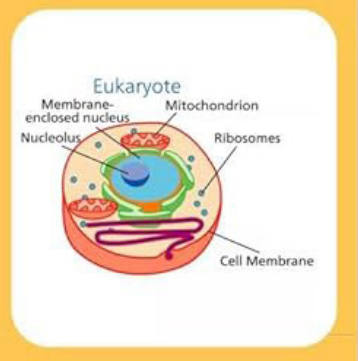

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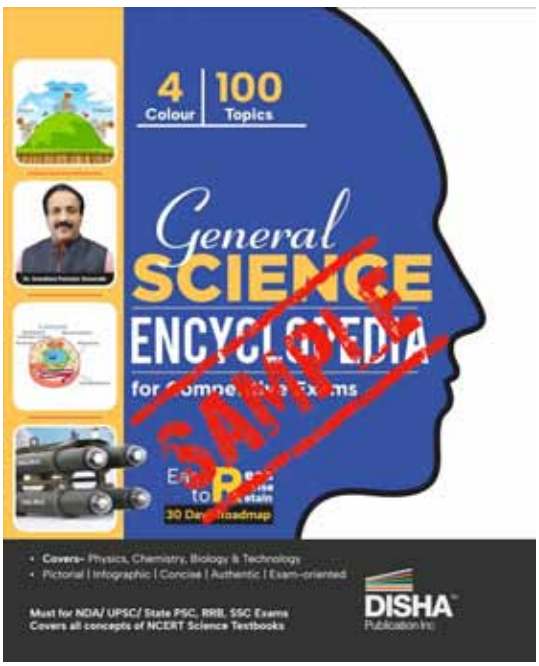

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Chapter 01

Units and Dimensions

In Physics, a physical quantity can be defined as something which can be measured. The quantities which can describe the laws of physics are called the Physical quantity. Some examples of physical quantities are length, mass, time, pressure, temperature, current etc.
The value of a physical quantity is the quantitative expression of a particular physical quantity as the product of a number and a unit, the number being its numerical value. Thus, the numerical value of a particular physical quantity depends on the unit in which it is expressed.

UNITS : Measurement of any physical quantity involves comparison with a certain basic, arbitrarily chosen, internationally accepted reference standard called unit.

Fundamental Units

The units which measure the base units are called Fundamental units.

Derived Units

The units which are combinations of fundamental units are called as derived units.

International System of Units

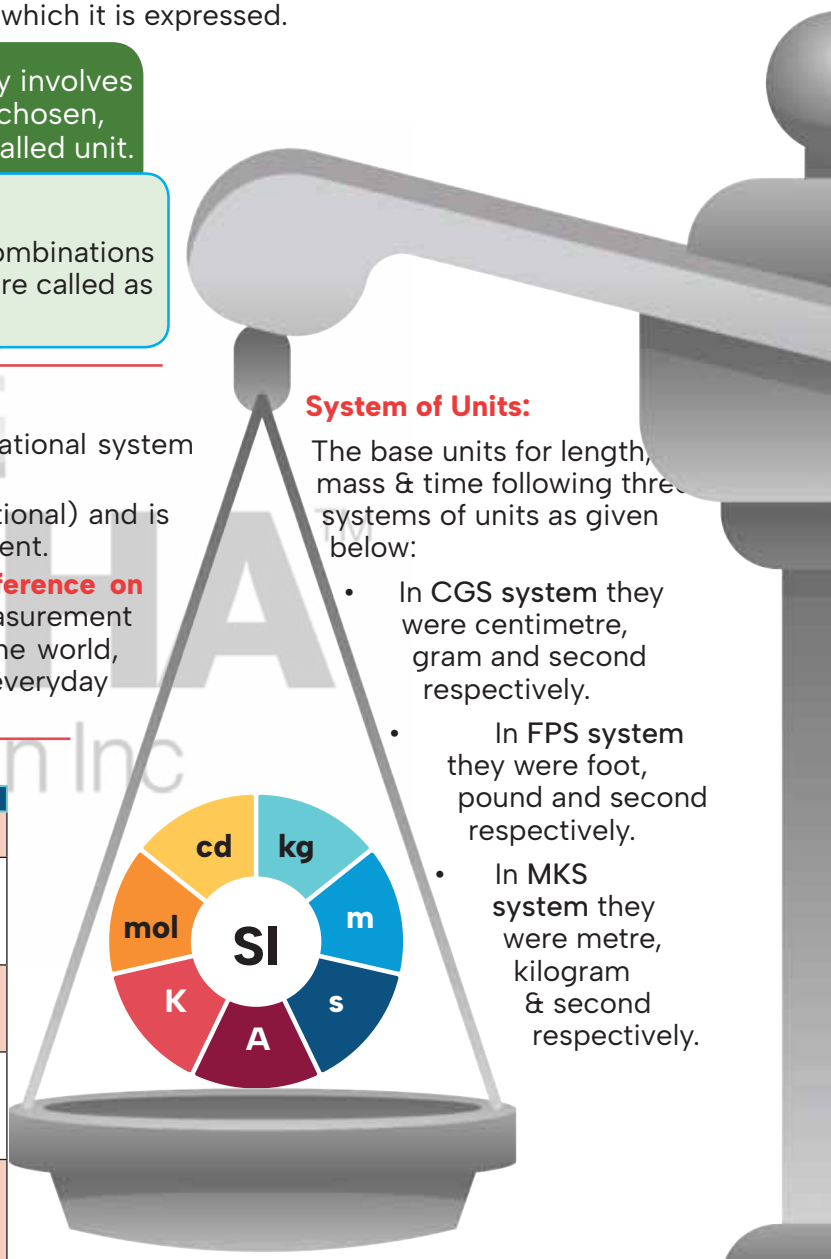
The modern metric system is called as the international system of units.

