

STANDARD NINE

SCIENCE

UNIT 1: MEASUREMENT

- Quantities which cannot be expressed in terms of any other physical quantities are called fundamental quantities. Example: Length, mass, time, temperature etc. Quantities which can be expressed in terms of fundamental quantities are called derived quantities. Example: Area, volume, density etc.
- SI (International System of Units) system of units was developed and recommended by General Conference on Weights and Measures at Paris in 1960 for international usage.
- One metre is the distance travelled by light through vacuum in $1/29,97,92,458$ second.
- **Astronomical unit (AU):** Mean distance of the centre of the Sun from the centre of the Earth. **$1 \text{ AU} = 1.496 \times 10^{11} \text{ m}$.**
- **Light year:** It is the distance travelled by light in one year in vacuum and it is equal to **$9.46 \times 10^{15} \text{ m}$.**
- **Parsec:** Parsec is the unit of distance used to measure astronomical objects outside the solar system. **$1 \text{ Parsec} = 3.26 \text{ light year}$.**
- Larger units for measuring time are day, month, year and millennium etc. **$1 \text{ millennium} = 3.16 \times 10^9 \text{ s}$.**
- Zero kelvin (0 K) is commonly known as absolute zero.
- The smallest length which can be measured by metre scale is called least count.
- The pull of gravity on the Moon is 1/6 times weaker than that on the Earth. This causes the weight of the object on the Moon to be less than that on the Earth by six times. Acceleration due to gravity on the **Moon = 1.63 ms^{-2}**

UNIT 2: MOTION

- **Linear motion:** Motion along a straight line.
- **Circular motion:** Motion along a circular path.
- **Oscillatory motion:** Repetitive to and fro motion of an object at regular interval of time.
- **Random motion:** Motion of the object which does not fall in any of the above categories.
- An object is said to be in uniform motion if it covers equal distances in equal intervals.
- **Distance:** It is measured in **metre in SI system**. It is a **scalar quantity having magnitude only**.
- **Displacement:** It is a **vector quantity having both magnitude and direction**. It is also measured in **metre in SI system**.
- **Speed:** SI unit of speed is ms^{-1} . Speed = Distance travelled / Time taken

UNIT 3: FLUIDS

- **Thrust and Pressure:** In SI units, the unit of **thrust is newton (denoted as N).** The unit of **pressure is newton per square metre or newton metre⁻² (denoted as Nm⁻²).**
- Blaise Pascal, 1 newton per square metre is called as 1 pascal denoted as Pa. **1 Pa = 1 N m⁻²**
- The instrument used to measure atmospheric pressure is **called barometer.**
- A mercury barometer, first designed by **an Italian Physicist Torricelli.**
- Measuring the density or relative density of the liquid is called **hydrometer.**
- Hydrometer is based on the **principle of flotation.**
- One form of hydrometer is a lactometer.
- The average reading of normal **milk is 32.**

UNIT 4: ELECTRIC CHARGE AND ELECTRIC CURRENT

- ✚ If an electron is removed from the atom, the atom becomes positively charged. Then it is called a positive ion. If an electron is added in excess to an atom then the atom is negatively charged and it is called negative ion.
- ✚ Electric charge is measured in **coulomb** and the symbol for the same is C.
- ✚ The movement of the positive charge is called as 'conventional current'. The flow of electrons is termed as 'electron current'.
- ✚ Ammeter is an instrument used to measure the strength of the electric current in an electric circuit.
- ✚ The SI unit for both electromotive force and potential difference is the same i.e., **volt (V)**.
- ✚ Voltmeter is an instrument used to measure the potential difference.
- ✚ The SI unit of **resistance** is ohm with the symbol (Ω).
- ✚ Components used for providing resistance are called as **resistors**. The resistors can be fixed or variable.
- ✚ This conversion of electrical energy into heating energy is called '**Joule heating**'.
- ✚ The process of conduction of electric current through solutions is called '**electrolysis**'. The solution through which the electricity passes is called '**electrolyte**'.
- ✚ **Frequency** is the number of complete cycle of variation, gone through by the ac in one second.
- ✚ The device used to convert ac to dc is called **rectifier**.
- ✚ The device used to convert dc into ac is called **inverter**.

UNIT 5: MAGNETISM AND ELECTROMAGNETISM

- The strongest natural magnet is lodestone magnetite.
- **Magnetic field (B)**: denoted by **B** and its unit is **Tesla**.
- Magnetic flux is the number of magnetic field lines passing through a given area. It is **denoted by Φ** and its unit is **weber (Wb)**.
- The number of magnetic field lines crossing unit area kept normal to the direction of field lines is called **magnetic flux density**. Its unit is **Wb/m²**
- Magnetic lines of force never intersect.
- The Magnetic field strength will be maximum at the poles than at the equator.
- It was on 21st April 1820, Hans Christian Oersted, a Danish Physicist was giving a lecture.
- After **Oersted's experiment** the electricity and magnetism were united and became a single subject called '**Electromagnetism**'.
- **Transformer** is a device used for **converting low voltage into high voltage and high voltage into low voltage**. It works on the principle of **electromagnetic induction**. It consists of primary and secondary coil insulated from each other.
- **Step up transformer**: The transformer used to **change a low alternating voltage to a high alternating voltage** is called a step up transformer. ie $V_s > V_p$.
- **Step down transformer**: The transformer used to **change a high alternating voltage to a low alternating voltage** is called a step down transformer ($V_s < V_p$).

UNIT 6: LIGHT

■ Reflection of Light

Laws of Reflection

1. Incident ray, reflected ray and normal lie in the same plane.
2. Angle of incidence = Angle of reflection.

■ Lateral inversion

- Lateral inversion means sidewise inversion. It is the apparent inversion of left and right that occurs in a plane mirror.
- Common example: "AMBULANCE" written in mirror image.

■ Spherical Mirrors

Two types:

- Concave mirror – converging
- Convex mirror – diverging

■ **Mirror Formula:** distance of the object (u), distance of the image (v) and the focal length (f) of a spherical mirror is called the mirror equation.

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

■ **Magnification:** ratio of the height of the image (h_i) to the height of the object (h_o). The magnification can be related to object distance (u) and the image distance (v).

$$m = \frac{h_i}{h_o} = -\frac{v}{u}$$

■ Refraction of Light

Definition: Bending of light when it travels obliquely from one transparent medium to another.

Laws of Refraction of light

1. The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
2. The ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant for a light of given colour and for the given pair of media.
3. Snell's Law:

$$\frac{\sin i}{\sin r} = \text{constant} = \mu$$

-  Light bends towards normal when it enters denser medium.
-  Light bends away from normal when it enters rarer medium.

