1. Introduction

Biology – Branch of science in which living beings are studied.

Bios = Life & *Logos* = Study. Therefore study of life is called *biology*. The term *biology* was first coined by *Lamarck* and *Treviranus* in the year 1801. Biology has two main branch.

1. **Botany** : Study of different aspects of plants. *Theophrastus* is known as father of Botany.
2. **Zoology** : Study of various aspects of animals. *Aristotle* is called father of Zoology as well as Biology.

Important Terms of Biology :

- Anatomy : Study of internal structure of organism.
- Agrology : Soil science dealing specially with production of crop.
- Agronomy : Science of soil management and production of crop.
- Agrostology : Study of grass.
- Arthrology : Study of joints.
- Apiculture : Rearing of honey bee for honey.
- Anthropology : Study of origin, development and relationship between the culture of past and present human.
- Anthology : Study of flower and flowering plant.
- Angiology : Study of blood vascular system including arteries and veins.
- Andrology : Study of male reproductive organ.
- Bryology : Study of Bryophytes.
- Biometrics : Statical study of Biological problem.
- Biomedical engineering : Production and designing of spare part for overcoming various defects in man. e.g. artificial limbs, Iron lung, Pacemaker etc.
- Biotechnology : Technology concerned with living beings for wilful manipulation on molecular level.
- Bacteriology : Study of bacteria.
- Cytology : Study of cell.
- Cryobiology : It is the study of effect of low temperature on organisms and their preservation.
- Clone : Clones are geneticaly identical individual in a population.
- Cardiology : Study of heart.
- Demography : Study of population.
- Diffusion : Random movement of molecule / ion or gases from a region of higher concentration to lower concentration.
- Dermatology : Study of skin.

- Dendrochronology : Counting and analysing annual growth rings of tree to know its age.
- Ecology : Study of inter-relationship between living and their environment.
- Evolution : Study of origin of life, variation and formation of new species.
- Embryology : Study of fertilization of egg, formation of zygote and development of embryo.
- Eugenics : Study of factors connected with the improvement of human race.
- Euthenics : Study of environmental condition that contribute to the improvement of human beings.
- Euphenics : Treatment of defective in heredity through genetics engineering.
- Ethnology : Study of science dealing with different races of human.
- Ethology : Study of animal behaviour in their natured habitats.
- Etiology : Study of causative agent of disease.
- Entomology : Study of insects.
- Exobiology: Study of possibility of life in space.
- Floriculture : Cultivation of plant for flower.
- Food technology : Scientific processing, preservation, storage and transportation of food.
- Forensic science : Application of science for identification of various facts of civilian.
- Fishery : Catching, breeding, rearing and marketing of fishes.
- Forestry : Development and management of forest.
- Fermentation: Process of incomplete oxidation that occur in microbes and other cells in absence of oxygen, leading to the formation of ethyl alcohol.
- Genetics : Study of variation and transmission of heredity character from parents to their young ones.
- Growth : Permanent increase in weight, volume and size of an organism.
- Genetic Engineering : Manipulation of gene in order to improve the organism.
- Gynecology : Study of female reproductive organ.
- Gerontology : Study of ageing.
- Gastroenterology : Study of alimentary canal or stomach, intestine and their disease.
- Hypertonic : When two solution have differcut sdute concentration. The sol at ion which have higher concentration is called hypertonic.
- Hypotonic : In two solutions which have lower solute concentration is called hypotonic

- Homeothermic : Animals who have constant body temperature are called home thermic or warmblooded animal.
- Histology : Study of tissue organisation and their internal structure with the help of microscope.
- Hygiene : Science taking care of health.
- Hydroponics : Study of growing plant without soil in water which contain nutrient.
- Haematology : Study of blood.
- Hepatology : Study of liver.
- Ichthyology : Study of fishes.
- Immunology : Study of immun system or resistance of body to disease.
- Kalology : Study of human beauty.
- Metazoans : All multicellular animals are called metazoans.
- Monoecious : Plant which have both male and female flower
- Morphology : Study of external structure.
- Microbiology : Study of micro-organism like virus, bacteria, algae, fungi and protozoa.
- Molecular biology : Study of molecule found in the body of living organism.
- Medicine : Study of treating disease by drug.
- Mammography : Branch of science which deal test of breast cancer.
- Mycology : Study of fungi.
- Nutrients : Chemical substance taken as food which are necessary for various function, growth and heath of living.
- Neurology : Study of nervous system.
- Neonatology : Study of new born.
- Nephrology : Study of kidneys.
- Osmosis : Movement of water molecule across semipermeable membrane from the region of its higher concentration to the region of lower communication.
- Odontology : Study of teeth and gum.
- Osteology : Study of bones.
- Oncology : Study of cancer and tumours.
- Obstetrics : Science related with care of pregnant women before, during and after child birth.
- Ornithology : Study of birds.
- Ophthalmology : Study of eyes.
- Orthopaedics : Diagnosis and repair of disorder of locomotery system.
- Phytoplanlktons : Microscopic organism which passively float on the surface of water.
- Parasite : Organism which depend on other living organism for their food and shelter.

- Poikilothermic : Organism which change their body temperature according to surrounding. These are also called cold blooded animal.
- Pigment : A substance which absorb light of certain wavelength like chlorophyll found in green leaves.
- Paleontology : Study of fossils.
- Physiology : Study of function of various system of organism.
- Pathology : Study of diseases, effects, causable agents and transmission of pathogens.
- Pomology : Study of fruit and fruit yielding plant.
- Psychiatry : Treatment of mental disease.
- Psychology : Study of human mind and behavior.
- Pisciculture : Rearing of fishes.
- Phycology : Study of algae.
- Paediatrics : Branch of medicine dealing with children.
- Parasitology : Study of parasites.
- Photobiology : Effect of light on various biological processes.
- Phylogeny : Evolutionary history of organism.
- Physiotherapy : Treatment of body defects through massage and exercise.
- Radiology : Science dealing with the effect of radiation on living beings.
- Rhinology : Study of nose and olfactory organs.
- Sonography : Study of ultrasound imaging.
- Saurology : Study of lizards.
- Serology : Study of serum, interaction of antigen and antibodies in the blood.
- Sphygmology : Study of pulse and arterial pressure.
- Taxonomy : Study of classification, nomenclature and identification of organism.
- Telepathy : Communication of thoughts or ideas from one mind to another without normal use of senses. In other word this is the process of mental contact.
- Veterinary Science : Science of health care and treatment of domestic animals.

2. What is living ?

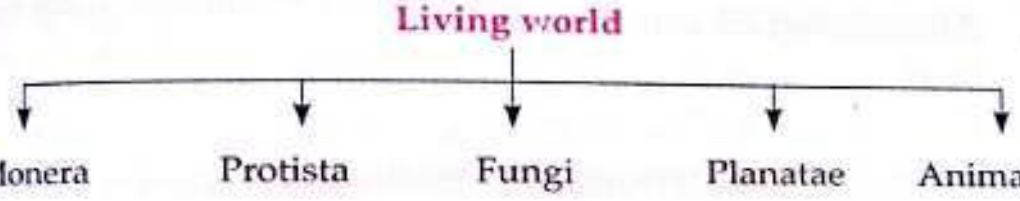
- The word living cannot be defined.
- There are certain characters by which can be distinguished from non living.
  - (i) Growth : Increase in the number of cell or mass is called growth
  - (ii) Reproduction : Living organism produce young ones of their same kind.
  - (iii) metabolism : Chemical reaction occurring inside a living cell.
  - (iv) Response of stimuli : Living have the ability to sense the condition of their surrounding and respond to these stimuli

3. Classification of Organism

- There are millions of organisms. It is impossible to study each individual separately. Classification means to categories organism into different groups. Study of an individual of a group gives us the idea of rest of the member of that group.
- *Linnaeus* divide all organism into two kingdoms - *Planate* and *Animalia* in his book "*System a Nature*". The foundation of modern classification system was laid in the line of classification system started by *Linnaeus*. Therefore *Linnaeus* is called '*Father of Taxonomy*'. Due to disputed position of organism like bacteria, virus, fungi and euglena, there is a need of reconsideration of system of classification.

Five Kingdom Classification

- Five Kingdom Classification was proposed in 1969 by *R.H. Whittaker*. The criteria of classifying organism into five kingdoms are its *complexity of cell structure, complexity of body of organism, mode of nutrition, life style and phylogenetic relationship.*



1. Monera: It includes all prokaryotic organism like bacteria, cynobacteria and archiobactera. Filamentous bacteria also come under this kingdom. All organism of this kingdom are microscopic.

2. Protista : This kingdom includes unicellular form usually found in aquatic habitats. On the basis of mode of nutrition they are autotrophic, parasitic, and saprophytic. Diatoms flagellates and protozoa come under this kingdom. *Euglena* have both heterotrophic and autotrophic mode of nutrition. So, it is placed between plant and animal.

