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CONTENTS

■ Development in the field of Information Technology	1
▶ Basic Computer/IT Terms	1
▶ Current Trends in Information Technology	4
▶ Emerging Trends in Information Technology.....	5
■ Life Sciences & Biotechnology	9
▶ Cells.....	11
▶ Genetics	16
▶ Mendel and his work, seven traits observed by Mendel	18
▶ Biotechnology.....	21
■ Space Program Development-India and World	25
▶ Genesis of Indian Space Programme.....	25
▶ Major milestones in Indian Space Programme	26
▶ Chandrayaan-2.....	27
▶ Gaganyaan.....	29
▶ Navigational Satellites	29
▶ GPS Satellite Systems around the World	30
▶ Japan (QZSS)	30
▶ Russia (GLONASS)	30
▶ Studying the Sun	31
▶ India's space diplomacy: South Asia Satellite	32
▶ Drones and Governance issues: Digital Sky Platform	33
▶ Tracking the s-junk: Graveyard Orbit.....	33
▶ Unravelling cosmos: The Oort Cloud	34
▶ World Space Week	34
▶ Space programs across the world.....	34

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DEVELOPMENT IN THE FIELD OF INFORMATION TECHNOLOGY

Information Technology (IT) is a generic term that covers the acquisition, processing, storage, and dissemination of information. It involves the application of computers and communication technology in the task of information handling, information, and information flow from the generation to the utilization levels.

Basic Computer/IT Terms

- **Adware:** It is a software package that automatically renders advertisements to generate revenue for its author.
- **Android:** It is a Linux based operating system designed primarily for touchscreen mobile devices such as smartphones and tablets computers.
- **Algorithm:** It is a step by step method of solving a problem. It is commonly used for data processing, calculation, and other related computer and mathematical operations.
- **Antivirus Software:** It consists of computer programs that attempt to identify threats and eliminate computer viruses and other malicious software (Malware).
- **Big Data:** It is a phrase used to mean a massive volume of both structured and unstructured data that is so large that it is difficult to process using traditional database and software techniques. In most enterprise scenarios the volume of data is too big or it moves too fast or it exceeds current processing capacity.
- **Bandwidth:** The maximum amount of data that can travel in a communication path in a given time, measured in bits per second (bps).

- **Bar Code:** It is a machine-readable representation of information in a visual format on a surface. The first bar code system was developed by **Norman Joseph Woodland and Bernard Silver in 1952.**
- **Blog:** It is a discussion or informational site published on the World Wide Web.
- **Bluetooth:** A protocol that permits a wireless exchange of information between computers, cell phones, and other electronic devices within a radius of about 30 feet.
- **Cryptograph:** The pre-fix “**crypt**” means “**hidden**” or “**vault**” and the suffix “**graphy**” stands for “**writing**”. Cryptography is a method of protecting information and communications through the use of codes so that only those for whom the information is intended can read and process it. It includes techniques such as microdots, merging words with images, and other ways to hide information in storage or transit.
- **Cookie:** A packet of information that travels **between a browser and the webserver.**
- **Data mining:** It is defined as a process used to extract (mining) usable data from a larger set of any raw data. It implies analysing data patterns in large batches of data using one or more software. Data mining has applications in multiple fields, like science and research, business.
- **Digital locker:** It is an online media storage service. Files stored include music, videos, movies, games, and other media. Most digital locker services require a user to register to avail of the service.
- **Digital Signature:** It is a mathematical technique used to validate the authenticity and integrity of a message, software, or digital document. The digital equivalent of a handwritten signature or stamped seal, a digital signature offers far more inherent security, and it is intended to solve the problem of tampering and impersonation in digital communications.
- **Digital divide:** It refers to the difference between people who have easy access to the Internet and those who do not. A lack of access is believed to be a disadvantage to those on the disadvantaged side of the digital divide because of the huge knowledge base that can only be found online.
- **Debugging:** It is a methodical process of finding and reducing the number of bugs, or defects, in a computer program or a piece of electronic hardware, thus making it behave as expected.
- **Encryption:** In cryptography, encryption is the process of encoding messages (or information) in such a way that hackers cannot read it, but authorised users can access it.
- **Graphic Interchange Format (GIF):** A simple file format for pictures and photographs that are compressed so they can be sent quickly.
- **JPEG:** It is a commonly used method of lossy compression for digital photography. The term ‘JPEG’ is an acronym for the **Joint Photographic Experts Groups.**
- **HyperText Transfer Protocol (HTTP):** It is an important protocol used on the World Wide Web for moving hypertext files across the internet. It requires an HTTP client program on one end and HTTP server program on the other end.
- **Internet Protocol (IP) Address:** IP addresses are assigned to every computer on a TCP/IP network. It ensures that data on a network goes where it is supported to go e.g., 192.168.2.250.
- **Internet Service Provider (ISP):** It is a business organization that offers users access to the Internet and related services.
- **Local Area Network (LAN):** In a LAN the connected computers are geographically close together. They are either in the same building or within a smaller area.
- **Metadata**
 - ▶ It is data that describes other data. Meta is a prefix that is used in information technology implying “**an underlying definition or description.**”
 - ▶ Metadata summarizes basic information about data, which can make finding and work with particular instances of data easier.

- ▶ For example, author, date created, and date modified and file sizes are examples of very basic document metadata.
- ▶ Having the ability to filter through that metadata makes it much easier for someone to locate a specific document.
- **Net Neutrality**
 - ▶ It is a principle affirming that all **ISP must treat all data on the internet equally**. They must not discriminate against certain services, users, content, applications, or methods of communication.
 - ▶ Under Net Neutrality regulations, an ISP is neither allowed to intentionally block, or slow down specific content or websites nor is an ISP is allowed to charge additional fees for access to certain internet services.
- **Piracy:** The illegal copying of software or other creative works.
- **Phishing**
 - ▶ It is a fraudulent attempt whereby cybercriminals try to get sensitive information from you, like credit card numbers and passwords.
 - ▶ Some specific techniques include spear-phishing (targets specific people or departments), whale phishing (targets important people like CEOs), and **Smishing** (phishing via text messages) and **vishing** (voice phishing that takes place over the phone, usually through impersonation)
- **Ransomware**
 - ▶ It is a subset of malware in which the data on a victim's computer is locked, typically by encryption, and payment is demanded before the ransomed data is decrypted and access returned to the victim.
 - ▶ The motive for ransomware attacks is nearly always monetary, and unlike other types of attacks, the victim is usually notified that an exploit has occurred and is given instructions for how to recover from the attack.
 - ▶ Payment is often demanded in a virtual currency, such as bitcoin so that the cybercriminal's identity isn't known.
- **Spoofing:** When cybercriminals try to get into your computer by masquerading as a trusted source. Examples include email spoofing (using email header that appears to be from someone you trust), IP spoofing (using a fake IP address to impersonate a trusted machine), and address bar spoofing (using malware to force you to view a specific web page).
- **Spyware:** Malware that gathers information about you, usually to track your internet use and deliver pop-up ads.
- **Spam:** Irrelevant or unsolicited messages sent over the Internet, typically to large numbers of users, for advertising. Phishing spreading malware, etc
- **Virtual Reality**
 - ▶ An artificial environment created with computer hardware and software and presented to the user in such a way that it appears and feels like a real environment.
 - ▶ To create this effect, the user needs Hardware devices like goggles, gloves, and earphones, etc inbuilt with sensors. It enables people to deal with information more easily.
 - ▶ VR provides a different way to see and experience information, one that is dynamic and immediate.
- **Zombie:** Malware used to take control of a system remotely at a later time.
- **Worm:** Malware that self-replicates and sends itself to other computers in your network.

Current Trends in Information Technology

The latest technology methods and best practices of 2019 will primarily stem from current trends in information technology. Advancements in IT systems relate to what the industry is leaning toward or disregarding now. Information technology is advancing so rapidly that new developments are quickly replacing current projections.

1. Cloud Computing

- Cloud computing is a network of resources a company can access, and this method of using a digital drive increases the efficiency of organizations.
- Instead of local storage on computer hard drives, companies will be freeing their space and conserving funds.
- According to Forbes, **83 percent of enterprise workloads will be in the cloud by 2020**, which means 2019 will show an increasing trend in closing in on this statistic.
- Cloud storage and sharing is a popular trend many companies have adopted and even implemented for employee interaction.
- A company-wide network will help businesses save on information technology infrastructure.
- Cloud services will also extend internal functions to gain revenue.
- Organizations that offer cloud services will market these for external products and continue their momentum.
- Organizations will transfer their stored files across multiple sources using virtualization.
- Companies are already using this level of virtualization, but will further embrace it in the year to come.
- Less installation across company computers is another positive result of cloud computing because the Internet allows direct access to shared technology and information.
- The freedom of new products and services **makes cloud computing a growing trend**.

2. Mobile Computing and Applications

- Mobile phones, tablets, and other devices have taken both the business world and the personal realm by storm.
- Mobile usage and the number of applications generated have both skyrocketed in recent years.
- Now, **77 percent of Americans own smartphones** — a 35 percent increase since 2011.
- Experts project mobile traffic to increase even further in 2019, and mobile applications, consumer capabilities, and payment options will be necessary for businesses.
- Fastest-growing companies have already established their mobile websites, marketing, and apps for maximized security and user-friendliness. Cloud apps are also available for companies to use for on-the-go capabilities.

3. Big Data Analytics

- Big data is a trend that allows businesses to analyze extensive sets of information to achieve variety in increasing volumes and growth of velocity.

- Big data has a high return on investment that boosts the productivity of marketing campaigns, due to its ability to enable high-functioning processing.
- Data mining is a way companies can predict growth opportunities and achieve future success.
- Examination of data to understand markets and strategies is becoming more manageable with advances in data analytic programs.
- This practice in information technology can be observed for its potential in data management positions for optimal organizations.
- Database maintenance is a growing sector of technology careers.

4. Automation

- Another current trend in the IT industry is automated processes.
- Automated processes can collect information from vendors, customers, and other documentation.
- Automated processes that check invoices and other accounts-payable aspects expedite customer interactions.
- Machine processes can automate repetitive manual tasks, rather than assigning them to employees.
- This increases organization-wide productivity, allowing employees to use their valuable time wisely, rather than wasting it on tedious work.
- Automation can even produce more job opportunities for IT professionals trained in supporting, programming, and developing automated processes.
- Machine learning can enhance these automated processes for a continually developing system.
- Automated processes for the future will extend to groceries and other automatic payment methods to streamline the consumer experience.

Emerging Trends in Information Technology

Trends in information technology emerging in 2019 are new and innovative ways for the industry to grow. These movements in information technology are the areas expected to generate revenue and increase demand for IT jobs.

1. Artificial Intelligence and Smart Machines

- **Artificial intelligence harnesses algorithms and machine learning to predict useful patterns humans normally identify.**
- **Smart machines take human decision-making out of the equation so intelligent machines can instigate changes and bring forward solutions to basic problems.**
- Companies are rallying around artificial intelligence in the workplace because it allows employees to use their abilities for the most worthwhile tasks, along with the management of these smart machines for a more successful system.
- The U.S. Army is **applying artificial intelligence measures from Uptake Technologies** to vehicles mainly used in peacekeeping missions for repair purposes.
- Their predictive software will reduce irregular maintenance and hone in on machine components that are more likely to deteriorate or get damaged.