Total Internal Reflection (TIR)

Critical Angle: Angle of incidence for which angle of refraction becomes 90° .

Important Formulas

Topic	Formula
Mirror formula	$1/f = 1/v + 1/u$
Magnification	$m = v/u$
Snell's Law	$\sin i / \sin r = \mu$
Focal length	$f = R/2$

UNIT 7: HEAT

- ❖ **Kelvin scale** is known as the absolute scale.
- ❖ The temperature at which the pressure and volume of a gas theoretically reaches zero is called **absolute zero**.
- ❖ Specific heat capacity of a substance is defined as the amount of heat required to raise the temperature of 1 kg of the substance by 1°C or 1 K. The **SI unit of specific heat capacity is $\text{Jkg}^{-1} \text{K}^{-1}$** . The most commonly used units of **specific heat capacity** are **J/kg°C** and **J/g°C**.
- ❖ Heat capacity or **thermal capacity** is defined as the amount of heat energy required to raise the temperature of a body by 1°C . It is denoted by C' .
- ❖ **SI unit of heat capacity is J/K. It is also expressed in cal/ $^{\circ}\text{C}$, kcal/ $^{\circ}\text{C}$ or J/ $^{\circ}\text{C}$.**
- ❖ The process in which a vapor is converted to liquid by releasing heat is called **condensation**.
- ❖ **Latent heat** is the amount of heat energy absorbed or released by a substance during a change in its physical states without any change in its temperature.
- ❖ **Specific latent heat** is the amount of heat energy absorbed or liberated by unit mass of a substance during change of state without causing any change in temperature. **The SI unit of specific latent heat is J/kg**.

UNIT 8: SOUND

- **Propagation of Sound Waves:** Sound needs a material medium like air, water, steel etc., for its propagation. **It cannot travel through vacuum.**
- **Sound also is a longitudinal wave.** Sound can travel only when there are particles which can be compressed and rarefied.
- **A sound wave is an example of a longitudinal mechanical wave.**
- If the vibration of a particle has large amplitude, the sound will be loud and if the vibration has small amplitude, the sound will be soft. **Amplitude** is denoted as A. Its SI unit is meter (m).
- The loudness of a sound depends on the intensity of sound wave. **Intensity** is defined as the amount of energy crossing per unit area per unit time perpendicular to the direction of propagation of the wave.
- The intensity of sound heard at a place depends on the following five factors.
 - i. Amplitude of the source.
 - ii. Distance of the observer from the source.
 - iii. Surface area of the source.
 - iv. Density of the medium.
 - v. Frequency of the source.
- The unit of **intensity of sound is decibel (dB)**. It is named in honour of the Scottish-born scientist Alexander Graham Bell who invented telephone.
- High pitch sound is **shrill** and low pitch sound is **flat**.
- A sound of single frequency is called a **tone** and a collection of tones is called a **note**.
- In any medium the speed of sound increases if we increase the temperature of the medium.
- **Echo**, The sensation of sound persists in our brain for about 0.1s.
- There is a separate branch in physics called **acoustics** which takes these aspects of sound in to account while designing auditoria, opera halls, theaters etc.

- An **echogram** is an image obtained by the use of reflected ultrasonic waves. It is used as a medical diagnostic tool. Ultrasonic sound is having application in marine surveying also.
- **Ultrasonic waves** are made to reflect from various parts of the heart and form the image of the heart. This technique is called '**echo cardiography**'.
- SONAR stands for **Sound Navigation and Ranging**. Sonar consists of a transmitter and a detector and is installed at the bottom of boats and ships.
- Time interval between transmission and reception of ultrasound signal be 't'. Then, the speed of sound through sea water is $2d/t = v$. This method is called **echo-ranging**. Sonar technique is used to determine the depth of the sea and to locate underwater hills, valleys, submarine, icebergs etc.

UNIT 9: UNIVERSE

- Earlier days, before the invention of astronomical instruments, people thought that Earth is the centre of all the objects in the space. This was known as the **geocentric model**.
- Later Polish astronomer Nicolaus Copernicus proposed the **heliocentric model** (helios = Sun), with Sun at the centre of the solar system. Invention of the telescope in the Netherlands, in 1608, created a revolution in astronomy.
- About 13.7 billion years ago, an explosion occurred and all the matter were ejected in all directions in the form of galaxies.
- Scientists believe that there are one hundred billion (10^{11}) galaxies in the observable universe.
- There are many galaxies besides our Milky Way. **Andromeda galaxy** is our closest neighboring galaxy. The **Milky Way galaxy** is spiral in shape.
- It is made up of approximately 100 billion stars and its diameter is 1,00,000 light years. Our solar system is 25,000 light years away from the centre of our galaxy.
- Hot stars are white or blue, whereas cooler stars are orange or red in colour. They also occur in many sizes.
- **Three quarters of the Sun has hydrogen gas and one quarter has helium gas.**
- **Sun** is believed to be more than **4.6 billion years old**.
- The time taken by a planet to complete one revolution is called its **period of revolution**.
- The time taken by a planet to complete one rotation is called its **period of rotation**. The period of rotation of the Earth is 23 hours and 56 minutes and so the length of a day on Earth is taken as 24 hours.
- The four planets grouped together in the inner solar system are Mercury, Venus, Earth and Mars. They are called inner planets. They have a surface of solid rock crust and so are called **terrestrial or rocky planets**.
- **The four large planets Jupiter, Saturn, Uranus and Neptune** spread out in the outer solar system and slowly orbit the Sun are called **outer planets**. They are made **of hydrogen, helium and other gases** in huge amounts and have very

dense atmosphere. They are known as gas giants and are called **gaseous planets**. The **four outer planets Jupiter, Saturn, Uranus and Neptune have rings** whereas the **four inner planets** do not have any rings.

- ❖ **Venus:** hottest planet in our solar system. This planet **spins in the opposite direction** to all other planets. So, unlike Earth, the Sun rises in the west and sets in the east here. Venus can be **seen clearly through naked eye**. It always appears in the **horizon of eastern or western sky**.
- ❖ **Mars:** The **first planet outside** the orbit of the Earth is Mars. It appears slightly reddish and therefore it is also called **the red planet**. It has **two small natural satellites (Deimos and Phobos)**.
- ❖ **Jupiter:** Jupiter is called as **Giant planet**. It is the largest of all planets (about 11 times larger and 318 times heavier than Earth). It has 3 rings and 65 moons. Its moon Ganymede is the largest moon of our solar system.
- ❖ **Saturn:** Having least density of all (30 times less than Earth), this planet is so light.
- ❖ **Neptune:** It appears as **Greenish star**. It is the eighth planet from the Sun and is the windiest planet. Every 248 years, Pluto crosses its orbit. This situation continues for 20 years. It has **13 moons – Triton being the largest**. Triton is the only moon in the solar system that moves in the opposite direction to the direction in which its planet spins.
- ❖ **Asteroids:** The biggest asteroid is Ceres – 946 km across.
- ❖ **Satellites:** Among the planets in the solar system all the planets have moons except Mercury and Venus.
- ❖ **Orbital Velocity:** The first artificial satellite **Sputnik** was launched in 1956. India launched its first satellite **Aryabhatta on April 19, 1975**.

