPP-3 and KAPP-4

PUBLISH DATE: February 26, 2024

Prime Minister's Office



PM witnesses the historic "Commencement of Core Loading" at India's first indigenous Fast Breeder Reactor (500 MWe) at Kalpakkam, Tamil Nadu

Upon completion of the core loading, the first approach to criticality will be achieved, leading to generation of power subsequently

In spirit of Aatmanirbhar Bharat, PFBR is indigenously designed and constructed by BHAVINI with contribution from more than 200 Indian industries including MSMEs

India's nuclear power program is aimed to meet the twin goals of energy security and sustainable development





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World / Climate

'Artificial sun' sets record for time at 100 million degrees in latest advance for nuclear fusion



step closer to unlimited clean energy

Researchers have broken a nuclear fusion record, bringing humanity one step close to limitless clean energy.



World's biggest experimental nuclear fusion reactor launched in Japan

Joint project with EU involves more than 500 scientists and engineers and more than 70 companies



✿ The JT-60SA in Naka aims to harness nuclear fusion, the same process that powers the sun. Photograph: National Institutes for Quantum Science and Technology (QST)/AFP/Getty Images



POLOIDAL MAGNETIC FIELD

TOROIDAL FIELD COIL

The Tokamak

It is a donut shaped device designed to confine the reactants with a very strong magnetic field at extreme conditions.

PLASMA ELECTRICAL CURRENT TOROIDAL MAGNETIC FIELD

CENTRAL

SOLENOID

HELICAL MAGNETIC FIELD

OUTER

POLOIDAL

FIELD COILS





INDIA HAS ONE OF THE LOWEST POWER CONSUMPTION PER CAPITA



INDIA'S ENERGY MIX





Chart: Samrat Sharma, Jaipal Sharma

©ARJUN PAUL



India V/S World Stats

- 23 Operational Reactors 2023
- 3.1% of Total Electricity Generation
- 7.4 GW
- TARGET 22.4 GW by 2031





Source: International Atomic Energy Agency Chart: Samrat Sharma, Jaipal Sharma

TOP 10 NUCLEAR-POWERED NATIONS

INDIA TODAY GROUP

INDIA AT 7^{TH} POSITION IN NUMBER OF REACTORS, 12^{TH} IN POWER GENERATION





India's Nuclear Programme History

1948:	 Establishment of the <u>Atomic Energy Commission (AEC).</u> India enters the nuclear age.
1950 s	 Formulation of the 3 Stage nuclear power program by Homi Bhabha. Aim to establish a self-sufficient nuclear power industry.
1969	 Commissioning of the first Pressurized Heavy Water Reactor (PHWR). Operationalization of Stage 1 of the nuclear power program.
1974	 Conducting of India's first nuclear test, Pokhran-I. Demonstration of nuclear capabilities.
Late 1970s –	 Development of fast breeder reactors (FBRs).
Early 1980s:	 Part of Stage 2 to enhance fuel efficiency and self-sufficiency.
1990s – 2000s:	 Focus on building a nuclear arsenal and delivery systems. Further nuclear tests in 1998.
Present:	 Possession of nuclear weapons and extensive nuclear fuel cycle capability. Ongoing developments in thorium-based reactors for Stage 3 of the nuclear power program



INDIA'S THREE-STAGE NUCLEAR PROGRAMME

Stages at a Glance

Three Stage Indian Nuclear Power Programme incorporates closed fuel cycle and thorium utilisation as a main-stay for sustained growth.



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India's 3 Stage Nuclear Programme

	Description	Timeline
Stage 1	Relies on PHWRs with natural uranium fuel.	Initiated in 1950s, operational since 1960s.
Stage 2	Focuses on FBRs using plutonium-239 from Stage 1.	Initiated in the 1970s and currently in the development phase.
Stage 3	Developing thorium- based reactors with India's thorium reserves.	Initiated in the late 1980s/early 1990s and currently in the research & development phase.