3. Fungi : This kingdom includes non-green plants. It has saprophytic nutrition and growing on dead and decaying organic matter. The cell wall is composed of chitin. Example : *Mushroom, Mucor, Albugo* etc.

4. Planatae : This kingdom includes all plants except some algae, diatoms, fungi and member of monera and protista.

5. Animalia : Almost all animal comes under this kingdom except protozoan.

- **Binomial nomenclature** : There was the need of uniform international naming of organism. In biology every organism is given two proper names. The first name is *genus* name always started with capital letter and the second name is *species* started with small letter. For example scientific name of human is *Homo sapiens*. Homo is the name of genus, whose one species is sapiens.

Scientific Names of some Organisms

Man	*Homo sapiens*	Frog	*Rana tigrina*
Cat	*Felis domestica*	Dog	*Canis familaris*

Cow	*Bos indicus*	Housefly	*Musca domestica*
Mango	*Mangifera indica*	Rice	*Oryza sativa*
Wheat	*Triticum aestivum*	Pea	*Pisum sativum*
Gram	*Cicer arietinum*	Mustard	*Brassica campestris*

4. Study of Cell

- **Cell** : Cell is the basic structural and functional unit of life.
- The word '*cell*' was first coined by British scientist *Robert Hook* in the year 1665.
- The smallest cell is *Mycoplasma gallisepticum*.
- The longest cell is *Neuron*.
- The biggest cell is *egg of Ostrich*.
- Schilden and Schwan established cell theory in the year 1838-39.

Main features of the cell theory :

1. All organism are composed of cell.
2. Body of every organism is made of cell.
3. Each cell arises from pre-existing cell.
4. Every organism starts its life from single cell.

Cell is of two kinds

1. Prokaryotic cell : These are primitive cell having three basic structure of typical cell but lack nuclear membrane. Nuclear material is present in a region of cytoplasm called nucleoid. Other membrane bound organelles are absent such as mitochondria, ribosome, golgi bodies etc. Ex.- Virus, bacteria and cynobacteria are Prokaryotes.

2. Eukaryotic cell : These are complete cell which contain membrane bound organelles and nucleus. Unicellular and multicellular plant and animal have Eurkaryotic cell.

Difference between Prokaryotes and Eukaryotes

Prokaryotes	Eukaryotes
1. Size of cell is generally small.	1. Size of cell is generally large.
2. Nucleus absent.	2. Nucleus present.
3. It contain single chromosome which is circular in shape.	3. It contains more than one chromosome
4. Membrane bound cell organelles are absent.	4. Cell organelles present.
5. Cell division takes place by fission or budding.	5. Cell division takes place by mitosis and meiosis.

- **Structure of typical cell** : A cell have following structure.

1. Cell wall : In plant cell there is a rigid cell wall which is non living and freely permeable. It is made up of cellulose and chitin. It provide shape and rigidity to the cell.

2. **Cell membrane** : It is also known as *plasma membrane* which form the outer covering of animal cell. In plant cell it is found within cell wall. It is thin, elastic, living, double layer, permeable membrane. It is made up of phospholipid molecules.

Function : It regulates movement of molecules inside and outside of the cell.

3. **Protoplasm** : The whole fluid present inside plasma-membrane is protoplasm. The name protoplasm is given by *Purkenje* in 1839. Protoplasm is made up of various chemical substances like water, ions, salt and organic molecule. It is the living part of cell. Protoplasm is divided into two parts.

A. Cytoplasm : The fluid found outside the nuclear membrane.

B. Nucleoplasm : The fluid found inside the nuclear membrane.

4. **Mitochondria** : Discovered by *Altman* in the year 1886. These are cylindrical, rod shaped or spherical structure found in cytoplasm. It is surrounded by double layered membrane. Inner membrane has many fold called *cristae*. The fluid present inside mitochondria is called *matrix*, which contain many enzyme and co-enzyme.

Function : Mitochondria is the respiratory site of cellular respiration. Mitochondria synthesize energy rich compound ATP. It is also known as "Power Hosue" of the cell.

5. **Golgi bodies** : Discovered by scientist *Camilo Golgi*. Golgi bodies are made up of group of tubes, vesicles and vacuoles. In plant it is more in number and here it is known as dictyosomes.

Function : It work as storage, processing and packaging of material. It also involved in the synthesis of cell wall, plasma membrane and lysosomes.

6. **Endoplasmic reticulum** : Membranous network of tubules like structure found in cytoplasm is called *endoplasmic reticulum*. It is attached with the nucleus on one side and on other side it is joined with plasma membrane.

Function : Endoplasmic reticulum helps in the distribution of material. It forms supporting framework of cell.

7. **Ribosome** : Discovered by *Palade*. Small granules like structure found attached to the endoplasmic reticulum or in free state.It is made up of ribonucleic acid. (RNA)

Function : Take part in protein synthesis.

8. **Lysosome** : Discovered by *De Duve*. These are sac like structure bounded by single membrane and contain hydrolytic enzyme.

Function : It helps in intracellular digestion. The enzyme found in lysosome may digest the entire cell. So it is also known as suicidal bag.

9. **Centrosome** : Discovered by *Boveri*. It is only found in animal cell taking part in cell division. It is not bounded by membrane consist of two centriole.

Function : Help in the formation of spindle fibre during cell division.

10. **Plastid** : Only found in plant cell. It is of three type : (a) Chloroplast (b) Chromoplast (c) Leucoplast.

(a) Chloroplasts : These are green pigment found in green plant involve in photosynthesis. So, it is known as '*Kitchen of the cell*'. Chloroplast is bounded by two unit membrane having grana and stroma. Grana are membrane bounded sac like structure found in stacks containing chlorophyll molecule. Stroma is the matrix present inside the chloroplast which contain photosynthetic enzymes and starch grain. Granum is the site of light reaction during photosynthesis while stroma is the site of dark reaction.

Function : Chloroplast provides green colour to plant & take part in photosynthesis.

(b) Chromoplast provides various colours to the plant.

(c) Leucoplast is colourless. It stores the food in the form of starch, fat & protein.

11. Vacoule : These are fluid filled single membrane bounded, dead organelles of cell. In plant cell it is larger in size but in animal it is smaller in size.

Function : It helps in osmoregulation. It stores toxic metabolic waste.

12. Nucleus : The nucleus is a spherical, centrally located is a major structure found in the cell. In plant cell it is shifted towards periphery. It is bounded by double layered nuclear membrane having pore. Within nucleoplasm nucleolus and chromatin material is present. Nucleolus is rich in protein and RNA. Chromatin material is thin thread like structure forming network. This is made up of genetic substance DNA (deoxyribo nucleic acid) and histone protein. During cell division chromatin breaks into pieces and forms chromosome.

Function : It controls all the activity of cells. So it is also known as "control room "of cell. Chromatin transmits hereditary characters from parents to their offspring.

Difference between Plant and Animal cells

Plant cell	Animal Cell
1. Plant cells are larger in size.	1. Animal cells are generally smaller in size.
2. Cell wall present, made up of cellulose and chitin.	2. Cell wall absent.
3. Plastid present.	3. Plastid absent.
4. Centrosome absent.	4. Centrosome present.
5. Vacuoles are larger in size	5. Vacoules are smaller in size.

Chromosome

➢ Chromosome is thread like structure found in the nucleus. It becomes visible during cell division. Each chromosome is made up of two chromatids joined together at a point centromere. Bead like structure found on chromosome is called *gene*. Genes are made up of DNA (deoxyribo nucleic acid) which is the carrier of genetic information from generation to generation. In some viruses RNA is the genetic material called *rietrovirus*. In prokaryotes there is only one chromosome, like bacteria and viruses.

➢ Eukaryotic cell posses many chromosome. A particular kind of species have definite number of chromosome in their cell, which are in pair known as *diploid*. The set of unpaired chromosome is called *haploid*. Gametes have haploid set of chromosome.

Number of chromosome in different organism

Pegion	40 pairs	Dog	39 pairs	Horse	32 pairs
Chimpanzee	24 pairs	Human	23 pairs	Wheat	21 pairs
Cat	19 pairs	Frog	13 pairs	Tomato	12 pairs
Onion	8 pairs	Pea	7 pairs	Ascaris	1 pairs

➢ **Nucleic Acid :** Nucleic acid is complex organic compound found in cell. It contains special genetic instruction in coded form. Nucleic acids are of two kinds.

A. Deoxyribo nucleic Acid (DNA) : *Frederic Meischer* was the first who isolated DNA from the nucleus of pus cells. DNA is a macromolecule in which large number of nucleotides are present. Chemically a nucleotide has three components. (1) Nitrogen base (2) Sugar (3) Phosphate group.

➢ Nitrogen base are of two type—*Purines* & *Pyrimidines*. Purines contain two nitrogen base—*Adinine* and *Guanine*. Pyrimidine nitrogen base are *Thymine* and *Cytosine*. Thus there are four kinds of nucleotides present in DNA.