Orbital velocity can be calculated using the following formula.

$$v = \sqrt{GM}/(R + h) \quad \text{where,}$$

G = Gravitational constant ($6.673 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2}$)

M = Mass of the Earth ($5.972 \times 10^{24} \text{ kg}$)

R = Radius of the Earth (6371 km)

h = Height of the satellite from the surface of the Earth.

- ❖ A group of stars forms an imaginary outline or meaningful pattern on the space, called **constellations**.

UNIT 10: MATTER AROUND US

- ⊕ The term **matter** to cover all substances and materials from which the universe is composed. They have mass and they occupy space.
- ⊕ **Cane sugar** is made up of three elements carbon, hydrogen and oxygen. The chemical formula of cane sugar is $C_{12}H_{22}O_{11}$.
- ⊕ **Common salt**, also known as sodium chloride, is a compound.
- ⊕ **Alloys** are mixtures of metals.
- ⊕ A mixture in which the components cannot be seen separately is called a **homogeneous mixture**. Tap water, milk, air, ice cream, sugar syrup, ink, steel, bronze and salt solution are homogeneous mixtures.
- ⊕ A mixture in which the components can be seen separately is called a **heterogeneous mixture**. Soil, a mixture of iodine and common salt, a mixture of sugar and sand, a mixture of oil and water, a mixture of sulphur and iron filings and a mixture of milk and cereals are heterogeneous mixture.
- ⊕ Certain **solid substances when heated change directly from solid to gaseous state without attaining liquid state**. The vapours when cooled give back the solid substance. This process is known as **sublimation**. Examples: Iodine, camphor, ammonium chloride etc.,
- ⊕ In milk diaries, centrifugation is used to separate cream from milk.
- ⊕ **Distillation = Evaporation + Condensation**
- ⊕ **Adsorption** is the process in which the particles of a substance is concentrated only at the surface of another substance.
- ⊕ **Absorption** is the process in which the substance is uniformly distributed throughout the bulk of another substance.
- ⊕ **Chromatography** is also a separation technique.
- ⊕ **Paper chromatography:** method is used to separate the different coloured dyes in a sample of ink.
- ⊕ **Tyndall effect:** Tyndall (1869) observed that when a strong beam of light is focused on a colloidal solution the path of the beam becomes visible. This phenomenon is known as Tyndall effect and the illuminated path is called Tyndall cone.

UNIT 11: ATOMIC STRUCTURE

- ⊕ In 1913, Neils Bohr, a Danish physicist, explained the causes of the stability of the atom in a different manner.
- ⊕ In atoms, the electron revolve around the nucleus in stationary circular paths called **orbits or shells or energy levels**.
- ⊕ In 1932 James Chadwick observed when Beryllium was exposed to alpha particles, particles with about the same mass as protons were emitted. These emitted particles carried no electrical charges. They were called as **neutrons**. It is denoted by ${}_0^1\text{H}$. Beryllium + alpha ray = carbon + neutron. Its mass is equal to $1.676 \times 10^{-24} \text{ g}$ (1 amu).
- ⊕ **Nucleus:** The protons and neutrons [collectively called nucleons]
- ⊕ **Atomic number and Mass number:**

Atomic number(Z) = Number of protons = Number of electrons

Mass number = Number of protons + Number of neutrons

Number of neutrons (n) = Mass number (A) – Atomic number (z)

- ⊕ **Electronic configuration of atoms:** The distribution of electrons in different shells is called **electronic configuration**.

Rule 1: The maximum number of electrons that can be accommodated in a shell is equal to $2n^2$

Rule 2: Shells are filled in a **stepwise manner** in the increasing order of energy.

Rule 3: The outermost shell of an atom cannot have more than 8 electrons, even if it has capacity to accomodate more electrons.

- ⊕ **Valence electrons:** The outermost shell of an atom is called valence shell and the electrons present in the valence shell are known as **valence electrons**. The chemical properties of elements are decided by these valence electrons.
- ⊕ Elements having completely filled outermost shell show **Zero valency**.
- ⊕ **Law of Reciprocal Proportions:** The law of reciprocal proportions was proposed by Jeremias Ritter in 1792.

UNIT 12: PERIODIC CLASSIFICATION OF ELEMENTS

- **Dobereiner's Triads:** In 1817, Johann Wolfgang Dobereiner, a German chemist, suggested a method of grouping elements based on their relative atomic masses. He called these groups as '**triads**' (**tri - three**).
- **Newlands' Law of Octaves:** In 1866, John Newlands arranged 56 known elements in the increasing order of their atomic mass. This arrangement was known as '**law of octaves**'.
- **Features of Mendeleev's Periodic Table:** It has **eight vertical columns** called '**groups**' and **seven horizontal rows** called '**period**'. **No place for isotopes in the periodic table.**
- **Modern Periodic Law:** Atomic number of an element (Z) indicates the number of protons (positive charge) or the number of electrons (negative charge).

Table 12.5 Groups in modern periodic table

Group	Families
1	Alkali metals
2	Alkaline earth metals
3 to 12	Transition metals
13	Boron Family
14	Carbon Family
15	Nitrogen Family
16	Oxygen Family (or) Chalcogen Family
17	Halogens
18	Noble gases

- **s-Block Elements:** It includes group 1 (alkali metals) and group 2 (alkaline earth metals) elements. They are also called as representative elements. The elements of group 1 (except hydrogen) are metals.
- **p-Block Elements:** These elements are in group 13 to 18 in the periodic table. They include boron, carbon, nitrogen, oxygen, fluorine families in addition to noble gases (Except helium). They are also called as representative elements.
- **d-Block Elements:** It includes group 3 to group 12 elements. They are found in the centre of the periodic table. Their properties are intermediate to that of s block and p block elements and so they are called transition elements.