It is majorly knows as SI system (Système International) and is the world's most widely used system of measurement.

Established and maintained by the **General Conference on Weights and Measures,** it is the only system of measurement with an official status in nearly every country in the world, employed in science, technology, industry, and everyday commerce.

The Seven SI base units are given below:

Unit	Measure	Symbol	Definition
Meter	Length	m	The distance travelled by light in a vacuum in 1/299,792,458 seconds.
Kilogram	Mass	kg	It is defined by taking the fixed numerical value of the Planck constant h to be 6.62607015×10^{-34} when expressed in the unit J s, which is equal to kg m^2 s^{-1}, where the metre and the second are defined in terms of c and Δvcs.
Second	Time	s	The duration of 9,192,631,770 periods of the radiation corresponding to the transition between two hyperfine levels of the ground state of the cesium-133 atom.
Ampere	Electric Current	A	The ampere is defined by taking the fixed numerical value of the elementary charge e to be $1.602176634 \times 10^{-19}$ when expressed in the unit C, which is equal to A.s, where the second is defined in terms of Δvcs.
Kelvin	Thermodynamic Temperature	K	The kelvin is defined by taking the fixed numerical value of the Boltzmann constant k to be $1.380\ 649 \times10^{-23}$ when expressed in the unit J K^{-1}, which is equal to kg m^2 s^{-2} K^{-1}, where the kilogram, metre & second are defined in terms of h, c and Δvcs.
Mole	Amount of Substance	mol	One mole contains exactly $6.02214076 \times 10^{23}$ elementary entities. This number is the fixed numerical value of the Avogadro constant, N_A.
Candela	Luminous Intensity	cd	The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency 540×10^{12} hertz and that has a radiant intensity in that direction of 1/683 watt per steradian.



System of Units:

The base units for length, mass & time following three systems of units as given below:

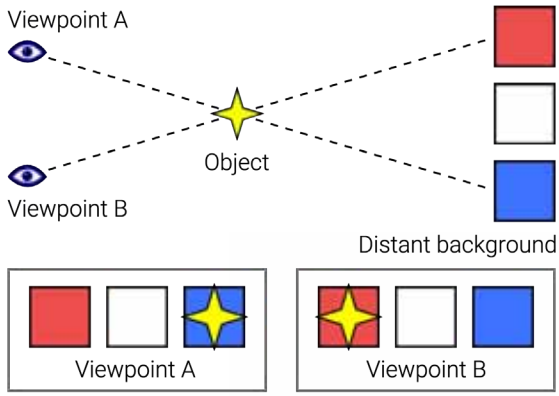
- In **CGS system** they were centimetre, gram and second respectively.
- In **FPS system** they were foot, pound and second respectively.
- In **MKS system** they were metre, kilogram & second respectively.