- Predictive vehicle repairs can grow and extend to civilian purposes in the coming years.
- AI face recognition is beginning to help with missing people reports, and it even helps identify individuals for criminal investigations when cameras have captured their images.
- **According to the National Institute of Standards and Technology**, face recognition is most effective when AI systems and forensic facial recognition experts team-up.
- AI will continue to promote safety for citizens in the future as software improvements shape these applications.
- Medical AI is another trend that reflects surprising success. Given patient information and risk factors, AI systems can anticipate the outcome of treatment and even estimate the length of a hospital visit.
- Deep learning is one way AI technology gets applied to health records to find the **likelihood of a patient's recovery and even mortality**.
- Experts evaluate data to discover patterns in the patient's age, condition, records, and more.
- Home AI systems are also increasingly popular to expedite daily tasks like listening to tunes, asking for restaurant hours, getting directions, and even sending messages.
- Many problem-solving AI tools also help in the workplace, and the helpfulness of this technology will continue to progress in 2019.
- AI careers are increasing in demand, but the nature of AI skills is shifting.
- AI projects have caught on throughout many businesses, but the outlook of company leaders is more than the projects are returning without properly equipped personnel to implement strategic AI advances. Positions related to AI are necessary to fulfill the potential of these enterprises.

2. Virtual Reality

- Technology that includes virtual reality is becoming prevalent.
- The software of virtual reality is making many industries prepared for various scenarios before entering them.
- The medical profession is projected to use virtual reality for some treatments and interactions with patients in the coming years.
- Virtual training sessions for companies can cut costs, fill in the need for personnel, and increase education.
- **According to Gartner**, by 2023, virtual simulations for selected patients with specific illnesses will reduce emergency room visits in America by 20 million.
- These simulations will have intelligence capabilities, so virtual-reality care can still provide patients with proper attention.
- Virtual-reality professionals will be in high demand in the coming years as the technology catches on in various industries.
- Specialized fields are the main places where virtual reality has caught on, but experts project it will become more applicable to other technological advances. Backgrounds in optics and hardware engineering are particularly sought-after skills.

3. Augmented Reality

- Augmented reality is a more versatile and practical version of virtual reality, as it does not fully immerse individuals in an experience.

- Augmented reality **features interactive scenarios that enhance the real world with images and sounds that create an altered experience.**
- The most common current applications of this overlay of digital images on the surrounding environment include **the recent Pokémon Go fad** or the additions on televised football in the U.S.
- Augmented reality can impact many industries in useful ways.
- Airports are **implementing augmented-reality guides** to help people get through their checks and terminals as quickly and efficiently as possible.
- Retail and cosmetics are also using augmented reality to let customers test products, and furniture stores are using this mode to lay-out new interior design options.
- The possibilities for augmented reality in the future revolve around mobile applications and health care solutions.
- Careers in mobile app development and design will be abundant, and information technology professionals can put their expertise to use in these interactive experiences.

4. Blockchain Data

- Blockchain data, like the new cryptocurrency Bitcoin, is a secure method that will continue to grow in popularity and use in 2019. This system allows us to input additional data without changing, replacing, or deleting anything.
- In the influx of shared data systems like cloud storage and resources, protecting original data without losing important information is crucial.
- The authority of many parties keeps the data accounted for without turning over too much responsibility to certain employees or management staff.
- For transaction purposes, blockchain data offers a safe and straightforward way to do business with suppliers and customers.
- Private data is particularly secure with blockchain systems, and the medical and information technology industries can benefit equally from added protection.

5. Cyber-Privacy and Security

- Shared company systems and the growth of the Internet leave a high amount of personal and company data at risk to breaches.
- Redesigned systems and new firewalls and gateways will be added to the services companies need to bolster their technology.
- Cybersecurity is a concentration of IT that will help secure clouds and improve the trust between businesses and their vendors.
- Recognition software will replace much of the password-protected systems companies use in 2019.
- Biometric measures and other safety protocols will increase the security of business practices, especially business-to-business interactions.
- Although authentication and recognition programs enhance protection, the Internet of Things technology requires further development.
- The vulnerability of the Internet of Things systems is **already projected to contain risks** the industry is not prepared for.

- As the Internet and shared company networks increase, cybersecurity and privacy are vulnerable to infiltration.
- However, many companies are already aware of the projected weak spots in their technology. IT professionals need to address these issues and find practical and fortifying solutions.

6. Internet of Things

- It is an emerging movement of products with **integrated Wi-Fi and network connectivity abilities**.
- Cars, homes, appliances, and other products can now connect to the Internet, making activities around the home and on the road an enhanced experience.
- Use of IoT allows people to turn on music hands-free with a simple command, or lock and unlock their doors even from a distance.
- Many of these functions are helping organizations in customer interaction, responses, confirmations, and payments.
- Remote collection of data assists companies the most. IoT almost acts like a digital personal assistant.
- The intelligent features of some of these IoT products can aid in many company procedures.
- Voice recognition and command responses will allow you to access stored data on cloud services.
- IoT enriches the IT industry, especially in job creation.

LIFE SCIENCES & BIOTECHNOLOGY

- Biology is the study of life, so Life Sciences is essential, the study of biology.
- The scientific method is the process by which biological information, like that of all other sciences, has been identified. This has resulted in several important biological scientific theories, including the cell theory and the theory of evolution.
- All life is built around the element carbon, and four categories of organic compounds: carbohydrates, lipids, proteins, and nucleic acids.
- One particular type of protein, enzymes, is biological catalysts, allowing biochemical reactions to proceed at the rate necessary to maintain life.

Important Disciplines in Biology

- Cytology: Study of cell structure.
- Embryology: It is the study of fertilization and development of a zygote into an embryo, larva or a miniature adult.
- Exobiology: Study of possibility of life in the outer space.
- Microbiology: It is the study of structure, life cycle and activities of micro-organisms invisible to naked eye.
- Pathology: Study of diseases, their effects, casual agents, transmission, and other activities of pathogens.

- Eugenics: Study of factors connected with impairment or improvement of a race.
- Euthenics: Study of environmental conditions that contribute to the improvement of intellect and other traits of human beings.
- Euphenics: Treatment of defective heredity through genetic engineering.
- Actinology: (i) Study of radiation affects (ii) Study of radially symmetrical animals.
- Aerobiology: Study of air borne organisms as well as structure (e,g spores) and their distribution.
- Agrobiology: Quantitative science of plant life and plant nutrition.
- Agronomy: Science of soil management of domesticated animals.
- Animal Husbandry: Raising and management of domesticated animals.
- Anthropology: Study of origin development and culture of present and past races of humans.
- Biometrics: (Biometry = Biostatistics). Statistical study of biological problems.
- Biotechnology: Technology connected with employing living beings or their products in industrial processes.
- Cardiology: Study of heart.
- Carcinology: Study of cancers or tumours.
- Dentistry: Care of teeth including cure, removal, filling and replacement.
- Dermatology: Study of skin and other body coverings.
- Ecobiology: (i) Study of adaptations in relation to habitat. (ii) Study of problems connected with existence of life in space and other planets.
- Economic Botany: Branch dealing with commercially exploited/exploitable plants/Economic Zoology animals.
- Ethnology: Science dealing with different races of mankind.
- Ethology: Study of animal behavior.
- Fishery: Catching, breeding, rearing and marketing of fish and other aquatic animals.
- Floriculture: Cultivation of plants for their flowers.
- Gastroenterology: Study of stomach, intestine and their diseases.
- Geology: Science of earth.
- Haematology: Study of blood.
- Hepatology : Study of liver.
- Horticulture: Development and management of orchards and gardens.
- Immunology: Study of immunity or resistance to disease.
- Mammology : Study of mammals.
- Molecular genetics: Molecular basis of genetics/science of inheritance and variations.
- Mycology: Study of fungi.
- Myology (Sarcology): Study of muscles.
- Neonatology: Scientific study of new born.
- Neontology : Science of present day or recent living beings.

- Nephrology: Study of kidneys.
- Neurology: Study of nervous system.
- Occupational Therapy: Treating mental and physical defects with occupation.
- Ornithology: Study of birds.
- Osteology: Study of Bones.
- Pharmacology: Study of synthesis and effects of medicine on an organism.
- Physiotherapy: Treatment of body defects through massage and exercise.
- Psychiatry: Treatment of mental diseases.
- Psychology: Study of human mind and behaviour.
- Radiology: Science dealing with X-rays and other imaging techniques for medical diagnosis.
- Radiotherapy: Treatment of diseases with X-ray and radio-active substances.
- Sericulture: Rearing silkworms for extraction of silk.
- Serology: Study of serum; interaction of antigens and antibodies in the blood.
- Therapeutics: Treatment of disease.
- Toxicology: Study of harmful effects of drugs and other substances.
- Tricology: Study of hairs.
- Urology: Science dealing with disorders of urinary tract (urino-genital tract in males).
- Venereology: Study and treatment of venereal disease.

Cells

- The cell is the structural and functional unit of all living organisms, and is sometimes called **the “building block of life.”**
- Some organisms, such as **bacteria are unicellular**, consisting of a single cell. Other organisms such as humans are **multicellular**.
- Humans have an estimated 100 trillion cells. The **largest** known cell is an **Ostrich egg**.
- **Anton van Leeuwenhoek** was the first person to build a microscope and draw protozoa, such as Vorticella from rainwater, and bacteria from his mouth.
- In 1665, **Robert Hooke** discovered cells in cork, then in living plant tissue using an early microscope.
- First of all, in 1839, **Schleiden and Schwann**, states that all organisms are composed of one or more cells.
- All cells come from **pre-existing cells**.
- Vital functions of an organism occur within cells, and all cells contain the **hereditary information** necessary for regulating cell functions and for transmitting information to the next generation of cells.
- In 1953, **Watson and Crick** made their first announcement on the double-helix structure for DNA.

Anatomy of Cells

- There are two types of cells, **eukaryotic and prokaryotic**.

- Prokaryotic cells are usually singletons, while eukaryotic cells are usually found in multicellular organisms.