- **f – Block Elements:** It includes 14 elements after (Lanthanum) La (57), called Lanthanides and 14 elements after (Actinium) Ac (89), called Actinoids. They are placed at the bottom of the periodic table. They are also called as inner Transition elements.
- **Metalloids:** Elements which have the properties of both metals and non-metals are called as metalloids. (eg) Boron, Arsenic.
- When metal is alloyed with mercury, it is called **amalgam**.

UNIT 13: CHEMICAL BONDING

- Based on the noble gas electronic configuration, Kossel and Lewis proposed a theory in 1916 to explain chemical combination between atoms and this theory is known as '**Electronic theory of valence' or Octet rule**'.
- The tendency of atoms to have eight electrons in the valence shell is known as the '**Octet rule' or the 'Rule of eight'**'.
- The covalent bond is formed because of the sharing of electrons which become common to both the atoms. It is also called as **Atomic bond**.
- In some compounds the formation of a covalent bond between two atoms takes place by the sharing of two electrons, both of which comes from only one of the combining atoms. This bond is called **Coordinate covalent bond or Dative bond**.
- Oxidation number also called **Oxidation State**.

UNIT 14: ACIDS, BASES AND SALTS

- ⊕ The word ‘acid’ is derived from the Latin name “acidus” which means **sour taste**.
Substances with sour taste are **called acids**.

Table 14.1 Acid and its source

Source	Acid Present
Apple	Malic acid
Lemon	Citric acid
Grape	Tartaric acid
Tomato	Oxalic acid
Vinegar	Acetic acid
Curd	Lactic acid
Orange	Ascorbic acid
Tea	Tannic acid
Stomach juice	Hydrochloric acid
Stings of Ant, Bee	Formic acid

- ⊕ **Monobasic Acid:** Acid that contain **only one replaceable hydrogen atom** per molecule is called monobasic acid. It gives one hydrogen ion per molecule of the acid in solution. Example: HCl, HNO₃
- ⊕ **Dibasic Acid:** An acid which gives two hydrogen ions per molecule of the acid in solution. Example: H₂SO₄, H₂CO₃
- ⊕ **Strong Acids:** These are acids that ionise completely in water. Example: HCl
- ⊕ **Weak Acids:** These are acids that ionise partially in water. Example: CH₃COOH.
- ⊕ **Concentrated Acid:** It has relatively large amount of acid dissolved in a solvent.
- ⊕ **Dilute Acid:** It has relatively smaller amount of acid dissolved in solvent.
- ⊕ **Properties of Acids:**
- sour taste
 - turns blue litmus red
 - react with metal carbonate and metal hydrogen carbonate to give carbon dioxide.
 - react with metallic oxides to give salt and water.
 - react with bases to give salt and water.

Table 14.4 Acid base indicator

Indicator	Colour in acid	Colour in base
Litmus	Blue to Red	Red to Blue
Phenolphthalein	Colourless	Pink
Methyl orange	Pink	Yellow

- pH Scale: The 'p' in pH stands for 'potenz' in German meaning power.
- Salts that contain water of crystallisation are called **hydrated salts**.
- Salts that do not contain water of crystallisation are called **anhydrous salt**.
- **Aquaregia** is a mixture of hydrochloric acid and nitric acid optimally in a molar ratio of 3:1

UNIT 15: CARBON AND ITS COMPOUNDS

- ⊕ Antoine Lavoisier named Carbon from the Latin word '**Carbo**'. The earth's crust contains only 0.032% of carbon. Thus, Carbon Chemistry is also called as **Living Chemistry**.
- ⊕ In 1855, English chemist **Benjamin Brodie** produced pure graphite from carbon, **proving graphite is a form of carbon.**
- ⊕ Graphene's discovery was announced in 2004 by **Kostya Novoselov and Andre Geim**, who used adhesive tape to detach a single layer of atoms from graphite to produce the new allotrope.
- ⊕ Catenation is **binding of an element to itself or with other elements through covalent bonds** to form open chain or closed chain compounds. Carbon is the most common element which undergoes catenation and forms long chain compounds.
- ⊕ This phenomenon in which the **same molecular formula may exhibit different structural arrangement** is called isomerism. Compounds that have the same molecular formula but different structural formula are called isomers (Greek, isos = equal, meros = parts).
- ⊕ **Allotropy** is a property by which an element can exist in more than one form that are physically different and chemically similar. The different forms of that element are called its allotropes.
- ⊕ Buckminster **fuller**. Because its structure reminded the framework of **dome shaped halls** designed by Fuller for large international exhibitions, it is called by the pet name **Bucky Ball**.
- ⊕ **Environment (Protection) Act = 1988.**
- ⊕ **Friedrich Wohler** is called **Father of Modern Organic Chemistry.**

UNIT 16: APPLIED CHEMISTRY

✚ Size of Nanoparticles:

- Our nails grow 1 nm each second.
- The virus most usually responsible for the common cold has a diameter of 30 nm.
- A cell membrane is around 9 nm across.
- The DNA double helix is 2 nm across.
- The diameter of one hydrogen atom is around 0.2 nm.

✚ Properties of nanomaterials :

Scanning Electron Microscope (SEM), Tunneling Electron Microscope (TEM) and Atomic Force Microscope (AFM) are used to analyse the surface properties of a nanoparticle with high resolution.

Table 16.1 Sources of drugs

Source or Process	Drug
Plants	Morphine, Quinine
Chemical Synthesis	Aspirin, Paracetamol
Animal	Insulin, Heparin
Minerals	Liquid Paraffin
Microorganism	Penicillin
Genetic Engineering	Human growth Hormone

✚ **Chemicals as Anaesthetics:** There are three major chemicals which are used as anaesthetics. They are: **Nitrous Oxide (N₂O)**, **Chloroform (CHCl₃)**, **Ether**.

✚ **Ether:** Diethyl ether or simple ether (C₂H₅—O—C₂H₅) is a volatile liquid. This is mixed with a stabilizer, 0.002% propyl halide. After absorption by tissues it attacks the central nervous system and makes the patient unconscious.

✚ **Analgesics** are the compounds which relieve all sorts of pains without the loss of consciousness. These are also called as **pain killer or pain relievers**. Aspirin and Novalgin are the commonly used analgesics. Aspirin acts both as antipyretic as well as analgesic. Certain narcotics (which produce sleep and unconsciousness) are also used as analgesics. The analgesics are given either **orally or applied externally**.

✚ **Antipyretics** are the compounds which are used for the purpose of reducing fever (lowering the body temperature to the normal). The most common antipyretics are, aspirin, antipyrine, phenacetin, and paracetamol.