Watson and *Crick* give the structural model of DNA —

1. DNA molecule is consists of two polynucleotide strand, forming a *double helix*. Each strand has a backbone of sugar and phosphate. Nitrogen base is attached to the sugar.

2. Nitrogenous base of the two strands of a double helix form a pair with the help of hydrogen bonds. Adenine pairs with thymine where as guanine pairs with cytosine. Adenine and thymine are complementary to each other and cytosine is complementary to guanine. Hydrogen bonding between nitrogenous base holds the two strands together. This structure can be compared with the steps of spiral staircase.

Function : 1. It contain genetic information in coded form.
2. DNA synthesise RNA.

Note : *DNA is mainly found in nucleus. In small amount it is also found in mitochondria and chloroplast.*

Gene : Gene is hereditary unit which is made by a segment of DNA found on the chromosome.

B. Ribonucleic Acid (RNA) : RNA is single stranded nucleic acid made up of phosphate, ribose sugar and nitrogen base uracil, adinine, guanine and cytosine. It is found in nucleus as well as cytoplasm.

RNA is of three kind.

1. Messenger RNA (*m*RNA) : It brings the massage from DNA found in the nucleus to cytoplasm in the coded form.
2. Ribosomal RNA (*r*RNA) : Present in ribosome which is the site of Protein synthesis.

3. Transfer RNA (*t* RNA) : It is the carrier of amino acid and transfer it to the ribosome.

Function : Synthesis of protein.

Difference between RNA and DNA

DNA	RNA
1. Sugar is deoxyribose type.	1. Sugar is ribose type.
2. It contains the base adenine, thymine and cytosine and guanine.	2. It contains uracil in place of thymine.
3. It is double stranded structure.	3. It is single stranded structure.
4. It is mainly found in nucleus.	4. It is found in both nucleus and cytoplasm.

➢ **Cell cycle** : It is the sequence of events in which cell duplicates its genetic material, synthesise the other constituents of cell and ultimately divide into two daughter cell.

➢ **Cell Division** : The process in which cell increase in their number is cell division. It is needed for growth, development and repair of body. There are mainly two kind of cell division.

A. Mitosis : Mitosis cell division occur in somatic cell which take part in growth, repair and development. In unicellular organism asexual reproduction takes place by this type of cell division.

➢ **Significance of Mitosis** : 1. After Mitosis cell division one cell divided into two daughter cell in which number of chromosome is equal to the parent cell.

2. Uncontrolled Mitosis may cause tumor or cancerous growth.

B. Meiosis : 1. Meiosis cell division occur in reproductive cell. This type of division takes place during the formation of haploid gamete. i.e. ova & sperm.

2. It is also known as *reduction division* during which each daughter cell have haploid number of chromosome.

3. Four daughter cells are produced from one meiotic cell division.

Terms related to cytology :

➢ Karyokinesis : Division of nucleus during cell division called *Karyokinesis.*

➢ Cytokinesis : Division of cytoplasm called *cytokinesis.*

➢ Diploid : Two complete set of chromosome is called *diploid,* found in somatic cell.

➢ Haploid : Single set of chromosome in cell is called *haploid* found in gametes.

➢ Crossing over : Exchange of genetic material between two non sister chromatids takes place during meiosis cell division is called *crossing over.*

➢ Homologous chromosome : A pair of chromosome having same size and shape bearing corresponding gene.

- Phenotype : The character of organism which can be seen directly.
- Genotype : Genetic constitution of organism is called genotype.
- Tonoplast : The membrane surrounding the vacuole.
- Unit membrane : The basic trilamilar structure of cell membrane.

5. Genetics

The process of transfer of hereditry character from one generation to next generation is called *Genetics*. *Johan Mendel* is known as *father of genetics*. Mendel experiments were based on cross breeding of two pea plant having contrasting characters for same feature i.e. tall and dwarf character of plant are for height of plant. He extended his work by two or three pair of contrasting characters called *dihybrid* and *trihybrid cross*. He concludes some result on the basis of his experiment called *Mendel's law*.

1. Law of paired unit : Mendel proposed that when two dissimilar unit factors are present in an individual only one is able to express. One that expresses itself is *dominant unit factor* while other which fails to express is *recessive unit factor*. For example tallness is dominant over dwarfness.

2. Law of dominance : Offspring of cross breed parent only show dominant characters in F_1 generation.

3. Law of segregation : In F_2 generation both the character which is governed by gene is separated.

4. Law of independent assortment : During dihybrid and tribhybrid cross two or three pair of characters are taken. These characters segregate separately without depending on other in F_2 generation.

Term related to genetics :

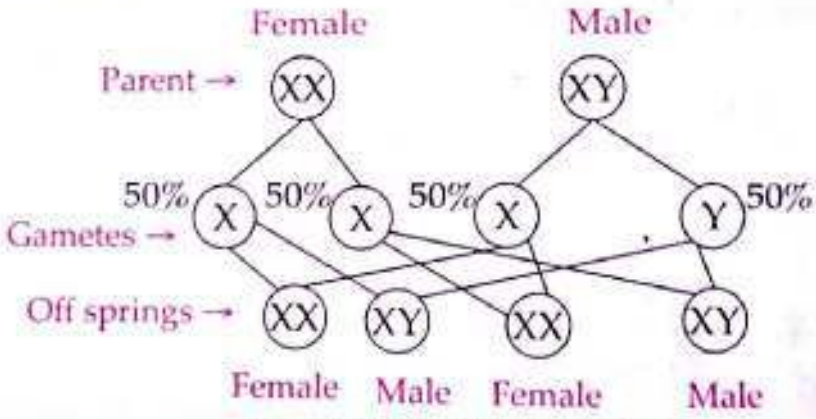
- Linkage : Linkage is an exception of Mendel law. When two different gene are present on the same chromosome their effects take place together insted of independently. This phenonmenon is known as *Linkage*. The word linkage first coined by *Morgan*.
- Mutation : A sudden change in the gene which is heritable from one generation to other. The term Mutation was first coined by *Hugo de Vries*.
- Variation : When characters are transmitted from one generation to next generation there is some change. Change in characters by recombination of gene in offspring takes place they looks different from their parents. This phenomenon is known as *Variation*.
- Chromosomal aberrations : Any change in chromosomal structure is known as *Chromosomal aberrations*.
- Cloning : It is a process of producing many identical organism from a single cell having same genetic character as his mother. Ex : *Sheep Dolly* was produced from single cell.
- Totipotency : It is the potential ability of a plant cell to grow into a complete plant.
- Pluriopotency : It is the potential ability of a cell to develop any kind of the cell of animal body.

- Genetically modified organism (GMO): Manipulation of gene by cutting or joining the segment of DNA to get desired varieties of organism is called *genetically modified organism*. This is also known as *genetic engineering*.
- Autosomes : Chromosomes found in cell which are responsible for characters other than sex are called *autosomes*.
- Sex Chromosome : The pair of chromosome which determine the sex of organism is called *sex-chromosome*.

  Human have 23 pair of chromosome in which 22 pair are autosome and 1 pair is sex chromosome.
- Genome : All gene present in a haploid cell is called *genome*.

6. Sex Determination in Human

In human male sex chromosome is 'XY', where as in female sex chromosome is XX. During gamete formation in male half of the sperm contain 'X' chromosome while other half contain 'Y' Chromosome. In female all gametes contain only one type of chromosome that is 'X'. Thus when a male gamete i.e. sperm carrying 'X' chromosome fertilize an ova, the zygote develop into female. When a sperm carrying 'Y' chromosome fertilizes an egg, zygote develops into male.



Sex determination in human

Sometime sex determination is regulated by environmental factor. In some reptiles temperature determine the sex at which the fertilized egg is incubated.

In human each cell contains 46 chromosomes. Any addition or removal in the number of sex chromosome or autosome cause genetic disorder.

1. KlinefelterSyndrome: When a male have an extra X or Y chromosome in sex chromosome then the condition will be XXY or XYY instead of XY. The individual with this syndrome have masculine development but feminine development is not completely suppressed and the individual became sterile.

In female when extra X chromosome is present instead of XX they show normal development but limited fertility. Mental retardness is also seen in this type of syndrome. Number of chromosome became 47 instead of 46.

2. Turner's Syndrome : When female has single sex chromosome (XO) their ovaries are rudimentary, lack of secondary sexual character.

3. Down's Syndrome : When an extra chromosome is added to 21st autosomal chromosomes this lead to develop Down's syndrome. In this syndrome person became Mangolism. The person is mentally retarded, eyes protruded an irregular physical structure is present.

4. Patau's Syndrome : This type of syndrome is develop by an addition of autosomal chromosome in 13th chromosome. There is a cut mark in the lip and person is mentally retarded. Discase due to change in gentical constituent of chromosome.

1. Sickle Cell Anaemia : In this disorder erythrocytes destroyed more rapidly than normal leading to anaemia. These occur due to change in 11th autosomal chromosome.