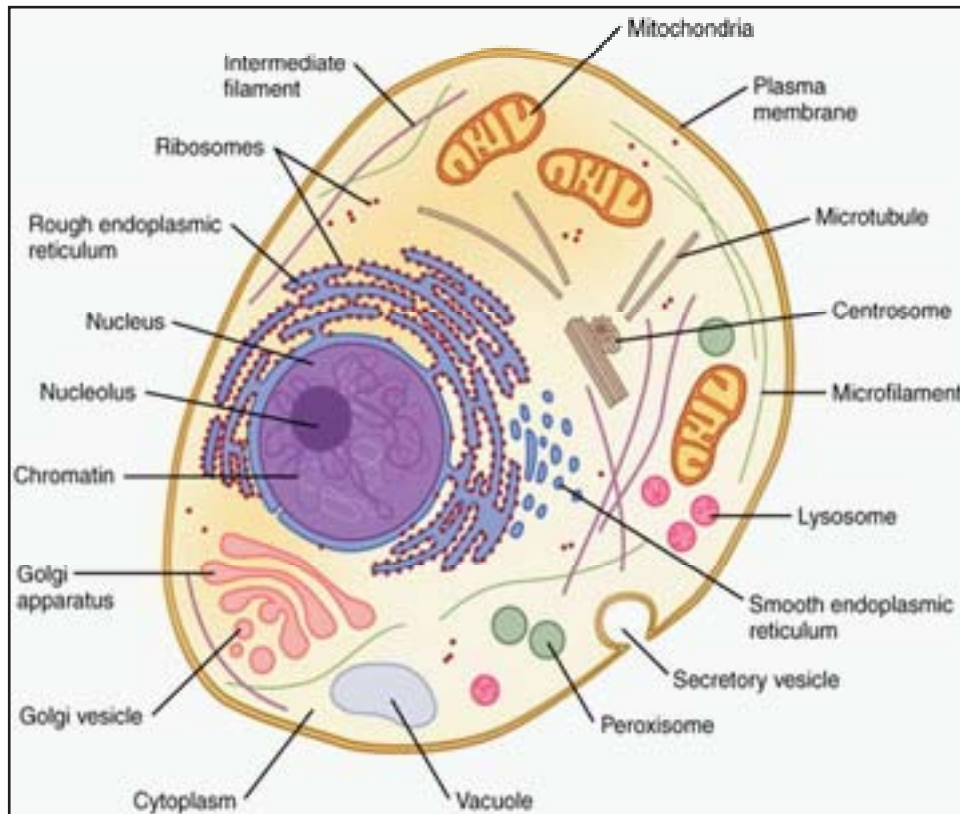
Comparison between Prokaryotes and Eukaryotes		
	Prokaryotes	Eukaryotes
Organisms	Bacteria	Protists, fungi, plants and animals
Cell size	Generally 1 to 10 mm measured lengthwise	Generally 10 to 100 mm, lengthwise
Metabolism	Anaerobic or aerobic	Anaerobic or aerobic
Organelles	None	Nucleus, mitochondria, chloroplasts, endoplasmic reticulum, Golgi apparatus, lysosomes, etc.
Cell support	External cell wall	Internal cytoskeleton
DNA	Circular DNA in single cellular compartment	Very long linear DNA contained within a membrane-bounded nucleus
RNA and protein	RNA and protein synthesized in the single compartment	RNA synthesized and processed in nucleus; proteins synthesized in cytoplasm
Transmembrane movement	No endocytosis or exocytosis	Endocytosis and exocytosis
Cell division	Chromosomes pulled apart by attachments to inner membrane	Chromosomes pulled apart by attachments to cytoskeletal components
Cellular organization	Mainly unicellular	Unicellular or multicellular, with many differentiated cell types

Subcellular Components

All cells, whether prokaryotic or eukaryotic, have a membrane, which envelopes the cell, separates its interior from its environment, regulates what moves in and out (selectively permeable), and maintains the electric potential of the cell. Inside the membrane, a salty cytoplasm takes up most of the cell volume. All cells possess DNA, the hereditary material of genes, and RNA, containing the information necessary to build various proteins such as enzymes, the cell's primary machinery. There are also other kinds of biomolecules in cells. The primary components of the cell and their functions are as follows:

- Cell Membrane (A cell's defining boundary)**

- ▶ The cytoplasm of a cell is surrounded by a cell membrane or plasma membrane. The plasma membrane in plants and prokaryotes is usually covered by a cell wall.
- ▶ This membrane serves to separate and protect a cell from its surrounding environment and is made mostly from a double layer of lipids and hydrophilic phosphorus molecules. Hence, the layer is called a **phospholipid bilayer**.
- ▶ This membrane has a variety of protein molecules that act as channels and pumps that move different molecules into and out of the cell.
- ▶ The membrane is said to be 'semi-permeable'. Cell surface membranes also contain receptor proteins that allow cells to detect external signaling molecules such as hormones.



◉ Cytoskeleton (A cell's scaffold)

- ▶ The cytoskeleton acts to organize and maintains the cell's shape; anchors organelles in place; helps during endocytosis, the uptake of external materials by a cell, and cytokinesis, the separation of daughter cells after cell division; and moves parts of the cell in processes of growth and mobility.
- ▶ The eukaryotic cytoskeleton is composed of microfilaments, intermediate filaments, and microtubules. There are a great number of proteins associated with them, each controlling a cell's structure by directing, bundling, and aligning filaments.
- ▶ The prokaryotic cytoskeleton is less well-developed but is involved in the maintenance of cell shape, polarity, and cytokinesis.

◉ Genetic Material

- ▶ Within a cell, two different kinds of genetic material exist **deoxyribonucleic acid (DNA) and ribonucleic acid (RNA)**.
- ▶ Most organisms use DNA for their long-term information storage, but some viruses (e.g., retroviruses) have RNA as their genetic material.
- ▶ The biological information contained in an organism is encoded in its DNA or RNA sequence.
- ▶ RNA is also used for information transport (e.g., mRNA) and enzymatic functions (e.g., ribosomal RNA) in organisms that use DNA for the genetic code itself.
- ▶ Prokaryotic genetic material is organized in a simple circular DNA molecule (the bacterial chromosome) in the nucleoid region of the cytoplasm.
- ▶ Eukaryotic genetic material is divided into different, linear molecules called chromosomes inside a discrete nucleus, usually with additional genetic material in some organelles like mitochondria and chloroplasts.
- ▶ A human cell has genetic material in the nucleus (the nuclear genome) and the mitochondria (the mitochondrial genome). In humans, the nuclear genome is divided into 46 linear DNA molecules called

chromosomes. The mitochondrial genome is a circular DNA molecule separated from the nuclear DNA. Although the mitochondrial genome is very small, it codes for some important proteins.

- **Organelles:** As the human body contains many different organs, such as the heart, lung, and kidney with different functions. Similarly, cells also have a set of **little organs**, called organelles that are specialized for carrying out one or more vital functions. Membrane-bound organelles are found **only in eukaryotes**.
- **Cell Nucleus (a cell's information center)**
 - ▶ The cell nucleus, found in a eukaryotic cell, is the **house of chromosomes** and is the place where almost all **DNA replication and RNA synthesis** occur. During processing, DNA is transcribed or copied into a special RNA, called **mRNA**. This mRNA is then transported out of the nucleus, where it is translated into a **specific protein molecule**.
 - ▶ In prokaryotes, DNA processing takes place in the cytoplasm.
- **Mitochondria and Chloroplasts (the power generators):** Mitochondria are **self-replicating organelles** that occur in various numbers, shapes, and sizes in the cytoplasm of all eukaryotic cells. As mitochondria contain their **genome** that is separate and distinct from the nuclear genome of a cell, they play a critical role in generating energy in the eukaryotic cell. **Chloroplasts**, broadly called plastids, are often involved in storage.
- **Endoplasmic Reticulum and Golgi apparatus (macromolecule managers):**
 - ▶ The endoplasmic reticulum (ER) is the **transport network for molecules** targeted for certain modifications and specific destinations, as compared to molecules that will float freely in the cytoplasm.
 - ▶ The ER has **two forms**: the **rough ER**, which has ribosomes on its surface, and the **smooth ER**, which lacks them.
 - ▶ The ER contains many **ribosomes, the protein production machine**.
 - ▶ The ribosome is a large complex composed of many molecules, only exist floating freely in the cytosol, whereas in eukaryotes they can be either free or bound to membranes.
- **Lysosomes and Peroxisomes:** The eukaryotic cell could not house such **destructive enzymes** if they were not contained in a membrane-bound system.
- **Vacuoles:** They store food and waste. Some vacuoles store extra water also they are often described as liquid filled space and are surrounded by a membrane. Some cells, most notably **Amoeba** have contractile vacuoles, which can pump water out of the cell if there is too much water

Cell Division

- The growth and the development of every organism depend exclusively on the multiplication and enlargement of its cells. The development of a multicellular organism from the unicellular zygote is achieved by cell division, growth, and differentiation.
- The division of the nucleated cells is achieved by two integral activities such as **division of the nucleus (called Karyokinesis) and the division of the cytoplasm (that is called cytokinesis)**. Usually, the Karyokinesis is followed by the Cytokinesis, but sometimes it does not follow and results in multinucleated cells.
- In animals and plants, following three types of cell division have been observed:
- **Amitosis**
 - ▶ It is the means of asexual reproduction in unicellular organisms like bacteria and protozoans. It also occurs in embryonic membranes of vertebrates.
 - ▶ In Amitosis, the splitting of the nucleus is followed by cytoplasmic contraction. I

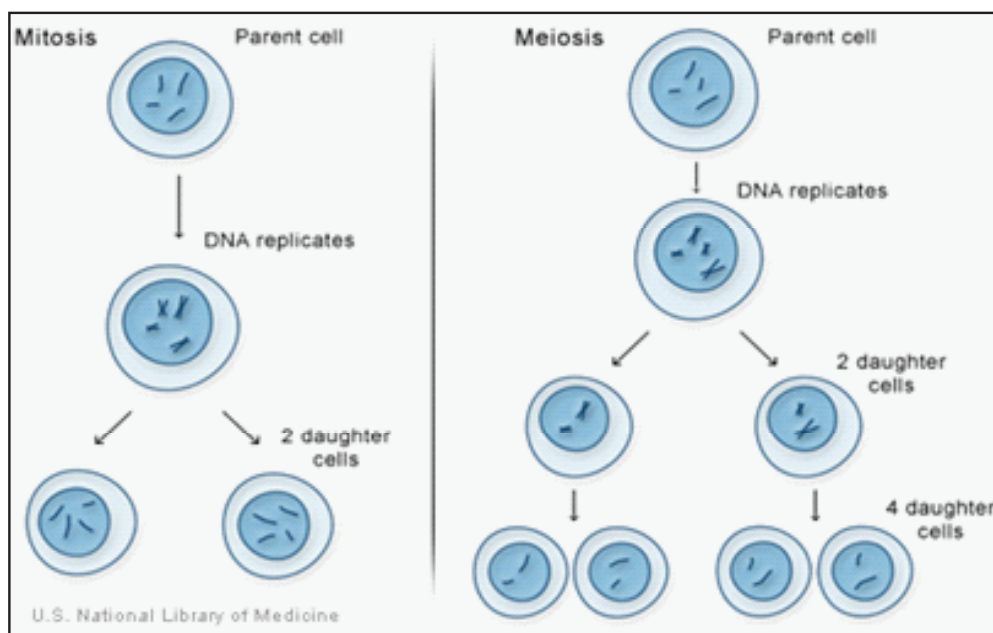
- ▶ In Amitosis, two daughter cells are formed without the occurrence of any nuclear event. It is also known as direct nuclear division.

- **Mitosis**

- ▶ It takes place as a result of mitotic division. One cell divides into 2 daughter cells which are quantitatively and qualitatively identical to the mother cell. No change in the Chromosome number occurs.
- ▶ In between two successive mitotic divisions, there is a rest period called the **interphase**.
- ▶ Mitosis has 4 phases- **Prophase, Metaphase, Anaphase & Telophase**.
 - ▶ **Prophase:** Disappearance of nuclear membrane and nucleolus along with the **doubling of chromosomes**.
 - ▶ **Metaphase:** Formation of a **spindle**, chromosomes join themselves to the **equatorial plane** of the spindle.
 - ▶ **Anaphase:** Centromeres divide **longitudinally**. Sister chromatids move towards the **opposite pole**.
 - ▶ **Telophase:** Grouping of chromatids at each pole along with the formation of new nuclear membrane and nucleolus.

- **Meiosis**

- ▶ Also called **Reproductive cell division** because it is associated with all sexual reproduction. As a result of the division in the daughter cells, chromosomes number becomes **half** to that of the mother cell.
- ▶ Each division results in 4 daughter cells in contrast to 2 daughter cells in each mitotic division.
- The division includes 2 phases i.e. **Reduction division and Equational division (Mitosis)** which also consist of the same 4 phases, i.e., **Prophase, Metaphase, Anaphase & Telophase**.
- But Prophase I (Division I) have 5 sub-stages: **Leptotene, Zygotene, Pachytene, Diplotene & Diakinesis**. The characteristics of each of the sub-stage are:



- ▶ **Leptotene:** Close association of homologous chromosomes.
- ▶ **Zygotene:** Pairing of homologous chromosomes, the phenomenon is called **Synapsis**. As a result, Bivalent Chromosomes are formed.
- ▶ **Pachytene:** Chiasma formation and crossing over.