Antiseptics:

- Iodoform (CHI_3) is used as an antiseptic and its 1% solution is a disinfectant.
- 0.2 % solution of phenol acts as an antiseptic and its 1% solution is a disinfectant.
- Hydrogen peroxide is a minor antiseptic mainly used for cleansing wounds.

-  **Antimalarial:** Malaria is a vector borne disease which causes shivering and fever. It raises the body temperature to 103-106 °F.
-  **Quinine** is a **natural antimalarial obtained from Cinchona bark**. The last antimalarial discovered in **1961 is pyrimethamine**. However, quinine, primaquine and chloroquine are some of the best antimalarials. **Chloroquine** is used specially to control malarial parasites such as plasmodium ovale, plasmodium vivax etc. It is not used in curing the disease. It is used as an additive with other antimalarial drugs.
-  **Antibiotics:** The first antibiotic 'penicillin' was discovered by **Alexander Fleming in 1929**, from the mold *Penicillium notatum*. Penicillin is extensively used for rheumatic fever, narrowing of heart wall, bronchitis, and pneumonia etc.

Table 16.2 Radioisotope in Diagnosis

Radioisotope	Diagnosis used for
Iodine-131	Location and detection of brain tumor, thyroid gland disorder.
Sodium-24	Location of blood clot and circulation disorders, pumping action of heart.
Iron-59	Diagnosis of anaemia, pregnancy disorder.
Cobalt-60	Diagnosis of cancer.
Hydrogen-3	Water content of the human body.

-  **Chemical Fertilizers:** Ammonium nitrate, calcium phosphate, urea, NPK (Nitrogen, Phosphorous and Potassium), etc. are some of the fertilizers.

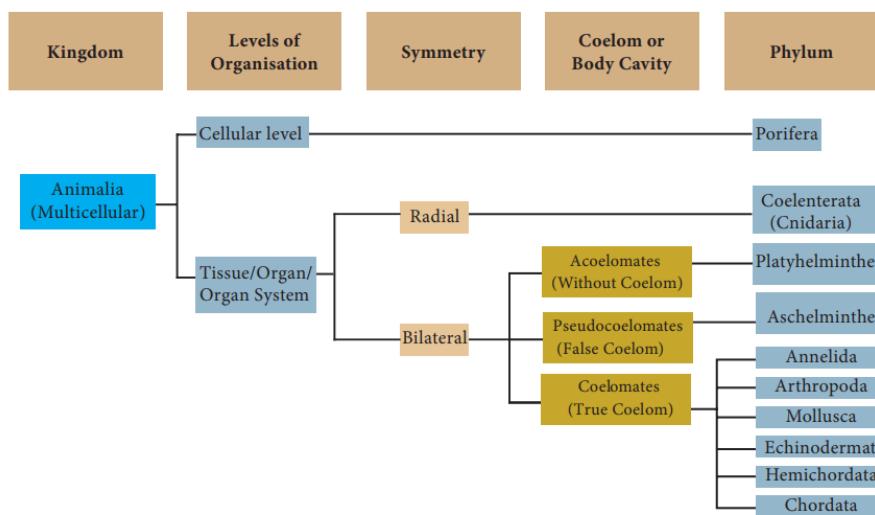
Method of Forensic Chemistry:

Finger print: Occult fingerprints are sometimes made visible by the **use of ninhydrin**, which turns purple due to reaction with **amino acids** present in perspiration. **Cyanoacrylate ester** fumes from glue are used with fluorescent dyes to make the fingerprints visible.

UNIT 17: ANIMAL KINGDOM

-  The first systematic approach to the classification of living organisms was made by a **Swedish botanist, Carolus Linnaeus**.
-  **The five kingdom classification** are Monera, Protista, Fungi, Plantae and Animalia.
-  **Germ layers:** Germ layers are formed during the development of an embryo.

Classification of kingdom Animalia based on fundamental features



-  Organisms with two germ layers, the ectoderm and the endoderm are called **diploblastic animals**. e.g Hydra.
-  Organisms with three germ layers, ectoderm, mesoderm and endoderm are called **triploblastic animals**. e.g Rabbit
-  **Coelom:** It is a fluid-filled body cavity.
-  Animals which do not possess notochord are called as **Invertebrates** or **Non-chordates**.

- Animals which possess notochord or backbone are called as **Chordates**.
- Binomial Nomenclature:** **Carolus Linnaeus** introduced the method of naming the animals with **two names** known as binomial nomenclature. **The first name is called genus** and the first letter of genus is denoted in capital and **the second one is the species** name denoted in small letter.

Common name	Binomial name
Amoeba	<i>Amoeba proteus</i>
Hydra	<i>Hydra vulgaris</i>
Tapeworm	<i>Taenia solium</i>
Roundworm	<i>Ascaris lumbricoides</i>
Earthworm	<i>Lampito mauritii/ Perionyx excavatus</i>
Leech	<i>Hirudinaria granulosa</i>
Cockroach	<i>Periplaneta americana</i>
Snail	<i>Pila globosa</i>
Star fish	<i>Asterias rubens</i>
Frog	<i>Rana hexadactyla</i>
Wall lizard	<i>Podarcis muralis</i>
Crow	<i>Corvus splendens</i>
Peacock	<i>Pavo cristatus</i>
Dog	<i>Canis familiaris</i>
Cat	<i>Felis felis</i>
Tiger	<i>Panthera tigris</i>
Man	<i>Homo sapiens</i>

INVERTEBRATA:

- **Phylum Porifera (Pore bearers):** Body is perforated with many pores called **ostia**. The body wall contains **spicules**, which form the skeletal framework.
- **Phylum Coelenterata (Cnidaria):** animals with tentacles & stinging cells(eg.jellyfish)
- **Phylum Platyhelminthes (Flat worms):** flatworms; dorsoventrally flattened, These worms are **hermaphrodites** having both male and female reproductive organs in a single individual. e.g- Liverfluke, Tapeworm.
- **Nematoda :** roundworms; unsegmented , **Phylum Aschelminthes (Round worms)**
- **Phylum Annelida (Segmented worms):** segmented worms (Earthworm, Leech)
- **Phylum Arthropoda (Animals with jointed legs):** jointed legs; largest phylum, Body cavity is filled with **haemolymph** (blood).