Did You Know?

A physical quantity maybe directionless but still may have units. For ex: plane angle is dimensionless but has radian as unit.

Parallax Method

This method is used to measure large lengths. The parallax method is a method of measuring the two angles and sides of a triangle formed by a star six months later, the Earth on one side, and the Earth on the other. Astronomers use parallax to find the distance between adjacent stars in the universe.



Supplementary Units system

S. no	Physical quantity	Unit of measurement	Symbol
1	Plane Angle	radian	rad
2	Solid Angle	steradian	sr

Range and Order of lengths

Observing closely, we understand that the day to day objects vary in size. From the objects which cannot be seen with naked eye like an atom or molecule to observable universe. We also use certain special length units for short and large lengths. These are

1 fermi = 1 f = 10^{-15} m | 1 angstrom = 1 Å = 10^{-10} m | 1 astronomical unit = 1 AU (average distance of the Sun from the Earth) = 1.496 × 10^{11} m | 1 light year = 1 ly= 9.46 × 10^{15} m (distance that light travels with velocity of 3 × 10^{8} ms^{-1} in 1 year) 1 parsec = 3.08 × 10^{16} m

Dimensions of Physical Quantities

Dimensions of a physical quantity are the powers to which the fundamental units are raised to obtain one unit of that quantity. An expression for a physical quantity is the powers to which the fundamental quantities mass, length and time must be raised to represent it. The physical quantities with dimensions and a fixed value are called dimensional constants. For example, **gravitational constant (G), Planck's constant (h), universal gas constant (R), velocity of light in a vacuum (C)**, etc. There are five fundamental dimensions in terms of which the dimensions of all other physical quantities may be expressed. They are **mass [M], length [L], time [T], temperature [θ], and charge**.

Physical Quantity	Symbol	Dimensional Formula
Length	L	[L]
Mass	M	[M]
Time	T	[T]
Velocity	v	$[LT^{-1}]$
Acceleration	a	$[LT^{-2}]$
Force	F	$[MLT^{-2}]$
Energy	E	$[ML^2T^{-2}]$
Power	P	$[ML^2T^{-3}]$
Pressure	P	$[ML^{-1}T^{-2}]$
Electric Charge	Q	[IT]
Electric Current	I	[I]
Voltage	V	$[ML^2T^{-3}I^{-1}]$
Resistance	R	$[ML^2T^{-3}I^{-2}]$
Capacitance	C	$[M^{-1}L^{-2}T^4I^2]$
Magnetic Flux	Φ	$[ML^2T^{-2}I^{-1}]$
Magnetic Field Strength	B	$[MT^{-2}I^{-1}]$
Inductance	L	$[ML^2T^{-2}I^{-2}]$
Frequency	f	$[T^{-1}]$

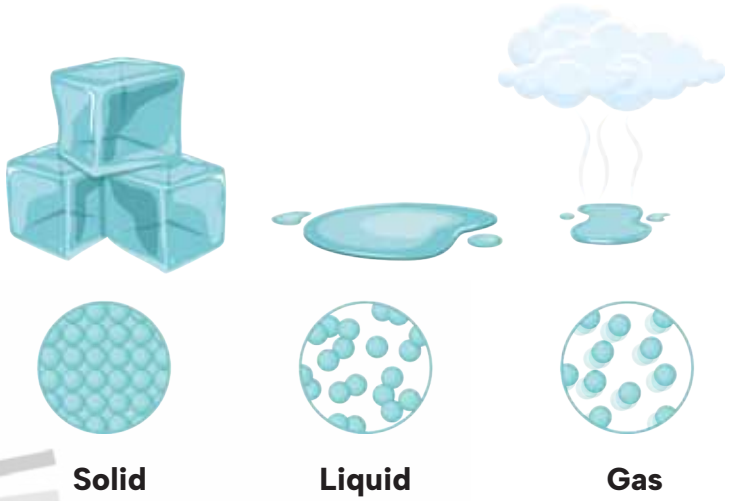
Chapter 27

States of Matter: Solid, Liquid and Gases

Understanding Matter

Everything in this universe is made up of material, which is called 'matter'. The air we breathe, the food we eat, the water we drink, stones, clouds, stars, plants and animals or a particle of sand – everything around us is matter.