- ▶ **Diplotene:** Terminations of chiasma starts.
- ▶ **Dikinesis:** Disappearance of nuclear membrane and nucleolus.
- In Metaphase I spindle formation and rearrangement of chromosomes. In Anaphase I separation of homologous chromosomes. In Telophase grouping of chromosomes and formation of nuclear membrane and nucleolus. This division is followed by Division II.

Genetics

Introduction

- The science dealing with the study of the mechanism of heredity and the causes of variation in all living beings is called Genetics. The word Genetics was derived from the Greek root word 'gen' which means to grow. **The term Genetics was coined by Bateson in 1906 for the study of the physiology of heredity and variations.** Genetics is the study of two contradictory aspects of nature i.e. Heredity and Variation.
 - ▶ **Heredity:** Because of this phenomenon of heredity, **offspring of all living organisms resemble their parents in several aspects.** Hereditary exactly gives the meaning "like produces like", all living organisms tend to produce offspring like themselves.
 - ▶ Hence, heredity may be defined as the transmission of characters from one generation to other/ from parents to their offspring's via gametes in sexual reproduction or via some asexual reproductive bodies in asexual reproduction. These transferable characters are called "**hereditary characters**". Thus, heredity is the cause of similarities between the offspring's, so that the individuals of the same parents resemble each other in most of the aspects.
 - ▶ **Variation:** Though offspring receive all the characters from their parents, they are not exact copies of their parents. Differences are found even between two offspring of the same parents. The progeny differs not only among themselves but also with the parents. These differences are called variations. Thus, **variations may be defined as the visible differences between the parents and the offspring's or between the offspring of the same parents.**
- Genetics explains the mechanism and the basis for **both similarities and differences** between related individuals. Genetics also tries to explain the phenomenon of the evolution of **cytodifferentiation**.

Branches of Genetics

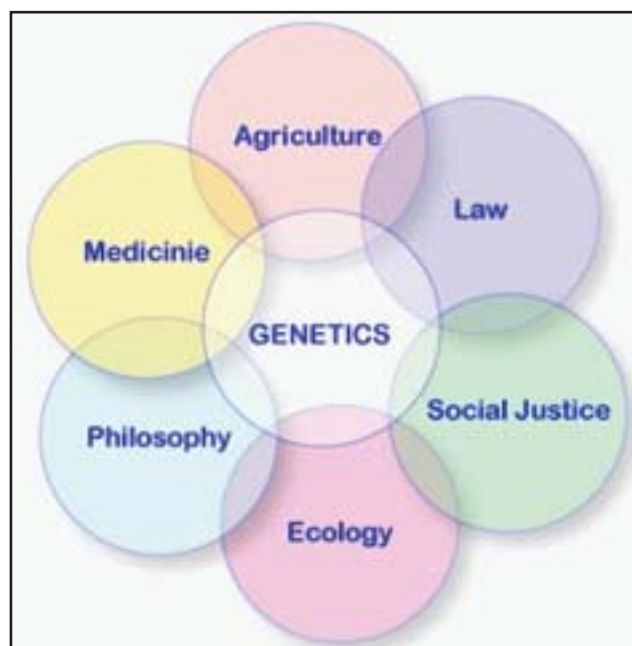
The science of genetics has proliferated into numerous distinctive sub-disciplines. The following are some of the distinctive branches of genetics:

- **Plant genetics:** The genetics of plants
- **Animal genetics:** The genetics of animals
- **Microbial genetics:** The genetics of Microorganisms (Viruses, Bacteria, unicellular plants, and animals)
- **Human genetics:** The study of heredity of human traits and human disorders and correction of human genetic disorders.
- **Viral genetics:** The genetics of viruses
- **Fungal genetics:** The genetics of Fungus
- **Drosophila genetics:** The Genetics of Fruit fly (Drosophila).
- **Mendelian Genetics:** It involves the study of heredity of quantitative (monogenic) and quantitative (polygenic) traits and the influence of the environment on their expressions.

- **Quantitative genetics:** It involves the study of heredity of quantitative traits such as height, weight, and IQ in human beings and milk production in cattle.
- **Morganian genetics:** It includes the study of recombination or crossing over in all kinds of organisms such as higher plants, animals, fungi, bacteria, and viruses. It also involves the preparation in linkage maps of chromosomes.
- **Non-Mendelian genetics:** It involves a study of the role of cytoplasm and its organelles in heredity.
- **Mutation Genetics:** They involve the study of heredity of both chromosomal changes and also gene mutation.
- **Cytogenetics:** It provides cytological explanations of different genetical principles.
- **Molecular genetics:** It includes the study of the structure and function of gene and regulation of its activity.
- **Transmission genetics:** It includes the study of the mode of gene transmission from generation to generation. The kind of studies, that Mendel performed are now included in the discipline of transmission genetics.
- **Clinical genetics:** Genetics involved in the detection of causes of diseases such as haemophilia, colour blindness, diabetes, Phenylketonuria.
- **Forward genetics and reverse genetics:** The term reverse genetics has been used in physical mapping and isolation of genes whose protein products are unknown. The term forward genetics has been used genes that are mapped based on phenotype using the technique of classical genetics.
- **Immuno-genetics:** It deals with the production of different types of antibodies. The diversity of the antibodies is found to be under the control of genetic regulation.
- **Behavioral genetics:** It involves the study of the interaction of genes with the environment to produce a particular pattern of behaviour.

Importance of Genetics

- Genetics explains a lot of things animals, plants and humans like what makes them unique, what makes them different and variable, why do they look like all the other members of their family, and why some diseases occur only in plants or animals or humans.
- The genetic information can be utilized to diagnose, treat, prevent, and cure many diseases in animals, plants, and humans. The genes can be better understood as the information, which guides and command the body to make proteins that are needed for the growth and survival of the organism. Geneticists identify and recognize the importance of these proteins for the betterment of human life with effective medicines and treatments.
- Genetic experts can trace and work out family relationships and ancestors by studying the differences in DNA. The common ailments like asthma, diabetes, etc., requires the involvement of many different genes. The identification of genetic influences and their interactions with various other factors can help in bringing great advancements in medical research.



- Scientists have decoded the genomes of humans and various other plants and animals. This decoding would help in improving the yield, selecting better traits, producing disease-resistant varieties which are the need of the hour to feed the ever-growing human population. Humans have about 24,000 different genes each made up a few hundred to a few thousand base pairs of DNA. All these genes are contained in 23 pairs of chromosomes, each of which carries thousands of different genes and millions of base pairs of DNA. When these genes are altered, there would be a direct effect on the synthesis of the corresponding proteins and consequently, this will lead to diseases.
- In recent years the advances in the field of biotechnology have created genetically engineered strains of bacteria and fungi that carry specific genes from unrelated organisms. These microbes produce useful compounds as insulin, human growth hormone, antiviral and anticancer agents.
- Finally, the information on genetic mechanisms has made us aware of some new dangers too. Some genetic experts fear there may be an accidental release of artificial pathogens from labs which may cause a great disaster. Also, some genetic experts fear that increased exposure of plant or animal products to the chemicals may bring about undesirable and haphazard outcomes. Anyways, modern genetic experts have revolutionized agriculture, horticulture, animal husbandry, philosophy, sociology, law, ecology, and many other branches of biology. Moreover, the science of genetics has helped in removing many faulty concepts of inheritance.

Mendel and his work, seven traits observed by Mendel

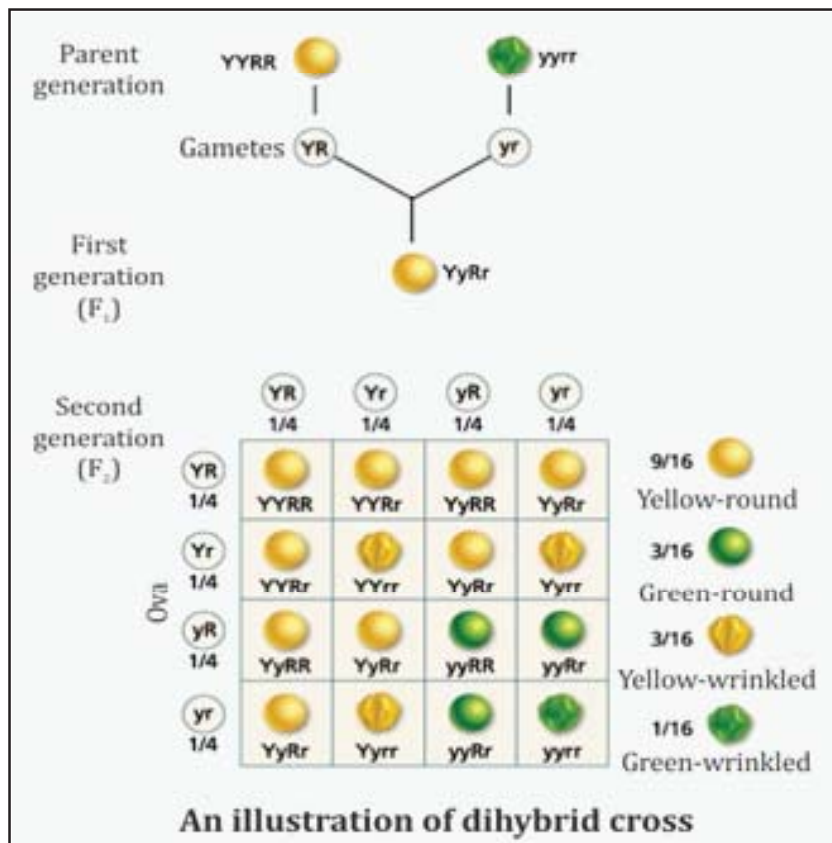
Introduction

- Farmers and herders have been breeding their plants and animals selectively for thousands of years. This kind of selective breeding leads to production of more useful hybrids. Initially, they did not know the actual mechanism behind the inheritance of characters. Consequently, with the developments made in various branches of science, we finally came to know the actual mechanism behind the selective plant breeding experiments.
- The invention of better microscopes in the 1890s allowed natural scientists to realize the basic facts of cell division and sexual reproduction. The attention of genetic research was then shifted to understanding what happens behind the screen during i.e. transmission of hereditary traits from parents to children. A number of assumptions were proposed to clarify the concept heredity, but finally, it was **Johann Gregor Mendel** who set the basis for the study of genetics. His ideas have been published in 1866 but his ideas went unnoticed until 1900.
- Although Mendel experimented with **plants**, the primary principles of heredity that he discovered also apply to humans and other animals. This is because the **mechanisms of inheritance are the same for all complex life forms**.

Seven traits observed by Mendel

- Mendel selectively cross-bred over 28,000+ common pea plants for many generations and he discovered that certain characters show up in offspring without any mixing of parent characteristics. For example, the pea flowers are either purple or white and intermediate colors do not appear in the offspring of cross-pollinated pea plants.
- Mendel observed the following seven traits that are easily recognized and these traits superficially occur only in one of two forms:

- ▶ Flower color is purple or white
- ▶ Flower position is axil or terminal
- ▶ Stem length is long or short
- ▶ Seed shape is round or wrinkled
- ▶ Seed color is yellow or green
- ▶ Pod shape is inflated or constricted
- ▶ Pod color is yellow or green



- During the 19th century, most of the genetic researchers believed in “**blending theory**”. This theory states that **inherited characters blend from generation to generation**. Hence Mendel carefully selected the characters which do not show up in offspring with intermediate forms. But later it was verified that this theory was wrong.
- Another equally wrong theory known as “**pangenesis**” was proposed by **Charles Darwin**. This theory proposed that inherited “**elements**” in our bodies are altered by the things we do during our lifetime. These altered elements were thought to migrate via blood to the reproductive cells and subsequently could be inherited by the next generation.