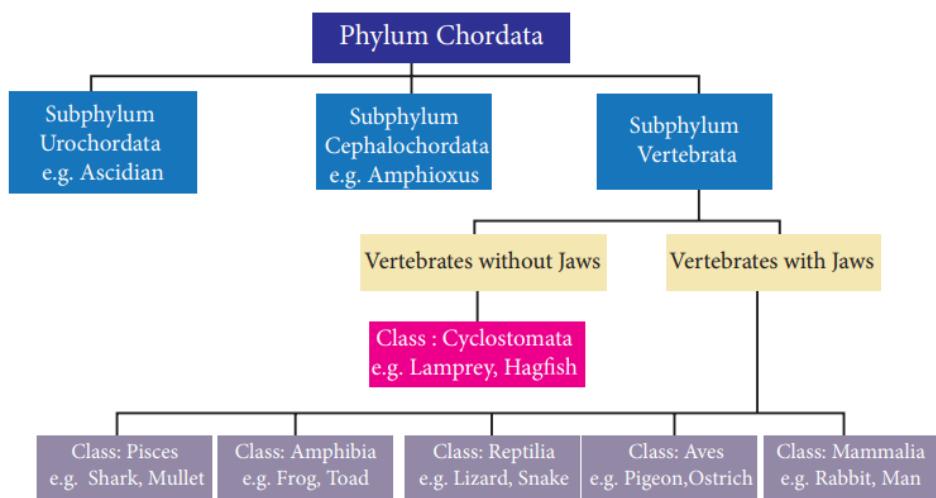
- **Phylum Mollusca (Soft Bodied Animals):** soft-bodied animals; hard shell, Respiration is through gills (**ctenidia**) or lungs or both.
- **Phylum Echinodermata (Spiny Skinned Animals):** spiny-skinned; water vascular system
- **Phylum Hemichordata:** Hemichordates are marine organisms with soft, vermiform and unsegmented body
- **Chordates :** animals with notochord,
- **Phylum Chordata** is divided into two groups: **Prochordata** and **Vertebrata.**
- **Vertebrates :** animals with backbone
- **Cold-blooded animals :** body temp varies with environment
- **Warm-blooded animals :** body temp constant

❖ **Warm-blooded animals are called?** Homeotherms

❖ **What is the skeleton of mollusks made of?** Calcium carbonate

❖ **Meristematic Tissues(Meristems)**

Classification of Phylum Chordata



❖ **In radial symmetry** the body parts are arranged around the central axis.

❖ **In bilateral symmetry**, the body parts are arranged along a central axis.

UNIT 18: Organisation of Tissues

- Plant tissues are classified into two types namely:
 - i. Meristems or Meristematic tissues.
 - ii. Permanent tissues
- **Meristematic Tissues (Meristems):** In plants, meristem is found in zones where growth can take place. Example: apex of stem, root, leaf primordia, vascular cambium, cork cambium, etc.,
- On the basis of their position in the plant, meristems are of three types: **Apical meristem, Intercalary meristem and Lateral meristem**
- **Apical meristem:** present at tip of root & shoot
- **Lateral meristem:** responsible for increase in girth
- **Permanent tissue :** non-dividing mature tissue
- **Simple Tissues:** Simple tissues are homogeneous tissues composed of structurally and functionally similar cells. eg., **Parenchyma, Collenchyma and Sclerenchyma.**
- **Parenchyma :** storage & photosynthesis tissue
- **Collenchyma :** provides flexibility
- **Sclerenchyma :** dead, thick-walled; provides strength

- **COMPLEX TISSUE:** Complex tissues consist of parenchyma and sclerenchyma cells. However, collenchymatous cells are not present in such tissues.
- **Xylem :** water-conducting tissue
- **Phloem :** food-conducting tissue
- **Animal Tissues:** The study of tissues is known as **Histology.**
- Animal tissues can be grouped into four basic types on the basis of their structure and functions.
 - a. **Epithelial tissue.**
 - b. **Connective tissue**
 - c. **Muscular tissue**
 - d. **Nervous tissue**
- **Epithelial tissue :** protective covering in animals
- **Muscle tissue :** responsible for movement
- **Nervous tissue :** transmits impulses

- **Connective tissue** : supports & binds organs
- **Epithelial Tissues:** There are **two types** of epithelial tissues. **Simple epithelium** is composed of **single layer** of cells resting on a basement membrane. **Compound epithelium** is composed of **several layers** of cells.
- Simple epithelium is further divided into following types:
 - **Squamous Epithelium:** It is made up of thin, **flat** cells, The squamous epithelium is also known as **pavement membrane**.
 - **Cuboidal Epithelium:** It is composed of single layer of **cubical** cells. Their main function is secretion and absorption.
 - **Columnar Epithelium:** It is composed of a single layer of **slender, elongated** and **pillar** like cells.
 - **Ciliated Epithelium:** Certain columnar cells bear numerous delicate hair like out growths called **cilia**.
 - **Glandular Epithelium:** Epithelial cells are often modified to form **specialized gland**.
 - **Compound Epithelium:** It consists of **more than one layer** of cells and gives a **stratified appearance**.
- The three types of cell division that occur in animal cells are:

- I. **Amitosis - Direct Division**
- II. **Mitosis - Indirect Division**
- III. **Meiosis - Reduction Division**

UNIT 19: PLANT PHYSIOLOGY

Tropism in Plants:

- ⊕ **Phototropism:** Movement of a plant part towards **light**. e.g. shoot of a plant.
- ⊕ **Geotropism:** Movement of a plant in response to **gravity**. e.g. root of a plant.
- ⊕ **Hydrotropism:** Movement of a plant or part of a plant **towards water**. e.g root of a plant.
- ⊕ **Thigmotropism:** Movement of a plant part **due to touch**. e.g. climbing vines.
- ⊕ **Chemotropism:** Movement of a part of plant in **response to chemicals**. e.g growth of a pollen tube in response to sugar present on the stigma.
- ⊕ **Tropism** is generally termed positive if growth is towards the signal and negative if it is away from the signal.
- ⊕ Shoot of a plant moves **towards the light**, the roots move away. Thus the shoots are **positively phototropic**.
- ⊕ **shoot system** of a plant is positively phototropic and negatively geotropic and **root system** is negatively phototropic and positively geotropic
- ⊕ **Nastic movements** are non-directional response of a plant or part of a plant to stimulus. Based on the nature of stimuli, nastic movements are classified as **photonomasty and thigmonasty**.
- ⊕ **Photonomasty:** Movement of a part of a plant in response to light. e.g. **Taraxacum officinale, blooms in morning and closes in the evening**
- ⊕ **Thigmonasty:** Movement of a part of plant in response to touch. e.g. **Mimosa pudica, folds leaves and droops when touched**. It is also known as **Seismonasty**.
- ⊕ **Thermonasty:** Movement of part of a plant is associated with change in temperature. e.g. **Tulip flowers bloom as the temperature increases**.
- ⊕ **Photosynthesis:** ‘Photo’ means ‘light’ and ‘synthesis’ means ‘to build’. Thus photosynthesis literally means ‘building up with the help of light’.
- ⊕ These activities show that certain things are necessary for **photosynthesis**. They are:
 1. **Chlorophyll - Green pigment in leaves**
 2. **Water**

3. Carbon dioxide (from air)

4. Sun light

- Stomata are minute opening on the leaves.