There has been majorly three states of matter which has been studied scientifically i.e. Solids, Liquids and Gases. However, with the expanding scope of science two more forms of matter that is Plasma and Bose-Einstein-Condensate has been studied.



Physical Properties of Matter

Solids: Solids can be defined as a state of matter in which the elements are closely packed, whose kinetic energy are much lower than those of liquids and gases. They have a rigid structure and tend to resist the external force applied to them.

Solids are virtually incompressible.

Shape and Volume
Solids have definite shape and volume. This means that they maintain their shape and volume regardless of the container they are placed in.

Compressibility Solids generally have low compressibility compared to gases and liquids. The particles in solids are closely packed and have strong intermolecular forces that resist compression.

Diffusion
Diffusion in solids is typically very slow compared to gases and liquids. While solids do exhibit diffusion to some extent, it usually occurs at a much slower rate due to the fixed positions of particles in the solid lattice.

Intermolecular Forces of Attraction
Solids are held together by strong intermolecular forces of attraction between their constituent particles (atoms, ions, or molecules). These forces may include ionic bonds, covalent bonds, metallic bonds, or van der Waals forces, depending on the type of solid.

Melting
Solids melt into liquids upon heating. The melting point is the temperature at which a solid changes into a liquid at atmospheric pressure. The melting point varies for different solids and depends on factors such as the strength of intermolecular forces and the arrangement of particles in the solid lattice.

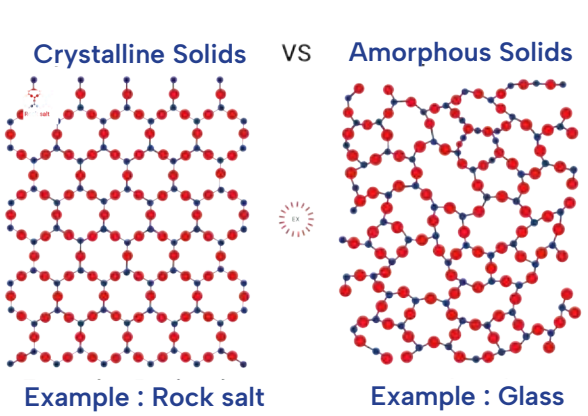
Classification of Solids

Amorphous Solids

- Amorphous solids are those which have particles arranged in a haphazard manner and not in a regular fashion.
- They do not possess a definite geometrical shape.
- They can melt over a high range of temperature.
- They do not have a heat of fusion.

Crystalline Solid

- A crystalline solid (also known as a crystal) is a solid in which the constituent atoms or molecules (or sometimes ions) are arranged in a highly ordered microscopic structure.
- They have a definite and regular geometrical form.
- They have a sharp melting point. Also, they have a definite heat of fusion
- They are rigid & incompressible



Liquid

A liquid is one of the three fundamental states of matter, characterized by its ability to flow and take the shape of its container.

Properties of Liquid

Shape and Volume: Molecular forces between the liquid molecules are not strong enough to keep it in a fixed position.

Density: The molecules of a liquid are closely stacked together in comparison to gases. There is a negligible effect of pressure on the density of liquid.

Compressibility: Liquids are relatively incompressible compared to gases but are more compressible than solids.

Evaporation: Evaporation is the process by which a liquid changes into a gas at the surface, even at temperatures below its boiling point. Factors such as temp., surface area, & the presence of air currents influence the rate of evaporation.

Gas

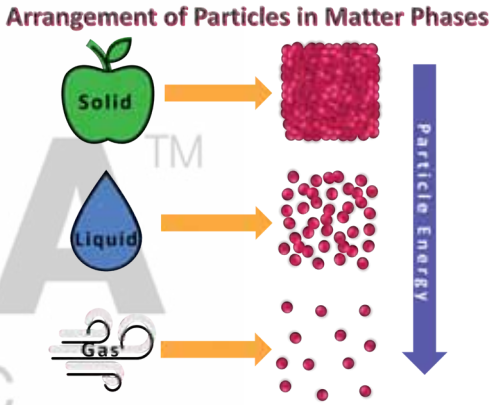
Gas is the third state of matter. It has no shape or volume and covers the entire area surrounded by it. The particles are very loosely bound. Due to very weak inter-molecular forces in gases, its molecules are in greater motion and show irregular movement. Therefore, gases do not posses definite size, shape and volume. Gases have very low density and high compressibility.