Benefits of Nuclear Power

7 AFFORDABLE AND CLEAN ENERGY	Affordable energy reduces poverty (SDG1) and inequality (SDG10), and supports health (SDG3), education (SDG4), industry (SDG9) and economic growth (SDG8)	Sustainable energy is cruc for climate action (SDG1 ecosystems (SDG14, 1 agriculture (SDG2), wa (SDG6, 14), and reduc waste (SDG
Energy for all fosters peace, justice (SDG16), and partnerships (SDG17)	Modern energy supports clean communities (SDG11), health (SDG3), and gender equality (SDG5)	Reliable energy is essential for industry (SDG9), agricult (SDG2), health (SDG3) and education (SDG4)

 Is Nuclear the Solution? Low Carbon Footprint cial 3), **Energy Security** 5), Sustained Growth ter ing **Uproot Energy Poverty** 12) Reliability Limited Growth Potential of ture Hydropower Low Operating Costs

- Reduced Fossil Fuel Import
- Reduced Fiscal Deficit

Global Development of Reactor Design





1 uranium pellet 17,0 (~1 inch tall) of

17,000 cubic ft of natural gas

120 gallons of oil 1 ton of coal







Heavy Water Reactor (PHWR)





Isotopes of Uranium and Hydrogen



Difference



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Stage 1: Reaction





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Stage 2: Breeding more Fuel

Plutonium-239 is produced as byproduct for Stage 2



- 1. Use Plutonium 239 to make Mixed Oxide Fuel (Mix with Uranium-238)
- 2. Transmutation into more Plutonium 239
- 3. Build up Pu-239 Stock for Stage 2

Liquid Metal cooled Fast Breeder Reactors (LMFBR)





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NUCLEAR WASTE AND ITS DISPOSAL

NUCLEAR POWER



435 NUCLEAR PLANTS WORLDWIDE 10,500 TONNES OF SPENT FUEL PER YEAR

As of 2019, nuclear power plants operate in 30 countries. Six countries have outright bans on use of nuclear reactors to generate electricity.



10% OF THE WORLD'S ELECTRICITY

Nuclear fuel releases many times more energy per gram than fossil fuels. Nuclear plants don't release carbon dioxide while they are operating.

WHAT IS NUCLEAR WASTE?

About 3% of spent nuclear fuel consists of radioactive fission products. In some countries, the spent fuel is reprocessed to separate the waste from uranium and plutonium.

SPENT FUEL COMPOSITION

Uranium-238 (95%)
 Uranium-235 (1%)
 Plutonium (1%)
 Fission Products (3%)

Radioactive waste contains unstable isotopes of elements which decay and emit alpha, beta or gamma radiation. Eventually they decay into non-radioactive elements.

HALF LIVES: UP TO 32 YEARS Cs-137 Sr-90 Cm-243 Cm-244 Co-60 HALF LIVES: 460-24,000 YEARS Th-229 Pu-239 Pu-240 Am-241 Am-243 HALF LIVES: 77,000-16,000,000 YEARS

Nb-94 I-129 Cs-135 Tc-99 Th-230 Np-237

As well as the radioactivity produced by nuclear waste, it also produces heat as isotopes decay. This poses issues for storage and disposal.

TYPES OF NUCLEAR WASTE

LOW LEVEL WASTE (LLW)

90% of all radioactive waste (by volume)1% of the total radioactivity of all waste

LLW is defined as not exceeding 4 gigabecquerels per tonne (GBq/t) of alpha activity or 12 GBq/t of beta-gamma activity.

INTERMEDIATE LEVEL WASTE (ILW)

7% of all radioactive waste (by volume) 4% of the total radioactivity of all waste

ILW produces more radiation than LLW, but doesn't generate as much heat as HLW. It includes metal fuel cladding.

HIGH LEVEL WASTE (HLW)

3% of all radioactive waste (by volume) 95% of the total radioactivity of all waste

HLW is defined as producing more than 2 kilowatts per metre cubed of heat due to its radioactivity. It requires shielding during transport and cooling before permanent disposal. It includes used fuel and separated waste.

WASTE STORAGE & DISPOSAL

NEAR-SURFACE DISPOSAL



Low level waste's radioactivity is usually compacted into steel canisters and stored in concrete vaults underground. When full, vaults are sealed, covered and left. They ensure no significant radiation reaches the surface.