2. Phenylketonuria : It is an inborn error of metabolism which result in mental retardation cause due to change in 12th autosomal chromosomes.

3. Haemophilia : Gene responsible for this disorder is linked with sex chromosomes. This disease lead to failure of blood clotting.

4. Colour blindness : This disorder lead to failure to distinugished red & green colour. The gene responsible for this disease is situated on sex chromosomes.

Number of Chromosomes in Different Organisms :

Pigeon	80	Dog	78	Horse	64
Chimpanzee	48	Potato	48	Human	46
Rabbit	44	Wheat	42	Cat	38
Frog	26	Tomato	24	Pea	14
House-fly	12	Mosquito	6	Ascaris	2

7. Organic Evolution

More and more creation of organism by gradual changes from low categories animal to higher animal is called *organic evolution*. There are several evidence regarding organic evolution.

- Homologous organ : Organ which are seen different due to use in various function but its structure and embryonic development are similar. Ex – *Flipper of whale, feather of bat, forelimb of horse, Paw of cat,* and *hands of human.*
- Analogous organ : Organ which looks similar due to be used in similar function but their internal structure and embryonic development are different. Ex – *Feather of butterfly, bats* and *birds* all looks similar but their internal structure and origin are different.
- Vestigial organ : These are organs which appear functionless in an organis.n but functional in their ancestor. For example *vermiform appendix of large intestine* and *nictitating membrane of human.* Vermiform appendix is functional in herbivorous mammal even now.
- Fossils – Fossils are the remains of ancient plant or animal which provide evidences for evolution. Example–Archaeoptery.
- Archaeopteryx : It is a fossils look like bird but bear a number of features found in reptiles. So, it is a connecting link between aves and reptile.

Theories of evolution

1. **Carolus Linnaeus** (1707 – 1778) contribution to classification provide an evolutionary relationship among the organism. He was also supported an idea that no species is new. Each and every species originates from some pre-existing species.

2. **Jean Baptist Lamarck** (1744 – 1829) tried to explain the evolutionary process in his book *Philosophic zoologique*. The theory proposed by Lamark is known as *theory of inheritance of acquired characters*. According to this theory use and disuse of an organ lead to acquiring change in the features of that organ. These changes are also inherited to offspring. The favourable changes after long period of time result in evolution of new species. But Lamarckism was very strongly criticised by *August Weismann*.

3. **Charles Robert Darwin** (1809 – 1882) explain the evolutionary principle in his book '*The origin of species*'. The theory proposed by him is popularly known as '*Theory of natural selection*' or *Darwinism*. Darwin explained that despite having the enormous potential of fertility, the population of organism remains within a limit. It is due to struggle between members of same species and different species for food, space and mate. Struggle eliminates the unfit individual. The fit organism possess some variations which are favourable and they can leave the progeny to continue the favourable variation. The variation when accumalated for long time give rise to origin of new species with progress in genetics, the sources of variation were explained and Darwin's theory was modified. Now the most excepted theory of evolution is *Modern synthetic theory*, in which origin of species is based on the interaction of genetic variation and natural selection.

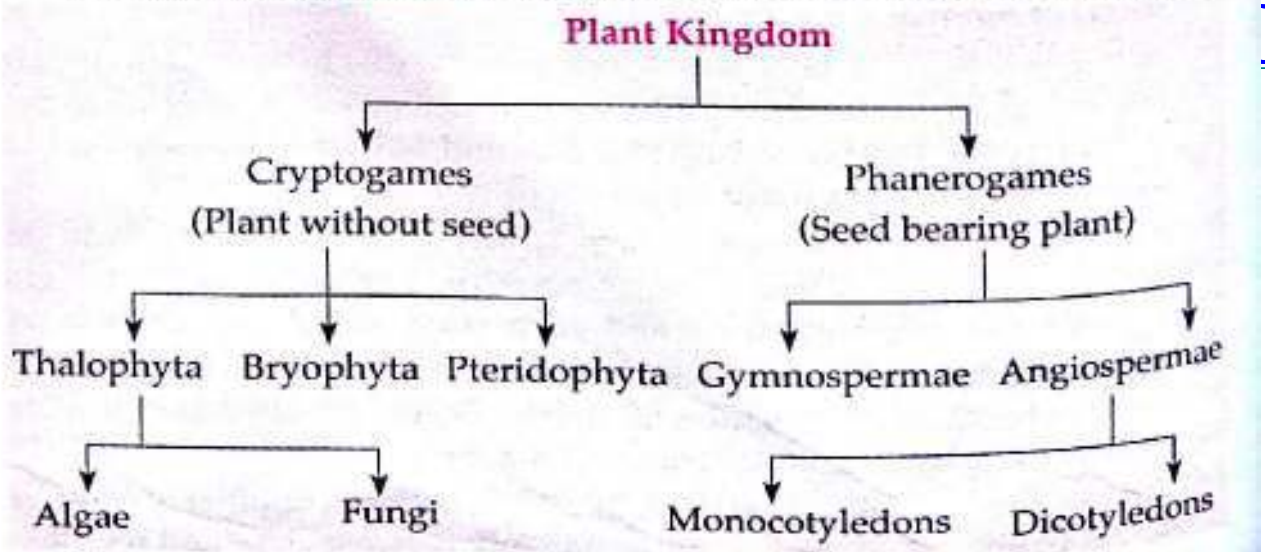
BOTANY

The study of different types of Trees, plants is called *Botany*.

Theophrastus is called the *father of Botany*.

1. Classification of Plantae

In the year 1883, **Eichler** has classified the Botanical world as under:-



I. Cryptogamus plants

There is no flower and seed in these type of plants. These are classified into the following groups:

Thalophyta :

1. This is the largest group of the plant kingdom.
2. The body of the plants in this group is thalus like i.e., plant are not differentiated into root, stem and leaves etc.
3. There is no conducting tissue. It is divided into two groups.
   (a) Algae and (b) Fungi

(a) Algae

1. The study of algae is called *Phycology.*
2. The algae normally have *chlorophyll* and *autrotrophic* mode of nutrition.
3. Its body is thalus like. It may be *unicellular, colonial* or *filamentous.*

Useful Algae :

1. As a food : *Porphyra, Ulva, Surgassum, Laeminaria, Nostoc* etc.
2. In making Iodine : *Laeminaria, Fucus, Echlonia* etc.
3. As a manure : *Nostoc, Anabina, kelp* etc.
4. In making medicines : *Chloreloline* from *Chlorella* and *Tincher iodine* is made from *Laminaria.*
5. In research works : *Chlorella Acitabularia, Belonia* etc.

Note : *An astronaut can get protein food, water and oxygen by sowing the chlorella algae in the tank of the aircraft so chlorella is known as space algae.*

(b) Fungi

1. Study of fungi is called *Mycology.*
2. Fungi is chlorophyll less, central carrier tissue less, Thalophyte.
3. Accumulated food in fungi remains as *Glycogen.*
4. Its cell wall is made up of *chitin.* Ex. Albugo, Phytophthora Mucor etc.

Fungi may creates serious diseases in plants. Most damage is caused by rust and smut. Main Fungal diseases in plants are as :

White rust of crucifer, Loose smut of wheat, Rust of wheat, early Blight of potato, Red rot of sugarcane, Tikka diseases of ground nut, Wart disease of potato, Brown leaf spot of rice, Late blight of potato, Damping off of seedlings etc.

Bryophyta

This is the first group of land plants. In this division approximately 25000 species are included.

1. In byophyta there is lack of Xylem and phloem tissue.
2. Plant body may be of thallus like and leafy erect structure as in moss.
3. They lack true roots, Stem and leaves.
4. This community is also called *Amphibian category of the plant kingdom.*

The moss namely Sphagnum is capable of soaking water 18 times of its own weight. Therefore, gardeners use it to protect from drying while taking the plants from one place to another.

The Sphagnum moss is used as fuel.

The Sphagnum moss is also used as antiseptic.

Pteridophyta

The plants of this group are mostly found in wet shady places, forests and mountains.

1. The body of plants are differentiated into root, stem, and leaves. Stem remains as normal rhizome.
2. Reproduction occurs by spores produced inside the sporangia.
3. Gametophytic phase is short lived. The diploid zygote develops into an embryo.
4. Plants of this community have conducting tissues. But Xylem does not contain Vessels and Phloem does not contain companion cells.

Examples : *Ferns, Azolla, Pteridium, Lycopodium* etc.

II. Phanerogamus or Floral plant

The plants in this group are well developed. All the plants in this group have flowers, fruits and seeds. The plants in this group can be classified into two sub-groups – *Gymnosperm* and *Angiosperm.*

(A) Gymnosperm

1. These plants are in the forms of trees and bushes. Plant body are differentiated into root, stem & leaves.
2. Plants are woody, perennial and tall. Plant bear naked seed.
3. Its tap roots are well developed.
4. Pollination takes place through air.