Conclusions of Mendel’s experiments

- Mendel concluded three important points from his experiments:
 - ▶ **Factors are the units that decide the inheritance of a character.** Factors remain unchanged and are transferred on to the offspring. These factors are now called **genes**.
 - ▶ An individual receives one such factor from each of the parents for each character.
 - ▶ Characters may not show up in an individual but can still be transferred to the next generation.

- It is important to note that, in Mendel's experiments, the starting parent plants were homozygous for pea seed color.
- Each parent had two identical alleles of the gene for this character. The plants of the first generation (F₁) were all heterozygous.
- Offsprings have inherited two different alleles-one from each parent plant. This can be understood more clearly when we look at actual genetic makeup (genotype) and physical characteristics (phenotype).
 - ▶ Each of the offspring of the first generation gets a yellow allele from one parent and a green allele from another parent. When these plants from the first generation are breed, they have an equal chance of passing on either yellow or green alleles to each offspring.
 - ▶ Among all the seven pea plant characters experimented by Mendel, on character appears to be dominant over the other. In other words, we can say that one character masked the presence of others.
- Mendel, based on the results he obtained from his experiments formulated three laws:
 - ▶ Law of Segregation
 - ▶ Law of Independent Assortment
 - ▶ Law of Dominance

Sex Linkage in Human Beings

- In human beings, there are **46 chromosomes (23 pairs)** present in each somatic cell. In **female individuals**, there are 22 pairs of autosomes and one pair of X-chromosomes (**22 pairs + XX**) and in **male individuals**, there are 22 pairs of autosomes and one 'X' and one 'Y' chromosome (**22 pairs + XY**). Since females will produce only one type of gametes, **gametes from a male individual will determine the sex of the progeny**. In man, about fifty X-linked diseases have been reported. The most important and common X linked disease of man are:
 - ▶ Colour blindness
 - ▶ Haemophilia
 - ▶ Anhidrotic ectoderma(non-functional sweat glands)
 - ▶ Night blindness
 - ▶ Myopia (short-sightedness)
 - ▶ Juvenile glaucoma (hardening of the eye ball).
- **Turner's syndrome:**It is characterised by monosomy of XO type i.e. one X chromosome of sex chromosome (XX) is missing, the Turner's syndrome individuals are phenotypically a female and can be characterised by short stature, webbed neck, underdeveloped breasts, and small uterus.
- **Klinefelter's Syndrome:**It is characterised by trisomy (XXY) with the total number of chromosomes 47. These are male individuals who are phenotypically fairly normal but have a very low sperm count and are therefore sterile. They have female-like breast development, small testes, and sparse body hairs.
- **Colour Blindness:** It is sex-linked inheritance found more often among men than women. It is **regulated by a recessive gene**. Individuals suffering from this failure to differentiate between colours, mainly between red and green colours.
- **Down's syndrome (Mongolism):**It develops due to the trisomy of the 21st chromosome i.e. representation of the chromosome thrice instead of twice. It occurs once in every 500 to 600 childbirths. The individual is mentally retarded and there is no cure for the abnormality.

- **Haemophilia:** This is a rare hereditary blood disorder marked by a tendency towards excessive bleeding. It is a sex-linked abnormality and is entirely restricted to males.
- **Albinism:** This affects skin preventing the development of skin pigments. It happens due to an autosomal recessive gene. Individuals suffering from this abnormality are found to lack pigmentation of skin, iris, retina, choroid, and hairs. It has been proved that albinism results from failure on the part of the amino acid.

Biotechnology

- Biotechnology is defined as the industrial application of living organisms and their biological processes such as biochemistry, microbiology, and genetic engineering, to make the best use of the microorganisms for the benefit of mankind.

Different types of biotechnology

- **Green Biotechnology:** It is defined as **the application of biological techniques to plants** to improve the nutritional quality, quantity, and production economics. It is done by implanting foreign genes to plant economically important species. This contains three main areas: plant tissue culture; plant genetic engineering and plant molecular marker-assisted breeding.
- **Red Biotechnology:** It is concerned with the **discovery and development of innovative drugs and treatments**. A key prerequisite was an increasing understanding of how proteins function, their roles in communication between and within cells, and the diseases caused when these proteins malfunction. This includes **Gene Therapy, Stem Cells, Genetic Testing**, etc.
- **White Biotechnology:** This field of biotechnology is **connected with the industry**. White biotech uses molds, yeasts, bacteria, and enzymes to produce goods and services or parts of products. It offers a wide range of **bio-products like detergents, vitamins, antibiotics, etc.** Most of the white biotech processes result in the saving of water, energy, chemicals, and the reduction of waste compared to traditional methods.
- **Blue Biotechnology:** It is concerned with the application of molecular biological methods **to marine and freshwater organisms**. It involves the use of these organisms, and their derivatives, for multiple purposes, the most remarkable are the identification process and development of new active ingredients from marine origin.
- **Yellow Biotechnology:** It refers to biotechnology with **insects — analogous to the green (plants) and red (animals) biotechnology**. Active ingredients or genes in insects are characterized and used for research or application in agriculture and medicine.

Applications

- **Biopharmaceuticals:** The drugs are being developed with the use of microorganisms without using any **synthetic materials and chemicals**. Large molecules of **proteins** are usually the source of biopharmaceutical drugs. They when targeted in the body attack the hidden mechanisms of the diseases and destroy them **without any side effect(s)**. Now scientists are trying to develop such biopharmaceutical drugs that can be treated against diseases like hepatitis, cancer, and heart diseases.
- **Gene therapy:** It is used in delicacy and diagnoses of diseases like **cancer and Parkinson's**. The apparatus of this technique is that the fit genes are under attack in the body which **either obliterate the injured cells or replace them**. In some cases, the fit genes make corrections in the genetic information and that is how the genes start performance in the favour of the body.

- **Flowers:** There is **extra to agricultural biotechnology** than just hostility disease or civilizing food quality. There is some simply aesthetic application and an example of this is the use of gene recognition and transfer techniques **to improve the colour, smell, size, and other features of flowers.**
- **Plant and Animal Reproduction:** Enhancing plant and animal behaviour by traditional methods like cross-pollination, grafting, and cross-breeding is time-consuming. Biotech advance let for specific changes to be made **rapidly, on a molecular level through over-expression or removal of genes, or the introduction of foreign genes.**
- **Food processing** is a process by which **non-palatable and easily perishable raw materials are converted to edible and potable foods and beverages,** which have a longer shelf life. The method, by which the microbial organisms and their derivatives are used to increase the edibility and the shelf life of foods, is known as fermentation.
- **Bioremediation:** The process of **cleaning up the hazardous substances into non-toxic compounds** is called the Bioremediation process. This process is majorly used for any kind of technology clean up that uses the natural microorganisms.

Biotechnology Projects

- **Human Genome Project**
 - ▶ The “genome” of any given individual is unique; **mapping the “human genome”** involved sequencing a small number of individuals and then assembling these to get a complete sequence for each chromosome. The **finished human genome is thus a mosaic, not representing any one individual.** It is an **international scientific research project.**
- **Advantages:**
 - ▶ It can help us understand diseases including: genotyping of specific viruses to direct appropriate treatment.
 - ▶ Identification of mutations linked to different forms of cancer.
 - ▶ The design of medication and a more accurate prediction of their effects.
 - ▶ Advancement in forensic applied sciences.
 - ▶ Biofuels and other energy applications.
 - ▶ Agriculture, animal husbandry, bioprocessing; risk assessment; bio-archaeology, anthropology, and evolution.
 - ▶ Commercial development of genomics research related to DNA based products, a multibillion-dollar industry.
- **Gene Editing**
 - ▶ This is a technique that allows the scientist to **edit the gene sequence and then modify it** to bring the desired changes. It helps to understand the sequence of genes and then use gene editing to cure incurable diseases like **Tay-Sachs and perhaps cystic fibrosis** through the modification of genes.
 - ▶ In addition to that, gene editing can be used as a research tool to simply learn more about these diseases.
- **GM Mustard Issue**
- **DMH-11 is a Genetically Modified (GM) mustard hybrid.** Hybrids are normally obtained by crossing 2 genetically diverse plants from the same species. The **1st-generation offspring resulting from it has higher yields** than what either of the parents is individually capable of giving.
- But there is **no natural hybridization system in mustard**, unlike in, say, cotton, maize, or tomato. This is because **its flowers contain both the female (pistil) and male (stamen) reproductive organs,**

making the plant naturally self-pollinating. What scientist has done is to create a viable hybridization system in mustard using GM technology. The resulting GM mustard hybrid, it is claimed, gives 25-30% more yield than the best varieties such as 'Varuna' currently grown in the country.

- Scientists at the **Centre for Genetic Manipulation of Crop Plants (CGMCP) in Delhi University**, however, showed that this problem could be addressed by crossing Indian mustard cultivars with juncea lines of East European origin like '**Early Heera**' and '**Donskaja**'. The combination of the 2 divergent gene pools enhanced the crossing options; the resultant F1 progeny were found to exhibit significant heterosis.

Terminologies associated with the biotechnology

- **DNA:** Deoxyribonucleic Acid (DNA) is a molecule that encodes the genetic instructions used in the development and functioning of all known living organisms.
- **Gene:** It is a **segment of nucleic acid** that contains the information necessary to produce a functional product, usually a protein. The genes are made up of a coding alphabet of 4 nucleotides made up of 4 bases: - **Adenine (A), Thymine (T), Guanine (G), and Cytosine (C).**
- **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.
- **Gene Therapy:** This is in a way, **genetic engineering of humans**, which would allow a person suffering from a disabling genetic disorder to lead a normal life.
- **Genome Resource Bank:** It is a **frozen repository of biological materials**, including sperm and embryos, tissue, blood products, and DNA. It is going to be used as a conservation tool for protecting and preserving biodiversity.
- **Bioinformatics:** It is an independent discipline that **merges the field of molecular biology and computer science**. This mainly involves the transformation of biological polymers such as nucleic acid molecules and proteins into sequences of digital symbols. The symbols and their meaning for the protein sequences have also been generated.
- **Bioremediation:** It is the **use of microorganisms for the degradation of hazardous chemicals** in soil, sediments, water, or other contaminated materials. It uses naturally occurring bacteria and fungi or plants to degrade or detoxify substances hazardous to human health and/or the environment.
- **Biosensors:** They are **biophysical devices that can detect the presence of specific substances** e.g. sugars, proteins, hormones, pollutants, and a variety of toxins in the environment.
- **Bioreactors:** It can be thought of as **vessels in which raw materials are biologically converted into specific products**, individual enzymes, etc., using microbial plant, animal, or human cells.
- **Bioprospecting** is an umbrella term describing the process of **discovery and commercialization of new products** based on biological resources, typically in less-developed countries. Bioprospecting often draws on indigenous knowledge about the uses and characteristics of plants and animals. In this way, **bioprospecting includes biopiracy**.
- **Biopiracy** is a situation where indigenous knowledge of nature, originating with indigenous people, is **used by others for profit, without permission** from and with little or no compensation or recognition to the indigenous people themselves.
- **Green consumerism** refers to **recycling, purchasing, and using eco-friendly products** that minimize damage to the environment. This involves decisions such as using Energy Star appliances that consume less power, buying hybrid cars that emit less carbon dioxide, using solar and wind power to generate electricity, and buying locally grown vegetables and fruits.
- **A Comprehensive Environmental Pollution Index (CEPI)** is a very useful tool to **capture the health dimensions of the environment including** air, water, and land. The CEPI is intended to act as an early

warning tool and can help in categorizing the industrial clusters/areas in terms of priority of planning needs for interventions.