DEEP GEOLOGICAL DISPOSAL



Intermediate and high level waste generate heat and greater levels of radioactivity. Most countries plan to use deep geological disposal. The rock and soil acts as a barrier to the radiation. Before this, high level waste is incorporated into glass and stored for up to fifty years to allow heat to dissipate.



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Stage 3: PuO_2 -ThO₂ MO_X, and ThO₂ - $U^{233}O_2$ MO_X



क्त सेवा मे

STATUSE OF

Stage 3: Thorium Conversion

- 1. Mix of Thorium 232 and Plutonium 239
- 2. Thorium Transmutes to U-233

Thorium-233 decays quickly (1/2 life = 22 minutes) to protactinium-233



Protactinium-233

Protactinium-233 decays slowly (1/2 life = 27 days) over a month to uranium-233

Thorium-233



Natural thorium absorbs a neutron from fission and becomes thorium-233



Uranium-233 absorbs a neutron and undergoes fission, releasing energy and neutrons to continue the process

Thorium-232



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Stage 3: Why Thorium

- Less Nuclear Waste
- Ability to Burn Up Most Highly Radioactive Particles
- Radioactive Waste Generated toxic for 300-400 years w.r.t. 1000 years
- Thorium Reactors are Cheaper High Burnup
- Huge Thorium Reserves in Monzanite form found in beach sands. World's 3rd largest

Current Environmental Issues

- Radioactive Wastes Disposal
- Nuclear Accidents and Meltdown Fukushima and Chernobyl
- Thermal Pollution
- Weapon Proliferation
- Mining



Current Implementational Challenges

- Prolonged Delays
- Limited Fuel Supply
- High Capital Costs
- Procurement Issues
- Regulatory Approvals
- Funding and Budget Constraints
- Political Instability
- Decommissioning Challenges
- Public Perception and Opposition



Way Forward

- Expansion of Stage 2 till 50 GW is reached
- Simultaneous Operationalise AHWR for Stage 3
- Strengthen and Streamline Regulatory Frameworks
- Promoting Public Awareness and Acceptance
- Diversification of Reactor Designs and Fuel Cycles Eg. SMRs
- Integration with other Renewable Sources
- Repurposing Radioactive Waste for Medical Purposes



International Atomic Energy Agency

- ESTD 1957 | HQ Vienna, Austria Members: 178
- Promote Peaceful use of Nuclear Energy
- 3 Main Mission
 - Promoting Peaceful Use
 - Implementing Safeguards and Verify non-Military Use
 - Promoting High Standards Nuclear Safety
- Intergovernmental Organisation
 - Scientific and Technical Cooperation
 - Conducts Nuclear Research
 - Provides Technical Support
- Reporting: To UNGA and UNSC

- Latest Members: 2023 (Cape Verde; Guinea, The Gambia)
- Director General: Rafael Mariano Grossi (Argentina Diplomat) 2019 onwards
- Non-Proliferation Treaty 1968
 - Gives Authority to IAEA to Monitor and Inspect
- 4 Types of Inspection:
 - Ad Hoc
 - Special
 - Routine
 - Safeguard Visits
- India Member of IAEA NPT not signed



परमाणु ऊर्जा विभाग

Department Of Atomic Energy

सत्यमेव जयते

- Estd. 1954 under Atomic Energy Act, 1948
- Atomic Energy Commission, 1958
- Formulates Policy Full Authority
- Under Direct Control of PMO



- Public Sector Unit Central Govt.
- Design, Construction, Operation and Maintenance of Nuclear Power Plant
- Administered by DAE
- 21 Reactors



- Public Sector Unit 2003
- Constructing and Commissioning of Prototype Fast Breeder Reactor at Kalpakkam, TN
- Administered by DAE







For the full industrialisation of under-developed countries, for the continuation of our civilisation and its further development, atomic energy is not merely an aid, it is an absolute necessity...

Dr. Homi Jehangir Bhabha Father of Indian Nuclear Programme

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Thank You Future Officers!

Presented by Arjun Kr. Paul