Interesting Facts

The Sun and blood in human body both exist in Plasma state of matter.

Properties of Gas

- **Compressibility:** The distance between the molecules of gases is much more as compared to solids or liquids. Therefore, on applying external pressure the gases can compress easily.
- **Homogenous Nature:** Gases have similar composition in all parts and are therefore homogenous in nature.
- **Liquefaction:** Gases can be liquefied by cooling and applying pressure.
- **Diffusion:** Diffusion occurs because gas particles move from regions of higher concentration to regions of lower concentration. This process continues until the concentration of gas particles is uniform throughout the container.

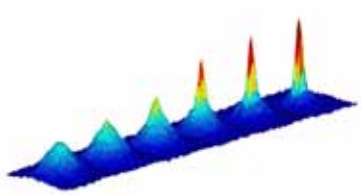


Fourth State of Matter: Plasma

- This state consists of super energetic and super excited particles like electron and irons.
- These particles are in the form of ionised gases.
- When electrical energy flows through gas, it gets ionised and hence plasma is created.
- Plasma glows with a special colour depending on nature of gas.

Bose- Einstein Condensate

- Bose-Einstein Condensate, or BEC, is a state of matter that results from cooling diluted gas of bosons to temperatures very close to absolute zero.
- Around 1924, Satyendra Nath Bose and Albert Einstein made the first proposal for BEC.
- The atoms are hardly moving with respect to one another when they reach that temperature because they have almost little free energy to do so.
- The atoms then start to group together and transition into the same energy levels. Physically they merge into one another, and the entire group begins to behave as though it were a single atom.



Chapter 54

Cell: Structure and Functions

Profoundly called the basic unit of life, Cells are the fundamental structural units of living organisms. They were discovered by Robert Hooke in 1665. Cells are the structural, functional, and biological units of all living beings. A cell can replicate itself independently. Hence, they are known as the building blocks of life. Each cell contains a fluid called the cytoplasm, which is enclosed by a membrane. Also present in the cytoplasm are several biomolecules like proteins, nucleic acids and lipids. Moreover, cellular structures called cell organelles are suspended in the cytoplasm.

Cell Theory

The cell theory states that Cells are the structural units of life, all living organisms are made up of one or more cells and new cell arise from pre existing cells. It was proposed by Schleiden and Schwann.