UNIT 20: ORGAN SYSTEMS IN ANIMALS

Table 20.1 Organ Systems in Animals

Organ Systems	Organs	Functions
Integumentary system	Skin and skin glands	Protection, Excretion, etc.
Skeletal system	Skull, Vertebral column, Sternum, Girdles and Limbs	Give support, shape and form to the body.
Muscular system	Muscle fibres	Contraction and relaxation resulting movement.
Nervous system	Brain, spinal cord and nerves.	Conduction of nerve impulse.
Circulatory system	Heart, blood and blood vessels	Transportation of respiratory gases, nutritive substances and waste products.
Respiratory system	Respiratory tract and Lungs	Breathing
Digestive system	Digestive tract and digestive glands	Digestion, Absorption, Egestion
Excretory system	Kidneys, ureters, urinary bladder and urethra.	Elimination of nitrogenous waste products.
Reproductive system	Testes and ovary	Gamete formation and development of secondary sexual characters.
Sensory system	Eyes, nose, ears, tongue and skin	Sight, smell, hearing, taste and touch.
Endocrine system	Pituitary, Thyroid, Parathyroid, Adrenals, Pancreas, Pineal body, Thymus, Reproductive glands, etc.	Co-ordinates the functions of all organ systems.

- The process of nutrition begins with intake of food, called **ingestion**
- Parts of the body concerned with the digestion of food form the **digestive system**.
- Digestive glands:** Glands associated with the alimentary canal are the salivary glands, gastric glands, pancreas, liver and intestinal glands.

■ **Mouth:** The mouth leads into the **buccal cavity**. The **buccal cavity** is a large space bound above by the palate (which separates the wind pipe and food tube), below by the throat and on the sides by the jaws. The jaws bear teeth.

■ **Pancreas** acts both as an **exocrine gland** and as an **endocrine gland**.

■ **Liver:** The liver cells secrete **bile** which is temporarily stored in the gall bladder.

■ In human beings **urea** is the major excretory product.

■ Some of the excretory organs other than kidneys are **skin and lungs**.

■ **SKIN:** The human body functions normally at a temperature of about **37 °C**.

■ **KIDNEYS:** Each kidney is about **11 cm long, 5 cm wide and 3 cm thick**. kidney consists of an outer dark region, **the cortex** and an inner lighter region, **the medulla**.

■ **Mechanism of Urine Formation:**

 □ □ **Glomerular filtration**

 □ □ **Tubular reabsorption**

 □ □ **Tubular secretion**

■ **Tubular secretion:** Substances such as H⁺ or K⁺ ions are secreted into the tubule. This tubular filtrate is finally known as urine, which is **hypertonic** in man. When the urinary bladder is full the urine is expelled out through the urethra. This process is called **micturition**.

■ **Alimentary canal** consists of mouth, buccal cavity, pharynx, oesophagus, stomach, small intestine (consisting of duodenum, jejunum and ileum), large intestine (consisting of caecum, colon and rectum) and anus.

UNIT 21: NUTRITION AND HEALTH

- **Carbohydrates:** Glucose, sucrose, lactose, starch, cellulose are examples for carbohydrates. Carbohydrates are classified as monosaccharide (Glucose), disaccharide (Sucrose) and polysaccharide (Cellulose). The classification is based on the number of sugar molecules present in each group.

Table 21.1 Dietary sources of major foodstuffs

Major food stuffs	Dietary sources	Daily requirements (grams)
Carbohydrates	Honey, sugarcane, fruits, whole grains, starchy vegetables, rice	150-200
Proteins	Legumes, pulses, nuts, soya bean, green leafy vegetables, fish, poultry products, egg, milk and dairy products	40
Fats	Egg yolk, saturated oil, meat	35

- **Minerals:** The **macrominerals** required by the human body are calcium, phosphorus, potassium, sodium and magnesium. The **microminerals** required by the human body also called **trace elements** are sulfur, iron, chlorine, cobalt, copper, zinc, manganese, molybdenum, iodine and selenium.
- **Food Quality Control:** In 1954, the Indian Government enacted the Food Law known as Prevention of Food Adulteration Act and the Prevention of Food Adulteration Rules in 1955 with the objective of ensuring pure and wholesome food to the consumers and protect them from fraudulent trade practices.
- **FCI (Food Corporation of India)** was set up in the year 1965.

UNIT 22: WORLD OF MICROBES

■ **Bacteria :** Bacteria are microscopic, single celled prokaryotic organisms without nucleus and other cell organelles. The size varies from less than 1 to 10 μm in length and 0.2 to 1 μm micrometer in width.

■ **Shapes of bacteria:**

Based on the shapes, bacteria are grouped as:

1. Spherical shaped bacteria called as cocci (or coccus for a single cell).
2. Rod shaped bacteria called as bacilli (or bacillus for a single cell).
3. Spiral shaped bacteria called as spirilla (or spirillum for single cell).

■ **Viruses:** A simple virus particle is often called a **virion**. They grow and multiply only in living cells.

■ **Fungi:** They lack chlorophyll, hence depend on living or dead host for their nutritional needs. Fungi living on living hosts are called **parasites**, and those living on dead organic matter are called **saprophytes**. The body of the fungus is called **thallus**.

■ **Prions:** The term 'prion' was coined by Stanley B. Prusiner in 1982. Prions are **viral particles** which contain only proteins. They do not contain nucleic acid.

■ **Microbes in Agriculture:** Microbes play a vital role in the cycling of elements like carbon, nitrogen, oxygen, sulphur and phosphorus. These are called **biological scavengers**.

■ **Microbes as biocontrol agents:** Microorganisms used for controlling harmful or pathogenic organisms and pests of plants are called as biocontrol agents (Biopesticides). *Bacillus thuringiensis* (Bt) is a species of bacteria that produces a protein called as 'cry' protein. This protein is toxic to the insect larva and kills them.

■ **Microbes in Industries:**

Production of fermented beverages: Beverages like wine are produced by fermentation of grape fruits by *Saccharomyces cerevisiae*.

Curing of coffee beans, tea leaves and tobacco leaves: Beans of coffee and cocoa, leaves of tea and tobacco are fermented by the bacteria *Bacillus megaterium*. This gives the special aroma.