The longest plant of the Plant kingdom, *Sequoia gigentia* comes under it. Its height is 120 meters. This is also called *Red Wood of California.*

- The smallest plant is *Zaimia Pygmia.*
- Living fossils are *Cycas, Ginkgo, biloba* and *Metasequoia.*
- *Ginkgo biloba* is also called *Maiden hair tree.*
- Ovules and Antherzoids of *Cycas* is the largest in Plant kingdom.

The pollen grains of Pinus are so much in number that later it turns into Sulphur showers.

Importance of Gymnosperm

1. *As a food* – Sago is made by extracting the juice from the stems of Cycas. Therefore, Cycas is called *Sago-palm.*
2. *Wood* – The wood of Pine, Sequoia, Deodar, Spruce etc. is used for making furniture.
3. *Vapour oil* – We get Tarpin oil from the trees of Pine, Cedrus oil from Deodar tree and Cedcast oil from Juniperous wood.
4. *Tannin* - It is useful in tanning and making ink.
5. *Resin* – Resin is extracted from some conical plants which are used in making varnish, polish, paint etc.

(B) Angiosperm

1. In the plants of this sub-group seeds are found inside the fruits.
2. In there plants root, leaves, flowers, fruits and seeds are fully developed.

In the plants of this sub-group there is seed-coat in seeds. On the basis of number of cotyledons plants are divided into two categories –

1. *Monocotyledon* and (2) *Dicotyledon*

Monocotyledon plants : Those plants which have only one cotyledon in seed. Example :

Name of category	Name of main plants
1. *Liliaceae*	Garlic, Onion etc.
2. *Palmae*	Nut, Palm, Coconut, Date etc.
3. *Graminaeceae*	Wheat, Maize, Bamboo, Sugarcane, Rice, Bajra Oat etc.

Dicotyledons plants : Those plants which have two cotyledon in its seed are called dicotyledons. Example :

Name of category	Name of main plants
1. *Cruciferae*	Radish, Turnip, Mustard etc.
2. *Malvaceae*	Jute, Lady's finger
3. *Leguminaceae*	Babool, Lajwanti, Ashok, Tamarind and all the Pulse crops.
4. *Composite*	Sunflower, Marigold, Lily etc.
5. *Rutaceae*	Lemon, Orange etc.
6. *Cucurbitaceae*	Melon, Water melon, Guard, Bitter etc.
7. *Solanaceae*	Potato, Chilly, Brinjal, Belladonna, Tomato etc.
8. *Rosaceae*	Strawberry, Apple, Almond etc.

Virus

- Study of virus is virology.
- Virus was discovered by Russian scientist *Ivanovsky* in the year 1892. (During the tests of Mosaic disease on tobacco).
- In nature, there are ultra microscopic particle known as viruses. Virus are connecting a link between living & non living.
- It has both the characters of living and non living, so it is a connecting link between living & non living.

Characters of virus

1. They became active inside a living cells.
2. Nucleic acids replicate themselves and they reproduce rapidly.
3. They cause disease like bacteria & fungi.

According to parasitic nature, virus is of three types –

1. *Plant virus* – RNA is present as its nucleic acid.
2. *Animal virus* – DNA or sometimes RNA is found in it.
3. *Bacteriophage*–They depend only on bacteria. They kill the bacteria. DNA is found in them. *Example* – T-2 phage.

➢ In man virus cause disease like mumps, chicken pox, hepatitis, palio, AIDs and Herpes.

➢ **Bacteriophages** : Bacteriophages are those virus which infect the bacteria. Example —Tobacco mosaic virus.

Note : *Those viruses in which RNA substance is found as genetic material are called Retrovirus.*

Bacteria

It was discovered by Antony von Lecuwenhoek of Holland in the year 1683.

➢ *Lecuwenhoek* is called the *father of Bacteriology*.

In the year 1829 *Ehrenberg* called it bacteria.

➢ The year 1843-1892 – Robert Koch discovered the bacteria of Tuberculosis diseases.

➢ The year 1812-1892 – *Louis Pasteur* discovered the vaccine of Rabies and pasteurization of milk.

On the basis of shape, bacteria is of different types :

1. Bacillus : This is rod-like or cylindrical.
2. Round or Cocus : These are round and the smallest bacteria.
3. Comma shaped or Vibrio : Like the English sign (,), example – *Vibrio cholerae* etc.
4. Spirillum : Spring or screw shaped.

➢ Some species of *Azotobacter, Azospirillum* and *Clostridium* bacteria live freely in the soil and fix atmospheric nitrogen into the nitrogenous compound.

Anabaena and *Nostoc cynobacteria* fix atmospheric nitrogen into soil.

➢ The species of *Rhizobium* and *Bradyrhizobium* etc. bacteria live in the roots of the Leguminous plants capable of converting atmospheric nitrogen into its compound.

Note : *To preserve the milk for many days pasteurization is done. There are two methods of pasteurization –*

(a) Low temperature holding method (LTH) : Milk is boiled at 62.8 degree Celsius for 30 minutes.

(b) High Temperature short time method (HTSt) : Milk is boiled at 71.7 degree Celsius for 15 seconds.

➢ In leather industry separation of hair and fat from leather is done by bacteria. This is called *tanning of leather.*

➢ Pickles, syrup is kept in salt or in dense liquid of sugar so that in case of bacterial attack bacteria are plasmolysed and destroyed. Therefore, pickles etc. do not get spoiled soon and can be preserved for long time.

➢ In the Cold Storage objects are kept at low temperature (-10 degree Celsius to -18 degree Celsius).

➢ **Mycoplasma** : Smallest known prokaryotic cell causing pleuropneumonia. It is also known as PPLO

2. Plant Morphology

➢ Morphology : The study of forms and features of different parts of plants like roots, stems, leaves, flowers, fruits etc. is called *Morphology*.

Root

Root is the descending part of the plant which develops from *radicle*.

Root generally grows in the soil away from light.

Roots are of two types—

(i) *Tap root* and (ii) *Adventitious root*.

Modification of Tap roots are :

1. *Conical* – like Carrot
2. *Napiform* – like Turnip, beet etc.
3. *Fusiform* – like Radish.

Stem

This is the part of a plant which grows towards light.

It develops from *plumule*.

The modification of stems are as under –

Underground stem

1. *Tuber* – like Potato.
2. *Corm* – like Colocasia, Saffron etc.
3. *Bulb* – like Onion, Garlic etc.
4. *Rhizome* – like Turmeric, Ginger etc.

Leaf

It is green. Its main function is to make food through photosynthesis.

Flower

This is the reproductive part of the plant.

In the flower *Calyx, Corolla, Androecium* and *Gynoecium* are found. Out of these androecium is male sex organ and the Gynoecium is female sex organ.

➢ Androecium : Unit of androcium is stamen there is one or more stamens in the androecium. Pollen grains are found in anther.

➢ Gynoecium : Unit of gynoecium is *carpel*. There are three parts of carpel – (i) *Ovary*, (ii) *Style* and (iii) *Stigma*.

➢ Pollination : After maturation of Anther, the process of reaching of pollen grains to stigma is called *pollination*. Pollination is of two types – (i) *Self-pollination* (ii) *Cross-pollination*

➢ Fertilization : Pollen tube reaches the egg cell after entering into the ovule through a pore called *micryopyle*. After that a male nucleus fuse with egg-cell. This is called *fertilization*. Fertilized egg is called *zygote*.

In angiosperm, the fertilization is triple fusion whereas in other category of plants it is double fusion.

➢ Parthenocarpy : In some plants fruits are developed from ovary without fertilization. This type of fruit is called *parthenocarpy*. Normally these types of fruits are seedless. Example – Banana, Papaya, Orange, Grapes, Pine-apple etc.

Formation of fruits

Fruit is a matured or ripened ovary developed after fertilization.

Formation of fruit takes place from ovary.

Fruits are divided into three types –

1. *Simple fruits* – like Banana, Guava etc.
2. *Aggregate fruit* – Strawberry, Custard apple etc.
3. *Composite fruit* – Jackfruit, Mulbery etc.

In the development of some fruits, Calyx, Corolla and thalmus takes part. These types of fruits are called *False fruits*. Example – Apple, Jackfruit, pear etc.