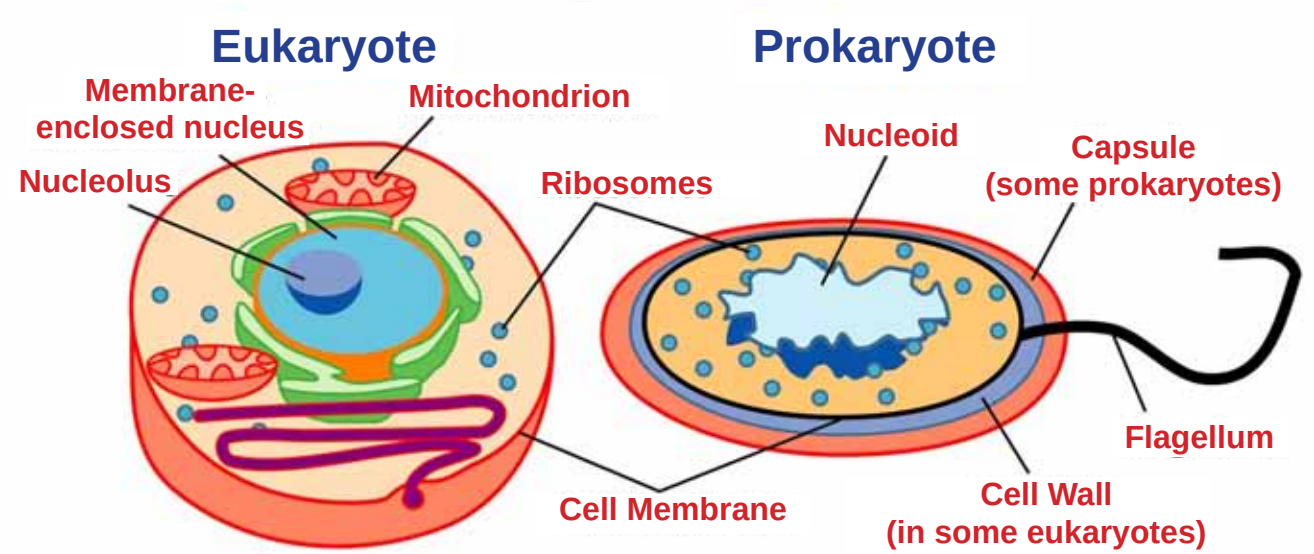
Types of Cell

Eukaryotic Cell

- Size: generally large (5–100 µm).
- The nucleus is well-defined and surrounded by a nuclear membrane.
- Possess more than one linear chromosome.
- Membrane-bound cell organelles are present. For example, Human cells.

Prokaryotic Cell

- Size: generally small (1–10 µm), Where 1 µm = 10^{-6}m.
- The nucleus is not well defined and known as a nucleoid.
- Single, circular chromosome.
- Membrane-bound organelles are absent. For example, Bacterial cell



Unicellular Organisms

- Composed of single cell.
- The total cell body is exposed to the environment
- Includes both eukaryotes and prokaryotes
- Cell differentiation is absent
- Can be either autotrophs or heterotrophs
- Asexual reproduction is predominant.
- Microscopic in nature
- Bacteria, amoeba, paramecium and yeast are examples of unicellular organisms

Multi- cellular Organisms

- Composed of more than one cell.
- Complex body organisation
- Only the outer cells are exposed to the environment
- Includes only eukaryotes
- Reproduction happens sexually as well as asexually
- Cell differentiation is present
- Humans, animals, plants, birds and insects, are examples of multicellular organisms

Looking inside the human Cells: (Components of the cell)

Cell Membrane
The cell membrane acts as the protective layer around the cell. It is porous in nature and selectively allows the entry of only some substances, preventing the movement of other materials.

Cytoplasm
It is the jelly-like substance present between the cell membrane and the nucleus.

Cell Wall
An additional covering over the cell membrane to protect plants of environmental changes. It is made up of cellulose.

Nucleus
A dense spherical body located at the centre of the cell. It is separated from the cytoplasm by nuclear membrane. It contains a spherical body called nucleolus and thread like structures called chromosomes.

Chromosomes
The thread like structure which carries genes and help in inheritance. They are composed of DNA in the form of Chromatin and protein.

DNA
DNA molecules contain the information necessary for constructing and organising cells.

Vacuoles
The vacuole stores the food, a variety of nutrients that a cell might need to survive or waste. They are like storage bubbles of irregular shapes, large in plant cells and provide rigidity to them.

Endoplasmic Reticulum
It is a membranous organelle, found in all eukaryotic cells.

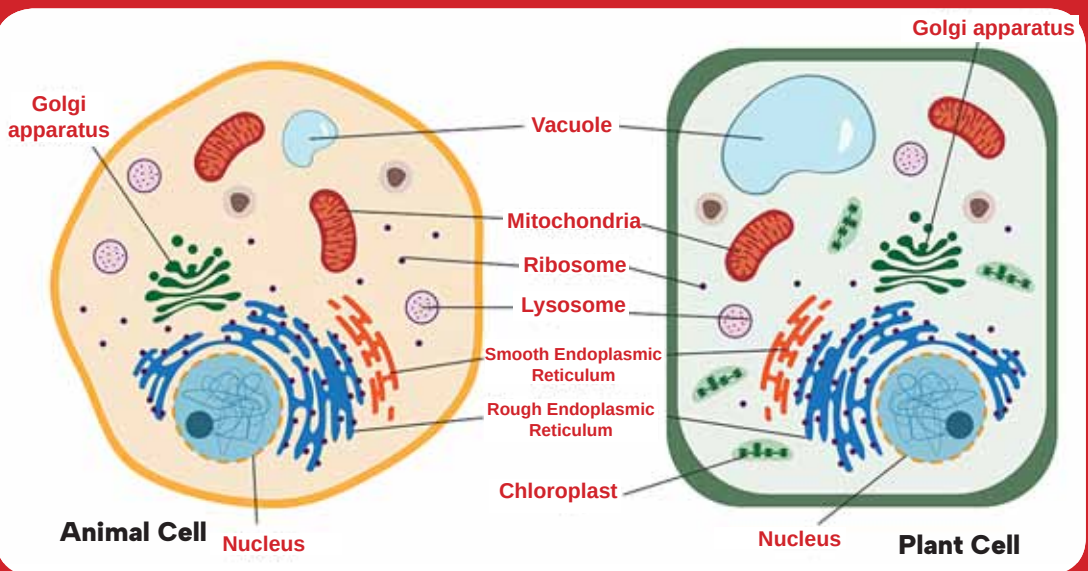
Smooth ER: It acts as storage organelle and helps in lipid (fat) synthesis. Rough ER: it is important for the synthesis and packaging of proteins.