- **Bioregionalism** is a **political, cultural, and ecological system** or set of views based on naturally defined areas called bioregions, similar to Eco-regions. Bioregions are defined through **physical and environmental features**, including watershed boundaries and soil and terrain characteristics. Bioregionalism stresses that the determination of a bioregion is also a cultural phenomenon, and emphasizes local populations, knowledge, and solutions.
- **Bioethics:** It is the **branch of ethics, philosophy, and social commentary** that deals with the biological sciences and its impact on society.
- **Vaccine:** A preparation that contains an agent or its components, administered to stimulate an immune response that will **protect a person from illness due to that agent**. A therapeutic (treatment) vaccine is given after the disease has started and is intended to reduce or arrest the progress of the disease. A preventive (prophylactic) vaccine is intended to prevent the disease from starting. Agents used in vaccines may be whole-killed (inactive), live-attenuated (weakened), or artificially manufactured. It can be created using the recombinant DNA process.
- **Vector:** A **vehicle that carries foreign genes** into an organism and inserts them into the organism's genome. Modified viruses are used as vectors for gene therapy.
- **Virus:** A sub-microscopic particle that **can infect other organisms**. It **cannot reproduce on its own** but infects an organism's cell to use that cell's reproductive machinery to create more viruses. It usually consists of a DNA or RNA genome enclosed in a protective protein coat.
- **Stem cell:** A **fundamental cell** that has the potential to develop into any of the 210 different cell types found in the human body. **Human life begins with stem cells**, which divide again and again and branch off into special roles, like becoming liver or heart cells. They are an important resource for disease research and for the development of new ways to treat disease.
- **Amniocentesis:** A procedure used in prenatal diagnosis **to look at the chromosomes of the developing foetus**. A flexible needle is inserted into the mother's uterus through the abdomen to remove a sample of the fluid surrounding the foetus (amniotic fluid). This sample can then be analysed by karyotype to look for changes in the chromosomes. The procedure can be done after 15 weeks of pregnancy. There is a 0.5% risk of miscarriage associated with this procedure, which means one in 200 women will miscarry following this procedure.
- **Embryonic stem cells:** Cells that are **removed from the early embryo** and can become any of the 210 cell types found in the human body. Researchers are looking at the great potential stem cells have in developing new treatments for disease and injury.

SPACE PROGRAM DEVELOPMENT- INDIA AND WORLD

Genesis of Indian Space Programme

- The space research activities were initiated in India during the **early 1960's**, when applications using satellites were in experimental stages even in the United States.
- With the live transmission of Tokyo Olympic Games across the Pacific by the **American Satellite 'Syncom-3'** demonstrating the power of communication satellites, **Dr. Vikram Sarabhai, the founding father of Indian space programme**, quickly recognized the benefits of space technologies for India.
- As a first step, the **Department of Atomic Energy** formed the **INCOSPAR (Indian National Committee for Space Research)** under the leadership of **Dr. Sarabhai and Dr. Ramanathan** in 1962.
- **The Indian Space Research Organisation (ISRO)** was later formed on **August 15, 1969**.
- The prime objective of ISRO is to **develop space technology and its application to various national needs**. It is one of the **six largest space agencies in the world**. The Department of Space (DOS) and the Space Commission were set up in 1972 and ISRO was brought under DOS on June 1, 1972.
- Since inception, the Indian space programme has been orchestrated well and had **three distinct elements such as, satellites for communication and remote sensing, the space transportation system and application programmes**.
- Two major operational systems have been established – **the Indian National Satellite (INSAT)** for telecommunication, television broadcasting, and meteorological services and the **Indian Remote Sensing Satellite (IRS)** for monitoring and management of natural resources and Disaster Management Support.

Major milestones in Indian Space Programme

- Indian Space Programme began at **Thumba Equatorial Rocket Launching Station (TERLS) located at Thumba near Thiruvananthapuram**. Thumba was selected for being rocket launching station because **geomagnetic equator of the earth passes over Thumba**.
- **On November 21, 1963**, the first sounding rocket was launched **from TERLS**. The first rocket, a **Nike-Apache** was procured from the US. (A sounding rocket is a rocket, which is **intended for assessing the physical parameters of the upper atmosphere**.)
- **The Satellite Telecommunication Earth Station** was set up at Ahmadabad on January 1, 1967.
- **India's first indigenous sounding rocket, RH-75**, was launched on November 20, 1967.
- **Aryabhata - First Indian Satellite** was launched on **April 19, 1975**. It was launched from the **former Soviet Union**. It provided India with the **basis of learning satellite technology and designing**.
- During 1975-76, **ISRO along with NASA** developed means of using **space communications system for TV broadcasting**. This resulted in the creation of the **project Satellite Instructional Television Experiment (SITE)**. It was a **one-year program** covering Indian **villages and districts**.
 - ▶ The main purpose of SITE was to experiment **usage of satellite broadcasting to educate the masses**.
 - ▶ OewSITE, hailed as **'the largest sociological experiment in the world'** benefited around 200,000 people, covering 2400 villages of six states and transmitted development oriented programmes using the **American Technology Satellite (ATS-6)**.
- **PSLV-C11 successfully launches CHANDRAYAAN-1** from Sriharikota on October 22, 2008. Chandrayaan-1 is a **scientific investigation – by spacecraft – of the Moon**. Chandrayaan-1 is the **first Indian planetary science and exploration mission**. Chandrayaan-1 was operational for **312 days till August 28, 2009**.
- **November 5, 2013 - PSLV - C25 successfully launches Mars Orbiter Mission (Mangalyaan) Spacecraft** from Sriharikota.
- On February 15, 2017, **PSLV-C37**, the 39th mission of the workhorse launch vehicle of ISRO, **injected ISRO's Cartosat-2 Series Satellite** weighing 714 kg and two **ISRO Nano-satellites namely INS-1A (8.4 kg) & INS-1B (9.7 kg) and 101 Nano-satellites**, from **six foreign countries into a Sun-Synchronous Orbit (SSO)** at an orbit of 506 km above earth, with an inclination of 97.46°. The mass of nano-satellites varied from 1 to 10 kg. The total weight of all the 104 satellites carried on-board PSLV-C37 was 1378 kg.
- **PSLV-C38/Cartosat-2 Series Satellite Mission** was launched on June 23, 2017 from SDSC SHAR, Sriharikota. India's Polar Satellite Launch Vehicle, in its 40th flight (PSLV-C38), launched the 712 kg Cartosat-2 series satellite for earth observation and 30 co-passenger satellites together weighing about 243 kg at lift-off into a 505 km polar Sun Synchronous Orbit (SSO).
- **India's latest communication satellite, GSAT-17** was inducted into the **INSAT/GSAT system** on June 29, 2017 **from Kourou, French Guiana by Ariane-5 VA-238**. Weighing 3477 kg at lift-off, GSAT-17 carries Payloads in Normal C-band, Extended C-band and S-band to provide various communication services. GSAT-17 also carries **equipment for meteorological data relay and satellite based search and rescue services being provided by earlier INSAT satellites**.
- **India's Polar Satellite Launch Vehicle**, in its **forty second flight (PSLV-C40)**, successfully launched the **710 kg Cartosat-2 Series Satellite** for earth observation and 30 co-passenger satellites together weighing about 613 kg at lift-off. PSLV-C40/Cartosat-2 Series Satellite Mission was launched on Friday, Jan 12, 2018.
- **GSLV-F08 is the 12th flight of Geosynchronous Satellite Launch Vehicle (GSLV) and Sixth flight with indigenous Cryogenic Stage**. GSLV -F08 / GSAT-6A Mission was launched on Thursday, March 29, 2018.

- India's Polar Satellite Launch Vehicle, in its forty-third flight (PSLV-C41) in XL configuration **launched IRNSS-1I Satellite..The IRNSS-1I is the eighth satellite to join the NavIC navigation satellite constellation and was launched on April 12, 2018.**
- PSLV-C42 Successfully Launches **two foreign satellites** from SatishDhawan Space Centre (SDSC), SHAR, Sriharikota on September 16, 2018. This mission was designed to launch two **earth observation satellites, NovaSAR and S1-4** (together weighing nearly 889 kg).
- PSLV-C43 lifted off on November 29, 2018 from the **First Launch Pad (FLP) of SatishDhawan Space Centre SHAR**, Sriharikota and successfully launched **India's Hyper spectral Imaging Satellite (HysIS)** and 30 international co-passenger satellites.
- India's next generation high throughput communication satellite, GSAT-11 was successfully launched on December 05, 2018 from Kourou launch base, French Guiana by Ariane-5 VA-246. Weighing about 5854 kg, **GSAT-11 is the heaviest satellite built by ISRO.**
- GSLV-F11 successfully launched GSAT-7A, ISRO's 39th communication satellite, on December 19, 2018 from SatishDhawan Space Centre SHAR, Sriharikota. GSLV-F11 is the 13th flight of India's Geosynchronous Satellite Launch Vehicle (GSLV) and its 7th flight with indigenous Cryogenic Upper Stage (CUS). GSLV – F11 is ISRO's fourth generation launch vehicle with three stages.
 - ▶ It is a geostationary satellite carrying communication transponders in Ku-band. The Satellite is built to provide communication capability to the users over the Indian region.
- **Gaganyaan Programme** - Cabinet has approved **Indian Human Spaceflight Initiative -Gaganyaan Programme. Two unmanned & one manned flight has been planned.**
- India's telecommunication satellite, GSAT-31 was successfully launched on February 06, 2019 from Kourou launch base, French Guiana by Ariane-5 VA-247.
- India's PSLV-C46 successfully launched RISAT-2B satellite from SatishDhawan Space Centre (SDSC) SHAR, Sriharikota on May 22, 2019. The satellite is intended to provide services to Agriculture, Forestry and Disaster Management domains.
- **Geosynchronous Satellite Launch Vehicle, GSLV MkIII-M1 rocket, carrying Chandrayaan-2 spacecraft** was launched from the SatishDhawan Space Centre, Sriharikota in Andhra Pradesh on July 22, 2019.

Chandrayaan-2

- Chandrayaan-2 mission is a **highly complex mission**, which represents a significant technological leap compared to the previous missions of ISRO, which brought together an **Orbiter, Lander and Rover** with the **goal of exploring South Pole of the Moon.**
- This is a unique mission aims at **studying not just one area of the Moon but all the areas combining the exosphere, the surface as well as the sub-surface of the moon in a single mission.**

Why did we go to the Moon?