Some fruits and their edible parts

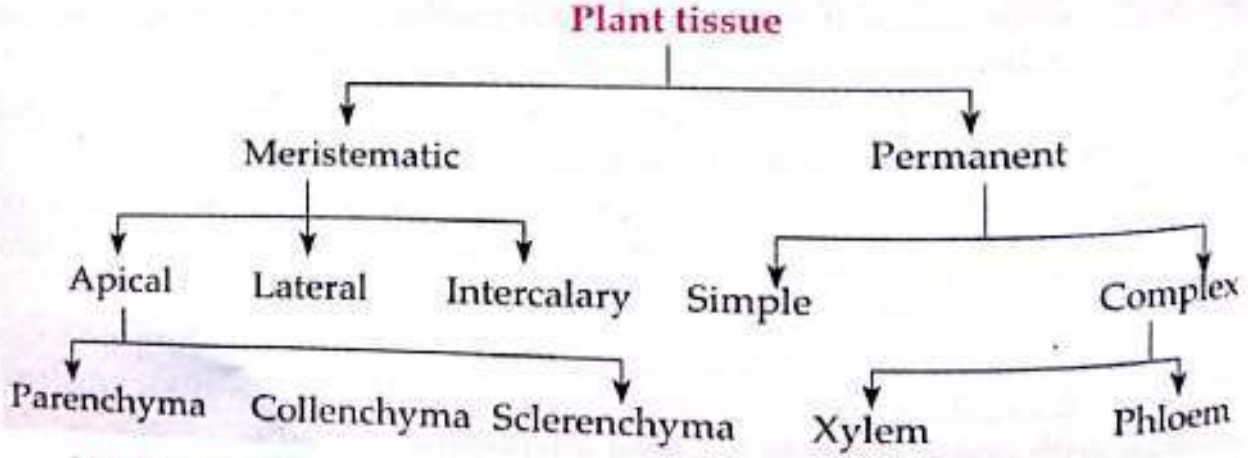
Fruit	Edible part
Apple	Fleshy thalamus
Pear	Fleshy thalamus
Mango	Mesocarp
Guava	Entire fruit
Grapes	Pericarp and Placenta
Papaya	Mesocarp
Coconut	Endosperm
Tomato	Pericarp and Placenta
Banana	Mesocarp & Endocarp

Fruit	Edible part
Wheat	starchy endosperm
Cashew nut	Peduncle & cotyledons
Lichi	Aril
Gram	cotyledons & embryo
Groundnut	Cotyledons
Mulberry	entire fruit
Jackfruit	Bract, Perianth and seed
Pine apple	Bract and Perianth
Orange	Juicy hair.

3. Plant Tissue

Tissue : The group of cells of similar origin, structure and functions is called tissue.

Types of Plant Tissue



(A) Meristematic tissue : Growing regions of the plants are called *Meristem*. Meristematic tissue have capability of cell division. Daughter cells formed out. It grow and constitute the different parts of the plant. This process continues till the life-span of the plant.

Specific features of the Meristematic tissues are as follows –

(i) It is round, oval or multi-sided.

(ii) Its wall is thin and cytoplasm is homogeneous.

(iii) Cell contains dense cytoplasm and a single large nucleus.

(iv) There is lack of inter-cellular spaces between the cells.

- Apical Meristems : These tissues are found in the root and stem apex and the initial growth (specially length) of the plants take place due to these tissue.
- Lateral Meristems : Due to the division in these tissue growth in the girth of roots and stems takes place. Hence, it increases the width of the root and stem.
- Intercalary Meristems : They are located at the base of internode. In fact, this is the remains of the Apical Meristems, which is divided by the incoming of permanent tissues in the centre. Plants increase its length by the activity of this. Its importance is for those plants whose apex parts are eaten by vegetarian animals. After being eaten the apex part the plants grow with the help of intercalary meristems only. Like – grass.

(B) Permanent tissue : Permanent tissues are made of those mature tissues that have lost their capacity of division and attain a definite forms for various works. These cells can be alive or dead.

- Simple tissue : If permanent tissue is made up of similar types of cells, it is called *simple tissue*.
- Complex tissue : If permanent tissue is made up of one or more types of cells, it is called *Complex tissue*.
- Xylem : This is usually called *wood*. This is conducting tissue. Its two main functions are –
  (i) Conduction of water and minerals and
  (ii) To provide mechanical consistency.

The determination of age of the plant is done by counting annual rings of the xylem tissue. The method of determining the age of plant is called *Dendrochronology*.

- Phloem : This is a conducting tissue. Its main function is to conduct foods prepared by the leaves to different parts of the plant.

4. Photosynthesis

In the presence of water, light, chlorophyll and carbon dioxide, the formation of carbohydrates in plant is called *photosynthesis*.

$$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Water}}{6H_2O} + \underset{\text{Oxygen}}{6O_2}$$

Carbon dioxide, water, chlorophyll and sunlight are necessary for photosynthesis

- Terrestrial plants takes CO_2 from atmosphere whereas aquatic plants use carbon dioxide mixed in water.
- Water enters into the cells of the leaves through osmosis and CO_2 through diffusion from atmosphere or release during respiration.
- Water necessary for photosynthesis is absorbed by the roots and the oxygen produced during photosynthesis is due to photolysis of water.

➢ The green colour of the plants is due to the presence of chlorophyll. Chlorophyll are photoreceptor molecule, which trap the solar energy. There are different type of chlorophyll molecule like 'a', 'b', 'c', 'd' & 'e'. Chlorophyll 'a' & 'b' are most common and are found in a plant.

➢ There is an atom of magnesium in the centre of chlorophyll.

➢ Chlorophyll absorbs the violet, blue and red colours of light.

The rate of photosynthesis is maximum in red light and is minimum in violet light.

➢ The process of photosynthesis is a reaction of oxidation and reduction. Oxidation of water takes place forming oxygen and reduction of carbon dioxide takes place forming glucose.

The stages of process of photosynthesis

(i) Photochemical reaction or light reaction and

(ii) Dark chemical reaction

(i) Photochemical reaction : This reaction is completed in the grana part of the chlorophyll. This is also called *Hill reaction*. In this process break down of water takes place and hydrogen ion and electron is formed. For photolysis of water, energy is received from the light. At the end of this process, ATP is formed from ADP & P.

(ii) Dark chemical reaction : This reaction takes place in the stroma of chlorophyll. In this reaction reduction of carbon dioxide takes place and sugar or starch are formed. It is also known as *Calvin Benson cycle*.

5. Plant Hormones

Following five hormones are found in plants –

1. **Auxins** : Auxins was discovered by Darwin in the year 1880.
This is the hormone which controls the growth of plants.
Its formation takes place in the apex parts of the plants.
Its main functions are –
(i) It prevents the separation of the leaves.
(ii) It destroys the straws.
(iii) It saves the crops from falling.

2. **Gibberellins** : It was discovered by a Japanese scientist *Kurosava* in the year 1926.
Functions :
(i) It turns the dwarf plants into long plants. It helps in creating flowering.
(ii) It hep in breaking the dormancy of plant.
(iii) It motivates the seeds to be sprout.
(iv) It increases the activity of cambium in the wooden plants.
(v) Large sized fruits and flowers can be produced by its scattering.

3. **Cytokinins** : It was discovered by *z* in the year 1955 but it was named by Lethem.
Functions :
(i) It naturally works in coordination with auxins.

(ii) It help in cell division and development in the presence of auxins.
(iii) It help in breaking the dormancy of seed.
(iv) It is helpful in making RNA and protein.

4. Abscisic Acid or ABA : This hormone was initially discovered by Carnes and Adicote and later on by *Waring*.

Functions :
(i) This hormone is against the growth.
(ii) It keeps the seeds & bud in dormant condition.
(iii) It plays main role in separation of leaves.
(iv) It delays in flowering of long day plant.

5. Ethylene : This is the only hormone which is found in gaseous form.

Functions :
(i) It helps in the ripening the fruits.
(ii) It increases the number of female flowers.
(iii) It motivates the separation of leaves, flowers and fruits.

6. Florigens : It is formed in leaves but helps in blooming of the flowers. Therefore, it is also called *flowering hormones*.

7. Traumatic : This is a type of dicarboxylic acid. It is formed in injured cells by which the injury of plants is healed.

6. Plant Diseases

1. Viral Diseases : (i) *Mosaic disease of tobacco* – In this disease leaves get shrinked and become small. The chlorophyll of leaves get destroyed. The factor of this disease is *Tobacco Mosaic Virus* (TMV).

Control – Affected plants should be burnt.

(ii) *Bunchy top of banana* – This diseases is caused by *banana virus*. In this disease plants become dwarf and all the leaves get accumulated like a rose on the branch.

2. Bacterial Disease :

(i) *Wilt of Potato* : It is also known as *ring disease* because brown ring is formed on the xylem. The factor of this disease is *Pseudomonas solonacearum* bacteria. In this disease the conduction system of the plant is affected.

(ii) *Black Arm of cotton* : The factor of this disease is *Xanthomonas Bacteria*. In this disease a water body (brown) is formed on the leaves.

(iii) *Bacterial blight of Rice* : This disease is caused by *Xanthomonas oryzae bacteria*. Yellow-greenish spot is seen on both side of leaves. Vascular bundles get blocked due to bacterial growth.

(iv) *Citrus Canker* : The factor of this disease is *Xanthomonas citri* bacteria. It has originated in China. Leaves, branches, fruits all are affected by this disease.

(v) *Tundu disease of wheat* : The factors of this disease are *Corinobacterium titrici* bacteria and Enzuina Titriki Nematode. In this disease lower parts of the leaves are faded and turned.