Golgi Apparatus
The membrane-bound Golgi apparatus, commonly known as the Golgi complex, is a nucleus. Its primary purpose is to alter proteins. It houses these altered proteins, helping them to be transported to other parts of the cell as needed.

Mitochondria
Mitochondria are membrane-bound cell organelles (mitochondrion, singular) that generate most of the chemical energy needed to power the cell's biochemical reactions. Chemical energy produced by the mitochondria is stored in a small molecule called adenosine triphosphate (ATP).

Lysosomes
A membrane bound structure that holds variety of enzymes. It contains an array of enzymes capable of breaking down all types of biological polymers—proteins, nucleic acids, carbohydrates, and lipids.

Difference between Plant and Animal Cells



Plant Cell
- Cell wall is present
- Nucleus is located in the periphery of the cell.
- Plastids are present
- A large single vacuole is present in the centre of the cytoplasm.

Animal Cell
- Cell wall is absent.
- Nucleus is located in the centre of the cell.
- Plastids are absent
- Numerous small vacuoles are present.

Chapter 77

Artificial Intelligence (AI)

Artificial Intelligence (AI) involves simulating human intelligence in machines, particularly computer systems. This computer science subfield aims to develop machines capable of performing tasks typically requiring human intelligence.

What is AI?

Artificial Intelligence (AI) includes specialized applications such as expert systems, natural language processing, speech recognition, and machine vision. AI refers to machines' capability to perform cognitive functions like thinking, perceiving, learning, problem-solving, and decision-making. The core of AI is the emulation of human intellectual processes by machines, particularly computer systems. AI systems analyze vast amounts of labelled training data to identify correlations and patterns, enabling them to predict future states.

Types of Artificial Intelligence

Theory of Mind	Theory of mind AI, still theoretical, aims to understand human emotions and behaviour. Researchers are working to develop this advanced AI, which seeks to socially interact with and comprehend human thoughts and perspectives.
Self Awareness	Future AI devices are envisioned to possess consciousness, emotions, and self-awareness, surpassing human intelligence. Achieving this hinges on understanding consciousness and replicating it in machines, enabling them to detect and understand human emotions and internal states.
Reactive Machines	Purely reactive AI, the simplest form of artificial intelligence, does not retain memories or prior experiences. These machines focus solely on the present situation and respond accordingly, perceiving and reacting to the world in real-time without using past experiences to inform their decisions.
Limited Memory	Limited memory in AI involves temporarily storing information and predictions to inform future decisions, increasing complexity compared to reactive machines. Unlike reactive AI, those with limited memory can utilize historical data for enhanced decision-making, enabling more advanced capabilities.

Evolution of AI:

- Although the term "Artificial Intelligence (AI)" was initially coined in 1956, it has gained more popularity recently due to increasing data volumes, advanced algorithms, and enhanced computing power and storage.
- Early AI research in the 1950s focused on challenges like problem-solving and symbolic methods.
- For instance, the Defence Advanced Research Projects Agency (DARPA) funded street mapping projects in the 1970s. DARPA also created intelligent personal assistants in 2003, predating the rise of Siri, Alexa, and Cortana.