 **Classification of Disease based on Occurrence:**

- **Endemic:** Disease which is found in a certain geographical area affecting a fewer number
- **Sporadic:** Disease which occur occasionally. e.g. Malaria and Cholera.

 **Incubation period:** The interval between infection and first appearance of the diseases is called incubation period.

 **Malaria:** Malaria continues to be one of the major health problems of developing countries. Malaria is caused by **protozoan** parasite *Plasmodium*. It spreads through the bite of an insect vector, the female *Anopheles* mosquito which feeds on human blood and usually lasts less than 10 days. Use of Quinine drugs kills the stages of malaria parasite.

 **Dengue:** Dengue is known as break bone fever. The name break bone fever was given due to the cause of intense joint and muscle pain. Dengue fever is caused by virus. It is transmitted by ***Aedes aegypti* mosquito**.

 **Filaria:** Filariasis is a major health problem in India. This disease is caused by **nematode** worm *Wuchereria bancrofti*. The adult worms are usually found in the lymphatic system of man. It is transmitted by the bite of infected *Culex* mosquito.

 **AIDS:** Acquired Immunodeficiency Syndrome (AIDS) is caused by **retrovirus** (RNA virus) known as **Human Immunodeficiency Virus (HIV)**. The virus attacks the white blood cells or **lymphocytes** and weakens the body's immunity or self defence mechanism.

 **Immunization Schedule:**

BCG (Bacillus Calmette Guerin): This was prepared by two French workers Calmette and Guerin (1908-1921). The bacilli are weakened and used for immunization against tuberculosis.

DPT (Triple Vaccine): It is a combined vaccine for protection against Diphteria, Pertussis (whooping cough) and Tetanus.

MMR: Mumps, Measles, Rubella vaccine gives protection against viral infections.

DT: It is a dual antigen or combined antigen. It gives protection from Diphtheria and Tetanus.

TT (Tetanus Toxoid): Toxin of Tetanus bacteria.

TAB: Combined vaccine for typhoid, paratyphi A and paratyphi B.

UNIT 23: ECONOMIC BIOLOGY

- **Horticulture:** Horticulture is a branch of agriculture that deals with cultivation of fruits, vegetables, and ornamental plants. The word horticulture is derived from the latin words 'hortus' meaning garden and 'colere' meaning to cultivate. There are four main classes of horticulture: (i) Pomology (fruit farming), (ii) Olericulture (vegetable farming), (iii) Floriculture (flower farming), (iv) Landscape gardening.
- **Green Manure:** Green manure is obtained by collection and decomposition of green leaves, twigs of trees, field bunds etc. e.g. Sunhemp (*Crotalaria juncea*), Dhaincha (*Sesbania aculeata*), Sesbania (*Sesbania speciosa*).
- **Mushroom Cultivation:** Mushroom is a fungi belonging to basidiomycetes.
- **Cattle Breeds:** They belong to two different species, *Bos indicus* (Indian cows and bulls) and *Bos bubalis* (buffaloes). These cattle animals are reared for milk and farm labour. They are classified into three types: Dairy breeds, Draught (or) Draft breeds, Dual purpose breeds.
 - The dairy breeds are: **a) Indigenous breeds b) Exotic breeds**
 - Indigenous breeds are native of India. They include **Sahiwal, Red Sindhi, Deoni** and **Gir**.
 - Exotic breeds (*Bos taurus*) are imported from foreign countries. They include **Jersey, Brown Swiss** and **Holstein-Friesian** etc.

- ❖ **Freshwater prawn culture:** The rearing of freshwater prawn is called freshwater prawn culture. *Macrobrachium rosenbergii* and *Macrobrachium malcomsonii* are cultured in freshwater.

UNIT 24: ENVIRONMENTAL SCIENCE

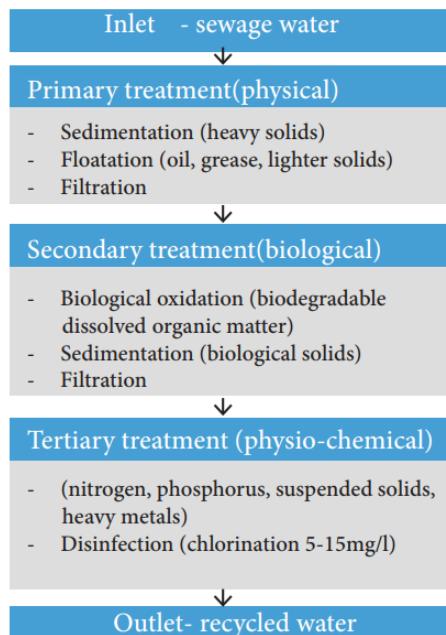
- ❖ **Nitrogen Cycle:** Atmosphere is a rich source of nitrogen and contains about 78% nitrogen.
- ❖ **Nitrogen fixation:** Nitrogen fixation is the conversion of atmospheric nitrogen, which is in inert form, to reactive compounds available to living organisms. This conversion is done by a number of bacteria and blue green algae (Cyanobacteria). Leguminous plants like pea and beans have a symbiotic relationship with nitrogen fixing bacteria **Rhizobium**. Rhizobium occur in the root nodules of leguminous plants and fixes nitrogenous compounds
- ❖ **Nitrification:** This process of nitrate formation is known as **nitrification**. The bacteria responsible for nitrification are called as nitrifying bacteria.

Table 24.1 Microorganisms involved in nitrogen cycle

Role played in nitrogen cycle	Name of the microorganisms
Nitrogen fixation	<i>Azotobacter</i> (in soil) <i>Rhizobium</i> (in root nodules) Blue green algae- <i>Nostoc</i>
Ammonification	Putrefying bacteria, Fungi
Nitrification	Nitrifying bacteria <i>i. Nitrosomonas</i> <i>ii. Nitrobacter</i>
Denitrification	Denitrifying bacteria <i>Pseudomonas</i>

- ❖ **Hydrophytes:** Plants growing in or **near water** are called hydrophytes.
- ❖ **Xerophytes:** Plants that grow in dry habitat are called **xerophytes**.
- ❖ **Mesophytes:** Mesophytes are common land plants which grow in situations that are neither too wet nor too dry. They do not need any extreme adaptations.

- ✚ **Nocturnality:** Earthworms are sensitive to light. It has no eyes but can sense light through light sensitive cells (Photoreceptors) present in their skin.



- ✚ Four of 34 globally identified biodiversity hotspots are found in India. They are:
 - The Himalayas
 - The Western ghats
 - The North-East
 - The Nicobar islands
- ✚ India became state member of IUCN in 1969, through the Ministry of Environment, Forest and Climate change(MoEFCC).