3. Fungal Diseases : The diseases included in this group are caused by fungi.

Some Important Facts Regarding Botany

Facts	Example and details
Largest angiosperm tree	*Eucalyptus.*
Longest tree in the world	*Sequoia* giganteum. This is a gymnosperm. Its height is 120 meter. This is also called *Coast Red Wood of California.*
Smallest (in shape) angiosperm plant	Lemna. This is aquatic angiosperm which is found in India too.
Plant with largest leaf	Victoria Regia. This is an aquatic plant which is found in West Bengal in India.
Largest fruit	*Lodoicea.* This is also called double coconut. This is found in Kerala in India.
Smallest Pteridophyta	*Azolla.* This is an aquatic plant.
Smallest seed	*Orchid.*
Smallest flower	*Wolfia.* Its diameter is 0.1 millimeter.
Largest flower	*Reflesia arnoldii.* Its diameter is 1 meter and its weight can be 8 kilograms.
Smallest angiosperm parasite	*Arceuthobium.* is a parasite on the stems of gymnosperms.
Largest male couplet	*Cycas.* This is a gymnosperm plant.
Largest seed-egg	*Cycas.*
Alive morph	*Cycas.*
Smallest chromosomes	*In algae.*
Longest chromosomes	In *Trillium.*
The plant with the largest number of Chromosomes	Ophioglossum (*Fern*). There are 1266 chromosomes in its Diploid cell.
The plant with the least number of chromosomes	Heplapapopus *gracilis.*
The smallest gymnosperm plant	*Zamia pygmea.*
The heaviest wooden plant	*Hardwichia binata.*
The lightest wooden plant	*Ochroma lagopus-balsa.*
The smallest cell	*Mycoplasma gallisepticum.*
Fruit like a tennis ball	*Kenth.*
Fire of the forest	*Dhak.*
Coffee giving plant	*Coffea arabica.* Caffin contains in it.
Coco giving plant	*Theobroma cococa.* Theobromin and caffeine contain in it.
Caffeine	*Pepaver somniferum* morphin contains in it.

7. Ecology

- Study of inter relationship between living organisms and their environment.
- Various population of living in a definite place is called *Biotic Community*.
- Ecosystem or Ecological system word was first coined by the scientist namely *Tansley*.

Every ecosystem is made up of two components –

(a) Biotic component – Living part

(b) Abiotic component – Non living part

(a) Biotic components : It is divided into three parts –

(1) Producer (2) Consumer (3) Decomposers

(1) Producer : Those components that make their own food. Like – green plants.

(2) Consumer : Those components that consumes the food made by plant. Consumers are of three types –

(i) *Primary consumers* : In this category those organisms are included that lives on green plants or some parts of them.

(ii) *Secondary consumers* : In this category those organisms are included that depends on the primary consumers as their food. Like – fox, wolf, peacock etc.

(iii) *Tertiary consumers* : In this category those organisms are included that depends on the secondary consumers. Like – Tiger, lion, cheetah etc.

(3) Decomposers : Mainly fungi and bacteria are included in this category. These decomposes dead producers and consumers and changes them into physical elements.

(b) Abiotic components : Abiotic components are as follows –

(i) Carbonic substance, (ii) Non-carbonic substance, (iii) Climatic factor

Example : Water, light, temperature, air, humidity, minerals etc.

- Food Chain : Transfer of energy from the producer through a series of organisms.

8. Nitrogen cycle

- Nitrogen fixation is a process in which free atmospheric nitrogen is converted by living organism into nitrogenous compound that can be used by plant
- Ammonification : Formation of ammonia from organic compound like proteins and nucleic acid by microorganism.
- Nitrification : A process in which ammonia is converted into nitrates and nitrates by Nitrobacteria.
- Denitrification : It is the process of converting fix nitrogen like nitrates, nitrites and ammonia into free nitrogen by denitrifying bacteria eg Pseudonymouna.

9. Pollution

Unwanted changes in the chemical and physical features of air, water and land (environment) that are dangerous to human and other organisms, their life conditions, industrial process and cultural achievements are called *pollution.*

The types of pollution are mainly –(i) Air pollution, (ii) Water pollution, (iii) Sound pollution, (iv) Soil pollution, (v) Nuclear pollution.

(i) Air pollution : When the pollution is in the atmosphere and the sufficient quantity of atmosphere reduces then it is called *Air pollution.*

Main air pollutants – *Carbon monoxide* (CO), Sulphur dioxide (SO_2), Hydrogen sulphide (H_2S), Hydrogen fluoride (HF), Nitrogen oxide (NO and NO_2), Hydrocarbon, Ammonia (NH_3), Smoke of tobacco, Fluorides smoke and particles of smoke, Aerosols etc.

Sulphur dioxide (SO_2), Sulphur trioxide (SO_3), Nitrogen oxide (NO) react with environmental water and creates Sulphuric acid and Nitric acid. These acids reach the earth with rain water and this is called *acid rain.*

On 3rd December, 1984 an incidence of leakage of Methyl Isocyanide gas took place in the fertilizer making Union Carbide Factory. (Bhopal)

(ii) Water pollution : Mixing of unwanted substances with water is called *water pollution.*

Sources of water pollution : The water pollution takes place mainly due to mixing up of Carbonate, sulphates of Magnesium and Potassium, Ammonia, Carbon monoxide, Carbon dioxide and Industrial remains in water. Sea-water pollution is due to mixing up of heavy metals, hydro carbon, petroleum etc. in water.

(iii) Sound pollution : The unwanted and undesirable sounds scattered in atmosphere are called *sound pollution.*

Sources of sound pollution : The source of sound pollution is loud sound or noise, in whatever ways it has produced.

(iv) Soil pollution : Distorted form of soil is called *Soil pollution.*

Sources of Soil pollution : acid rain, water from mines, excessive use of fertilizers and germicide chemicals, garbage, industrial remainins, excretion in open field etc. are the main sources of soil pollution.

(v) Nuclear pollution : This pollution is created by radioactive rays.

Following can be the sources of radioactive pollution –

(i) Pollution from the rays which are used in treatment.

(ii) Pollution created from fuels used in Atomic reactors.

(iii) Pollution created from the use of nuclear weapons.

(iv) Pollution created remaining substances coming out of Atomic power-houses.

Population, Biotic Community

- **Population** : Population is a group of individuals of same species occupying the same area at a given time.
- **Population density** : Total number of individual present in per unit area.

- Natality : Increase in the number of individuals in a given population by birth is called natality
- Mortality : Number of individuals removed from a population due to death under given environmental condition at a given time is called mortality
- Biotic potential : It refers the maximum capacity of inherent of an organism to reproduce.
- Environmental resistance : Environmental factors, which put a check on the growth of population.
- Mutalism : It is a functional association between two different species in which both the species are benefited.
- Commensalism : It is an association between individuals of two different species in which one species is benefited and other one is neither benefited nor affected.
- Population Explosion : The dramatic increase in population size over a relatively short period is called population explosion.
- Demographic transition : If the birth rate is equal to the death rate, it results in zero population growth, which is called demographic transition.
- Psychosis : It is a mild form of mental illness where the patient show prolonged emotional reaction.
- Drug abuse : When drugs are taken for a purpose other than their normal clinical use in an amount that impairs ones physical, physiological and psychological function of body is called drug abuse.

ZOOLOGY

Zoology : Scientific study of the structure, form and distribution of animals.

1. Classification of Animal Kingdom

Animals kingdom of the world is divided into two sub-kingdoms :

(i) Unicellular animal (ii) Multi-cellular animal.

Unicellular animals are kept in a single phylum Protozoa whereas multi-cellular animals are divided into 9 phylums.

Classification of animals according to *Storer* and *Usinger* –

A. **Phylum Protozoa : Main features** – Unicellular
(i) It's body is made of only one cell.
(ii) There is one or more nuclei in its cytoplasm.
(iii) Are both the types commensalism and parasite.
(iv) All the metabolic activity (eating, digestion, respiration, excretion, reproduction) takes place in unicellular body.
(v) Respiration and excretion take place by diffusion.
Example – *Amoeba, Euglena, Trypanosoma* etc.

B. **Phylum Porifera :** All animal of this group are found in marine water & bear pores in body.
(i) These are multicellular animals but cells do not make regular tissues.
(ii) Numerous pores known as *ostia* found on body wall.
(iii) Skeleton is made up of minute calcareous or silicon spicules.
Example – *Sycon, Sponge* etc.

C. **Phylum Coelenterate : Main features** – Coelenteron is present
(i) Animals are aquatic and diploblastic.
(ii) Around the mouth some thread-like structure are found known as tentacles, which help in holding the food.
(iii) Body radial symmetry.
(iv) Specialized cnidoblast cell are found help in catching the food.
Example – *Hydra, Jelly fish, Sea Anemone* etc.