Timeline	Description
1956	The phrase “artificial intelligence” was created by John McCarthy, who also hosted the first AI conference.
1969	Shakey was the first all-purpose mobile robot created. It can now accomplish things with a purpose rather than merely a set of instructions.
1997	Deep Blue, a supercomputer, was created and defeated the world champion chess player in a match. The development of this enormous computer was a significant milestone for IBM.
2002	It was invented the first commercially viable robotic vacuum cleaner.
2005 – 2019	Today’s advancements include voice recognition, robotic process automation (RPA), a dancing robot, smart houses, and more.
2020	During the early phases of the SARS-CoV-2 (COVID-19) epidemic, Baidu makes the Linear Fold AI algorithm available to medical and scientific organizations working on a vaccine. The program predicts the virus’s RNA sequence in less than 27 seconds, which is 120 times quicker than prior approaches.

Government Initiatives for promotion of AI in India

ASkDisha
The Indian Railway Catering and Tourism Corporation (IRCTC) created an Intelligent Virtual Assistant using AI (Artificial Intelligence) and Natural Language Processing (NLP) (Natural Language Processing). The AskDISHA bot is now accessible on the IRCTC website and mobile app, providing travellers with quick replies and information in a variety of languages via voice and text.

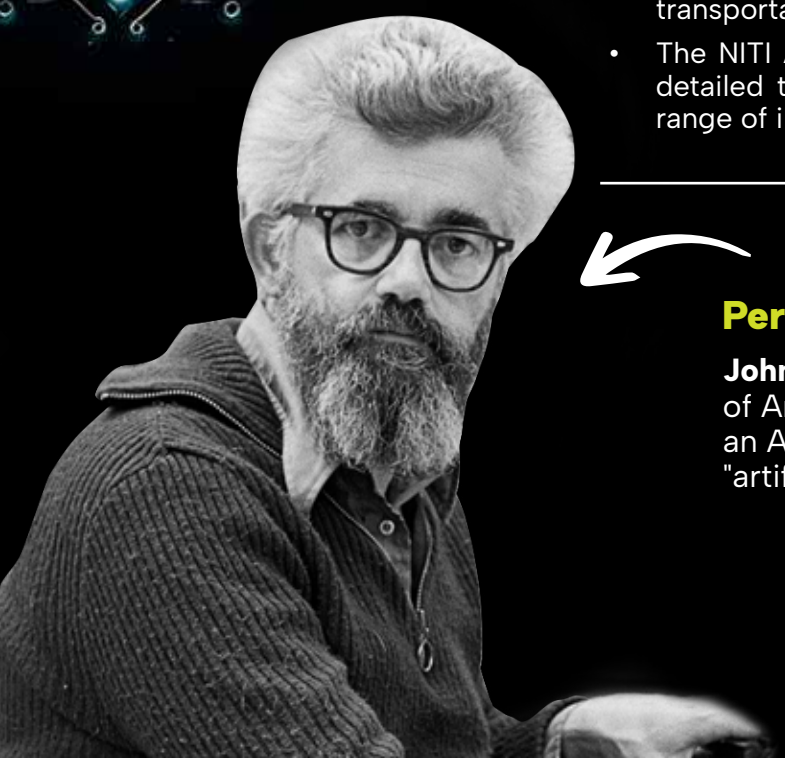
Amazon Web Services (AWS
The Ministry of Electronics and Information Technology (MeitY) intends to establish a Quantum Computing Applications Lab in collaboration with Amazon Web Services (AWS).

ICTAI
ICTAI (International Centre for Transformational Artificial Intelligence) will provide an environment for the development and implementation of application-based technologies, as well as carry out the obligations of the IM-ICPS framework.

AIRAWAT
(AI research, analytics, and knowledge assimilation platform) will be a cloud platform for Big Data Analytics and Assimilation, featuring a massive, power-optimized AI Computing infrastructure with powerful AI processing. It will foster the advancement of AI-based improvements in image identification, speech recognition, and natural language processing for research and development.

Scope of AI in India

- Anticipated strategic AI developments in 2024's Union Budget highlight its growing importance, requiring substantial acknowledgment and attention in the future.
- Using such dynamic data, Artificial Intelligence (AI) technologies and initiatives assist India in meeting societal needs in sectors such as healthcare, education, agriculture, smart cities, and infrastructure, including smart mobility and transportation.
- The NITI Aayog's national strategy for artificial intelligence has detailed the route forward for leveraging the power of AI in a range of industries.



Personality of Interest

John McCarthy is considered as the father of Artificial Intelligence. John McCarthy was an American computer scientist. The term "artificial intelligence" was coined by him.