- The Moon is the **closest cosmic body** at which space discovery can be attempted and documented.
- It is also a **promising test bed to demonstrate technologies required for deep-space missions.**
- Chandrayaan-2 aims for enhancing our **understanding of the Moon, stimulate the advancement of technology, promote global alliances and inspire a future generation of explorers and scientists.**

About Chandrayaan-2 India's second Moon mission

- The Chandrayaan-2 mission comes nearly 11 years after India's first expedition to the moon in October 2008.
- Chandrayaan-2 moon mission is **totally an indigenous mission**. It was launched on 22 July, 2019 via GSLV-Mk-III rocket from **SatishDhawan Space Centre, Sriharikota**.
- The journey of Chandrayaan-2 is around **3.84 lakh km to Moon**.
- The weight of Chandrayaan-2 spacecraft is approximately 3840 kilograms.
- It will **collect data on water, minerals and formations of rock**.
- Chandrayaan-2 spacecraft have three modules a **Lander (Vikram), an Orbiter and Rover (Pragyan)**.
- Scientific goals are to **study lunar topography, mineralogy, elemental abundance, the lunar exosphere and signatures of hydroxyl and water ice**.
- The primary objective of ISRO to launch Chandrayaan-2 was to **demonstrate the ability to soft-land on the lunar surface(SouthPole) and operate a robotic rover on the surface**.

What is soft landing?

- A soft-landing protects the **object from impact while a hard landing doesn't**.
- Soft-landing ensures that the **object is able to carry out further experimentation on the target planet or satellite, mostly with the help of a rover vehicle**.
- **Soft-landing on any planetary surface is complicated**.
- Vikram was to **use five thrusters — four at the corners and one at the centre to make its final descent**.
- **Maintaining the required velocity with such thrusters is difficult as a fine balance among them needs to be maintained**.
- Then there is the issue **of moon dust which could wreck the engines of the thrusters**.

The Orbiter:

- The orbiter is safe in the intended orbit around the moon. And with the **"precise launch and mission management"**, its life span will extend to **almost seven years**.
- Carrying **eight of the 13 payloads**, the orbiter will spend the next **nearly seven years making high-resolution maps of the lunar surface, mapping the minerals, understanding the moon's evolution, and most importantly looking for water molecules in the polar regions**.
- Some of the impact craters in the South Pole are permanently shadowed from sunlight and could be ideal candidate sites to harbour water.
- **Water** on the moon would, in principle, be **used for life support and manufacturing rocket fuel**.
- With the U.S. wanting to send astronauts to the South Pole by 2024, **the National Aeronautics and Space Administration (NASA), in particular is keen on data from the Chandrayaan 2 orbiter**.

The Launcher:

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

- Its components are:
 - ▶ **S200 solid rocket boosters**
 - ▶ **L110 liquid stage**
 - ▶ **C25 upper stage**

The Lander

- The Lander of Chandrayaan-2 **was named Vikram after Dr Vikram A Sarabhai, the Father of the Indian Space Programme.**
- It was designed to function for **one lunar day**, which is equivalent to **about 14 Earth days.**

The Rover

- Chandrayaan-2's Rover was a **6-wheeled robotic vehicle named as Pragyan**, which translates to '**wisdom**' in Sanskrit.

Gaganyaan

- In the 2018 edition of Indian defence expo, ISRO released the **astronaut's space suit Gaganyaan** ("Skycraft") is (planned) India's autonomous **3.7-tonne spacecraft** designed to carry a **3-member crew** to orbit and safely return to the Earth after mission duration of few orbits and up to **seven days.**
- The space vehicle is planned to be launched **on ISRO's GSLV Mk III in 2022.**
- It is planned currently, **an Indian astronaut**, who is yet to be chosen, would be stationed at an **altitude of 400 km from earth for 5-7 days.**
- To maintain this altitude (which is very low compared to orbits which are parallel to equatorial plane which is 36000 km) one needs to orbit only in **plane perpendicular to equatorial plane.**
- The payload consists of a **crew module and a service module.**
- Based on the payload capability of the GSLV-III booster, the service module would have a mass of about 3 tonnes which being heavier needs **cryogenic technology.**
- The flight would take 16 minutes to reach its orbit and during the period of stay, the astronaut would carry out a series of experiments, particularly microgravity experiments.
- The descent would take 36 minutes as care would be taken to avoid heating up while heading back to earth.
- If successful, it would make India only the **fourth member (after Russia, the US, and China) of an elite club of nations with indigenous manned space programmes.**

Navigational Satellites

IRNSS: India's Navigation system

- IRNSS is an **Independent regional navigation satellite system** being developed by India.

- The **NAVIC (Navigation in Indian Constellation)** system consist of a **constellation of 3 satellites in Geostationary orbit (GEO), 4 satellites in Geosynchronous orbit (GSO)**, approximately 36,000 kilometres (22,000 mi) altitude above earth surface, and **two satellites on the ground as stand-by, in addition to ground stations.**
- It is designed to provide accurate position information service to users in India as well as the **region extending up to 1500 Km from its boundary**, which is its primary service area.
- IRNSS provide **two types of services**, namely **Standard Positioning Service (SPS)** which is provided to all the users and **Restricted Service (RS)** which is an **encrypted service provided only to the authorized users.**

- Satellite navigation means using a portable radio receiver (like a cell phone) to pick up speed-of-light signals from orbiting satellites so that one can figure out precise position, speed, and local time.
- To pinpoint location accurately, the receiver (here cellphone) needs to receive signals from at least four navigational satellites
- The receiver determines your distance from each of the satellites by measuring the time taken by the signal to travel from the satellite to your receiver antenna

GPS Satellite Systems around the World

United States (GPS)

- The United States is the **first country to introduce satellite technology with the global positioning system (GPS).**
- This satellite navigation system, operated by the United States government offers **navigation and tracking technology, including location, time and other data throughout the planet. Individuals, corporations, and military personnel utilize GPS devices and GPS trackers.**

Japan (QZSS)

- The **Quazi-Zenith Satellite System (QZSS)** is Japan's satellite system which is similar to GPS satellites with some slight variations.
- The QZSS is a system using **three satellites.**
- The satellites in this constellation are expected to **orbit Japan and other areas of Asia**, which will further increase the accuracy of GPS signals in the US.

Russia (GLONASS)

- Russia also has its own satellite system called the **Russian Global Navigation Satellite System (GLONASS).**
- In the last 10 years new satellites have been introduced into the system and it now has **optimal signal coverage.**
- GLONASS is similar to GPS and includes **24 satellites located in 3 orbit places.**

China Peoples Republic of China (BeiDou Navigation Satellite System)

- BeiDou Navigation Satellite System (formerly referred to as Compass) is the **navigational system of China**.
- It will consist of more than **30 satellites**.
- This satellite system intends to have **two levels of signals** to be used for **military and civilians**.
- Chinese government has reported that the satellite constellation is expected for **global availability by 2020**.

European Union (Galileo)

- Galileo system of Europe is a Global Navigation Satellite System (GSNN).
- The development for Galileo **began in 2003 and is expected to be fully completed by 2019**.
- Galileo will have **30 satellites** (27 active with 3 spares) with **signals reaching throughout the globe**.
- Galileo is funded by **public and private sectors**, as opposed to the public only funding of the US GPS system.

GAGAN- Geo Augmented Navigation System

- **GPS Aided Geo Augmented Navigation "GAGAN"** is an augmentation system to enhance the accuracy and integrity of GPS signals to meet precision approach requirements in Civil Aviation and is being implemented jointly by **AAI and ISRO**.
- It will augment **GPS signals over the Indian land mass, the Bay of Bengal, South East Asia, the Middle East and the Arabian Sea widening its reach up to Africa**.
- At present **radio navigation** (through reflections of Ionosphere) is used for **precision landing and approaches at Indian airports**.

Studying the Sun

Parker Solar Probe

- Sent by **NASA** in order to **understand Sun's corona and to protect a society** that is increasingly dependent on technology from the threats of space weather.
- The primary science goals for the mission are:
 - ▶ To trace the **flow of energy** that heats and accelerates the solar corona and solar wind.
 - ▶ Understand the **heating of the solar corona; determine the structure and dynamics of the plasma and magnetic fields at the sources of the solar wind**.
 - ▶ Explore mechanisms that **accelerate and transport energetic particles**.
 - ▶ Parker Solar Probe provides a **Statistical Survey of the Outer Corona**.

ADITYA-1

- It is the **1st Indian space based Solar Coronagraph** intended to study the outermost region of the sun called '**Corona**'.
- The project will increase our understanding about the Sun. The Temperature of the solar corona goes beyond million degrees.
- From the ground, the Corona **could be seen only during total solar eclipses** mainly due to the **bright solar disc and the scattering of the sunlight by the Earth's atmosphere**.
- One has to go beyond the atmosphere to be able to mask the bright solar disc and study the Corona.
- **Objectives of the Mission:** The major scientific objectives of Aditya-1 are to achieve a fundamental understanding of the physical processes that:
 - ▶ **Heat the solar corona**
 - ▶ **Accelerate the Solar Wind**
 - ▶ **Produce Coronal Mass Ejections (CMEs)**

Gadanki Ionospheric Radar Interferometer (GIRI)

- The Indian Space Research Organisation (ISRO) has installed the Gadanki Ionospheric Radar Interferometer (GIRI) Radar System near **Tirupati, Andhra Pradesh**.
- **Primary objective:**
 - ▶ Carry out unattended observations for studying the forces from the sun like variation in solar flare, solar flux and magnetic storm on the ionospheric irregularities.
 - ▶ Studies unattended observations from the underneath atmosphere on the ionospheric irregularities (for e.g. waves generated by weather phenomena).
 - ▶ Provide important information about the angular location of plasma irregularities during the onset phase. Also establish its relationship to background ionospheric state parameters and sunset terminator.

India's space diplomacy: South Asia Satellite

- The South Asia Satellite, also known as **GSAT-9**, is a **geostationary communications** and **meteorology satellite** operated by the **Indian Space Research Organisation (ISRO) for the South Asian Association for Regional Cooperation (SAARC) region**.
- Geostationary Satellite are heavier satellites weighting more than 3 tonnes hence require Cryogenic engines. The 2,230-kg satellite has been fabricated in three years and is purely a communications satellite costing ₹235 crore.
- The uniqueness of this satellite is that it will have a **footprint that extends all over South Asia**.
- Its **applications touch everyday life and the neighbours use its applications free of charge**.
- The satellite will enable a range of applications and services to our neighbour only in the areas of **telecommunication and broadcasting applications viz. television, direct-to-home (DTH), very small aperture terminals (VSATs), tele-education, telemedicine and disaster management support**. **Each country** has to develop its **own ground infrastructure**.
- The South Asia Satellite has **12 Ku band transponders** which our neighbours can utilise to increase communications.

- The satellite also provides **secure hot lines among the participating nations in addition since the region is highly prone to earthquakes, cyclones, floods and tsunamis.**
- **Pakistan has fully opted out of the project.**
- Rest of the seven nation's part of the South Asian Association for Regional Co-operation (SAARC) are on-board.

Drones and Governance issues: Digital Sky Platform

- **Remotely Piloted Aerial Systems (RPAS)**, popularly referred to as **drones**, are a technology platform with wide-ranging applications.
- India announced the release of **Civil Aviation Regulations (CAR)** to enable **safe flying of RPAS in India.**
- Digital Sky Platform is a first of its kind that implements '**no permission, no take-off**' (NPNT) – a **novel system of software-based self-enforcement to minimize deviations from the CAR.**
- The regulations were to come in effect from **December 1, 2018** allowing the industry time to ready them for the launch.

Significance for Drone users:

- Existing drone operators and potential drone owners are required to buy **No Permission-No-Takeoff (NPNT)-compliant RPAS.**
- The import of drones is **now permitted as well.**
- To get permissions to fly, RPAS operators or remote pilots will have to **file a flight plan.**
- Flying in the '**green zones**' will require **only intimation of the time and location of the flights via the portal or the app.**
- **Permissions will be required for flying in 'yellow zones' and flights will not be allowed in the 'red zones'.**
- **Permission, if granted, will be available digitally** on the portal.
- If an RPAS does not have permission to fly, it will not be allowed to take-off under the policy of (NPNT).

Why framing regulations took so long?

- Drone technologies have been evolving very rapidly.
- Many countries are still experimenting with their drone regulations and no ICAO (International Civil Aviation Organisation) standards have been developed.
- India's security environment necessitates extra precautions.

Tracking the s-junk: Graveyard Orbit

- A **Graveyard Orbit** also called a **Junk Orbit or Disposal Orbit** is an orbit that **lies away from common operational orbits.**

- One significant graveyard orbit is a **super synchronous orbit** well above **geosynchronous orbit**. Satellites are typically moved into such orbits at the end of their operational life to reduce the probability of colliding with operational spacecraft and generating space debris.

Unravelling cosmos: The Oort Cloud

- The **OortCloud** is a **thick bubble of icy debris** that surrounds our solar system.
- This distant, predicted cloud may extend a third of the way from our Sun to the next star—somewhere between 1,000 and 100,000 astronomical units.
- There may be hundreds of billions, even trillions, of icy bodies in the Oortcloud. Every now and then, something disturbs one of these icy worlds and it begins a long fall toward our Sun. Two recent examples are comets **C/2012 S1 (ISON)** and **C/2013 A1 Siding Spring**.
- The Oortcloud is too far to be seen with **current telescopes**, so it hasn't been directly seen or discovered.

Important:

- Comets that take more than 200 years to make one revolution around the Sun are notoriously difficult to study. Because they spend most of their time far from our area of the solar system, many "**longperiod comets**" will never approach the Sun in a person's lifetime.
- In fact, those that travel inward from the distant Oortcloud can have periods of thousands or even millions of years.

World Space Week

- United Nations General Assembly in 1999 declared **4 to 10 October as World Space Week** to celebrate each year at the **international level the contributions of space science and technology** to the betterment of the human declaration.
- World Space Week** has grown into the largest public space event on Earth. The 2018 theme is "**Space Unites the World**" and 2019 theme "**The Moon: Gateway to the Stars.**"
- World Space Week consists of a myriad of space-related events held by **space agencies, aerospace companies, schools, planetaria, museums, and astronomy clubs in a common timeframe to achieve greater student and public impact through synchronization.**

Space programs across the world

Gravity Recovery and Interior Laboratory (GRAIL)

- GRAIL mission was a **NASA rover cum orbiter mission** designed to create the most **accurate map of the moon** (distribution of gravity), which when combined with topographic data, can provide insight into the moon's internal structure, composition and evolution.
- GRAIL mapped the **moon's gravity** by measuring the push and pull around the moon.
- The spacecraft collected data on the moon's far side by communicating with one another when the signal to Earth is obscured. The mission has ended in December 2012.

Star-Planet Activity Research CubeSat (SPARCS)

- SPARCS is a **space telescope** to study the **habitability and high-energy environment around M-dwarf stars**.
- Dwarf stars **are generally cooler** and they may be **surrounded by many habitable zones**.
- The telescope will study the **Ultra-Violet light emitted by dwarf stars**.

GOLD and ICON mission

- They refer to **Global-scale Observations of the Limb and Disk (GOLD)** and **Ionospheric Connection Explorer (ICON)** respectively.
- ICON will be in **low-Earth orbit** at 560 km above Earth and GOLD will be at **35398 km above earth surface in a geostationary orbit**.
- They will study the **Ionosphere region or the boundary area between Earth and the space** where electrically-charged electrons and ions by the Sun's radiation are present.
- The missions will help in **understanding how upper atmosphere changes in response to hurricanes and geomagnetic storms**.

Interplanetary Mission: Mars Mission

- **NASA's Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight)** is a **robot** which touched down on the **Red Planet (in 2018)** after an almost seven-month, 300-million-mile (458million-kilometer) journey from Earth.
- Its **two-year mission to study the deep interior of Mars** to learn how **all celestial bodies with rocky surfaces, including Earth and the Moon, formed**.
- Two small satellites **WALL-E and EVE** were launched on the **Atlas V rocket** from California. **Similar in size to a briefcase or large cereal box**, the satellites are on way to Mars, right behind InSight.
- This is the first time that any little **cube-shaped satellites, Cube-Sats** as they're known, have been sent to **deep space missions**. The journey will span **6 1/2 months and 485 million kilometers**.

Chang'e 4 project

- China became **world's first country to launch a lunar probe on far side of moon**.
- China announced its plans to launch a lunar probe in 2018 to achieve the world's **first soft landing on the far side of the moon** to showcase its ambitious space programme. The mission is called **Chang'e 4 project**.

About the mission:

- Chang'e 4 is the **fourth mission in the country's lunar mission series** which is being named after the **Chinese moon goddess**.

Significance of the mission:

- According to experts, landing on the far side of the moon is undoubtedly one of the most challenging missions ever launched by any of the world's superpowers. The far side of the moon known as **'South**

Pole-Aitken Basin still remains a mystery among space scientists and by sending a probe there, China will outdo the historical achievements of the US and USSR.

History of China's lunar exploration programmes:

- China began their lunar exploration program in 2007 by launching a **simple lunar orbiter** named '**Chang'e 1**'. The second mission in the program named '**Chang'e 2**' was launched in 2010, and it was later followed by the third mission '**Chang'e 3**'.
- '**Chang'e 3**' made headlines all around the world as it marked the **first soft moon landing since 1976**.

Point Nemo

- It is considered the **most remote place on Earth** (at about 2400 km from any spot of land in middle of the South Pacific Ocean).
- It is often used to **crash-land defunct satellites** and thus is called the **spacecraft cemetery**.
- Between 1971 and mid-2016, space agencies all over the world have dumped between **260 and 300 spacecraft into the region**.

NASA confirms Saturn's rings will be gone in 100 million years

- Saturn is losing its iconic rings** at the maximum rate estimated from **Voyager 1 and 2 observations made decades ago**, confirms new NASA research that estimates that the **rings have less than 100 million years to live**.
- The rings are being **pulled into Saturn by gravity** as a **dusty rain of ice particles** under the **influence of Saturn's magnetic field**.

Gaofen – 11

- China successfully launched Gaofen-11**. It is the **sixth in Gaofen series** launched this year.
- Gaofen means "**high resolution**" in Chinese.
- It is ambitious space project of China that aims to launch **seven high-definition observationsatellites before 2020**.

About Gaofen – 11:

- It is an **optical remote sensing satellite**, as part of the **country's high-resolution Earth observation project**. It was developed by **China Academy of Space Technology (CAST)**.
- It will become part of **China High-resolution Earth Observation System (CHEOS)** initiated in **2010 to provide all-weather, all-day coverage by 2020**.
- It is placed in **Sun – Synchronous Orbit**.
- Applications:** The satellite can be used for **land survey, urban planning, road network design, agriculture, and disaster relief**.

GRACE Mission

- NASA's GRACE mission has **confirmed that a massive redistribution of freshwater is occurring across the Earth**, with **middle-latitude belts drying and the tropics and higher latitudes gaining water supplies**.

Key Findings

- The resulting map of the findings shows an overall pattern, in which **ice sheets and glaciers lose by far the most mass at the poles, but at the same time, middle latitudes show multiple areas of growing dryness even as higher latitudes and the tropical belt tend to see increases in water.**
- The study emphasizes that the **34 separate changes that it detects do not all have the same cause – not close.**
- There's very suspicion that the **melting of glaciers and ice sheets is tied to climate change.** On land, it's possible that **some droughts and rainfall increases may be also, though the study is cautious about that, noting that natural variability can also be a major factor here.**
- There are also some major cases of humans increasing water storage in the landscape, **particularly in China, where massive dam construction has created enormous reservoirs.**
- Mainly, though, what's striking about the map is the way that a combination of human-driven water withdrawals and droughts seem to be punishing the central latitudes of the northern hemisphere in particular, but also the southern hemisphere to a significant extent.

Analysis

- A combination of the **effects of climate change, vast human withdrawals of groundwater and simple natural changes are behind this.**
- If this continues, it could have profound consequences leading to a situation in which some **highly populous regions could struggle to find enough water in the future.**

Resource Prospector Mission

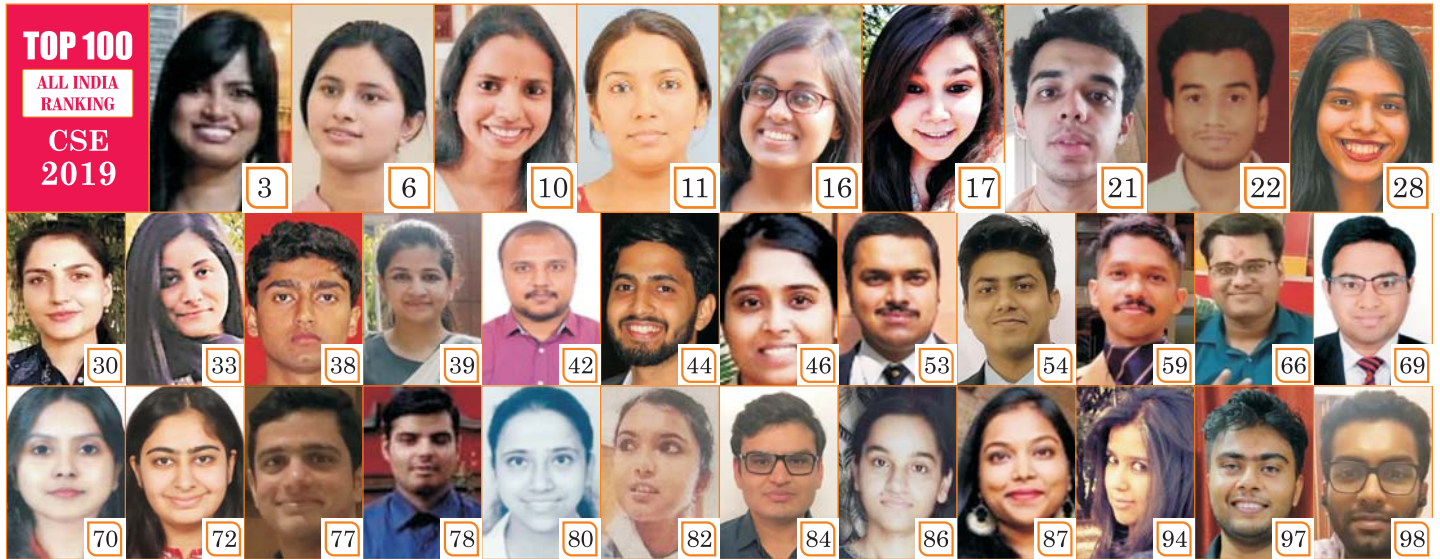
- NASA is developing an **exploration strategy** to meet the **agency's expanded lunar exploration goals.**
- Consistent with this strategy, NASA's **Resource Prospector mission**, which is in pre-formulation, aims to be the **first mining expedition on another world.**

Key Facts

- Using a suite of instruments to locate **elements from a lunar polar region**, the **planned rover is designed to excavate volatiles such as hydrogen, oxygen and water from the moon.**
- The mission consisted of a **lander and a solar powered rover** equipped with a drill.

Analysis

- **In-situ resource utilization (ISRU)** will foster more affordable and sustainable human exploration to many deep-space destinations.
- Launching one pound of any material into space costs thousands of dollars. One gallon of water weighs more than eight pounds, so **the ability to generate water, air and fuel in space could represent enormous cost savings for future deep-space missions.**
- Humans living, working and exploring other planetary bodies must be able to make their own breathable air and potable water.



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