D. **Phylum Platyhelminthes : Main features** – Flat worm
(i) Triploblastic and no body cavity.
(ii) Dorso-ventraly flattened animal.
(iii) Alimentary canal with single opening, anus absent.
(iv) Excretion takes place by flame cells.
(v) There is no skeleton, respiratory organ, circulatory system etc.
(vi) These are hermaphrodite animal.
Example – *Planaria, Liver fluke, Tape worm* etc.

E. **Phylum Aschelominthes : Main features** – Round worm
(i) Long, cylindrical, unsegmented worm.
(ii) Bilaterally symmetrical and triploblastic.
(iii) Alimentary canal is complete in which mouth and anus both are present.
(iv) There is no circulatory & respiratory systems but nervous system is developed.
(v) Excretion takes place through *Protonephridia.*
(vi) They are unisexual.
(vii) Most form are parasitic but some are free living in soil & water.
Example – Round worm, like – *Ascaris, Thread worm, Wuchereia* etc.

Note : *(i) Enterobius (pin worm/thread worm) – It is found mainly in the anus of child. Children feel itching and often vomits. Some children urinate on the bed at night.*

(ii) Filarial disease is caused by Wuchereia bancrofti.

F. **Phylum Annelida : Main features** – Annulus body Bearing ring
(i) Body is long, thin, soft and metamerically segmented.
(ii) Locomotion takes place through *Setae* made up of Chitin.
(iii) Alimentary canal is well developed.
(iv) Normally respiration through skin, in some animals it takes place through *coelom.*
(v) Nervous system is normal and blood is red.
(vi) Excretion by *nephridia.*
(vii) Both unisexual and bisexual.
Example : *Earthworm, Nereis, Leech* etc.

Note : *There are four pairs of heart in earthworm.*

G. **Phylum Arthropoda : Main features** – Jointed leg
(i) Body is divided into three parts – Head, Thorax and Abdomen.
(ii) Body is covered with a thick chitinous exoskeleton.
(iii) Jointed leg.
(iv) Circulatory system is open type.
(v) Its body cavitys are called *haemocoel.*
(vi) *Trachea, book lungs, body surface* are respiratory parts.

(vii) These are mainly unisexual and fertilization takes place inside the body.

Example – *Cockroach, prawn, crab, bug, fly, mosquito, bees* etc.

Note : *(i) There are six feet and four wings in insects. (ii) There are 13 chamber in the Cockroach's heart. (iii) Ant is a social animal which reflects labour division. (iv) Termite is a social animal which lives in colony.*

H. **Phylum Mollusca : Main features** – Soft bodies animal

(i) Body is soft divided into head and muscular foot.
(ii) Mantle is always present in it, which secretes a hard calcareous shell.
(iii) Alimentary canal is well developed.
(iv) Respiration takes place through *gills* or *ctenidia.*
(v) Blood is colourless.
(vi) Excretion takes place through kidneys.

Example – *Pila, Octopus, Loligo, Squid* etc.

Note :

Mollusca	Other name in vogue
Aplysia	Sea rabbit
Doris	Sea lemon
Octopus	Devil-fish
Sepia	Cuttle-fish

I. **Phylum Echinodermata : Main features** – Spiny skin

(i) All the animals in this group are marine.
(ii) Water vascular system is present.
(iii) There is Tube feet for locomotion, taking food which works as sensation organ.
(iv) Brain is not developed in nervous system.
(v) There is a special capacity of regeneration.

Example : *Star fish, Sea urchin, Sea cucumber, Brittle stars* etc.

Note : *The work of the Aristotle lantern is to chew the food. It is found in sea urchin.*

J. **Phylum Chordata : Main features**

(i) Notochord is present in it.
(ii) All the chordates are triploblastic, coelomate and bilaterally symmetrical.
(iii) A dorsal hollow tubular nerve cord and paired pharyngeal gill slits are other features of chordates.

According to classification there are two sub phyla in Chordata.
(a) Protochordates and (b) Vertebrata

Some main groups of phylum Chordata :

1. **Pisces : Main features – Aquatic life**

(i) All these are cold blooded animals.
(ii) Its heart pumps only impure blood and have two chamber.
(iii) Respiration takes place through *gills.*

Example : *Hippopotamus, Scoliodon, Torpedo.* etc.

2. **Amphibia : Main features** – Found both on land & water

(i) All these creatures are amphibian.

(ii) All these are cold-blooded.
(iii) Respiration takes place through gill, skin and lungs. Heart have three, chamber two auricles and one ventricle.
Example : Frog, Necturus, Toad, etc. *Icthyophis, Salamander.*

Note : *In fact the croaking of frogs is the call for sex.*

3. **Reptilia : Main features** – Crawlling animal
(i) Land vertebrate, cold-booded, terrestrial or aquatic vertebrates.
(ii) It contains two pair of limbs.
(iii) The skeleton is completely flexible.
(iv) Respiration takes place through lungs.
(v) Its eggs are covered with shell made up of Calcium carbonate.
Example : *Lizard, snake, tortoise, crocodile, turtle, sphenodon* etc.

Note : *Mesozoic era is called the era of reptiles.*
Cobra is the only snake which makes nests.
Heloderma is the only poisonous lizard.
Sea snake which is called Hydrophis is the world's most poisonous snake.

4. **Aves : Main features** – Warm blooded tetrapod vertebrates with flight adaptation.
(i) Its fore-feet modified into wings to fly.
(ii) Boat shaped body is divisible into head , neck, trunk and tail.
(iii) Its respiratory organ is lungs.
(iv) Birds have no teeth, beak help in feeding.
Example : *crow, peacock, parrot* etc.

Note : *(i) Flightless Birds – Kiwi and Emus. (ii) Largest alive bird is Ostrich. (iii) Smallest bird is Humming bird. (iv) Largest zoo in India is Alipur (Kolkata) and the largest zoo of the world is Cruiser National Park in South Africa.*

5. **Mammalia : Main features**
(i) Sweat glands and oil glands are found on skin.
(ii) All these animals are warm blooded.
(iii) Its hearts are divided into four chamber.
(iv) Tooth comes twice in these animals. (Diphyodont)
(v) There is no nucleus in its red blood cells (except in camel and lama).
(vi) Skin of mammal have hair.
(vii) External ear is present.

Mammals are divided into three sub-classes :
(i) *Prototheria* – It lays eggs. Example – *Echidna.*
(ii) *Metatheria* – It bears the immature child. Example – Kangaroo.
(iii) *Eutheria* – It bears the well developed child. Example – *Human.*

Note : *(i) In mammal the highest body temperature is of goat. (Average 39 degree Celsius). (ii) Echidna and Duck billed Platypus are the egg laying mammal.*

2. Animal Tissue

The animal tissues can be divided into following categories–(i) Epithelial Tissue, (ii) Connective Tissue, (iii) Muscular Tissue, (iv) Nervous Tissue.

(i) Epithelial Tissue : Epithelial tissue cover the external surface of the body and internal free surface of many organs. Epithelial cell arranged very close to each other. There is no blood vessels supplying nourishment to epithelial cells. They receive nourishment from underlaying connective tissue. The principle functions of epithelial tissues are covering and lining of free surface.

Example : skin, intestine, gland, hollow organ like fallopian tube, nasal passage bronchioles, trachea etc.

(ii) Connective Tissue : These tissue connect and bind different tissues or organs. It provides the structural frame work and mechanical support to body. It play role in body as defense tissue, repair fat storage etc.

Example : Adipose tissue found beneath the skin. Ligament made up of fibrous connective tissue. Cartilage, bone and blood.

Note : *Blood is only tissue which is found in the form of fluid.*

(iii) Muscular Tissue : This is also known as contractile tissue. All the muscles of the body are made up of this tissue. Muscle tissue is of three types – (a) Unstriped, (b) Striped and (c) Cardiac

(a) Unstriped : This muscle tissue is found on the walls of those parts which do not controled by will. These are called involuntary muscle, like – Alimentary canal, Rectum, Ureter, Blood vessels. Unstriped muscles control the motions of all those organs that move on their own.

(b) Striped : These muscles are found in the parts of the body that move voluntary. Normally one or both the end of these muscles turn and connect with bones as tendon.

(c) Cardiac : These muscles are found only on the walls of the heart. The contraction and expansion of the heart is due to these muscles that move throughout the life without fail.

- There are 639 muscles in the human body.
- The largest muscle of the human body is *Gluteus Maximus* (muscle of the hip).
- The smallest muscle of the human body is *Stapedius.*

(iv) Nervous Tissue : This tissue is also called sensitive tissue. The nervous systems of the organisms is made up of these tissues. This is made up of two specific cells – (a) Nerve cell or Neurons and (b) Neuroglia.

Nervous tissue controls all the voluntary & involuntary activities of the body.

3. Human Blood

- Blood is a fluid connective tissue.
- The quantity of blood in the human's body is 7% of the total weight.
- This is a dissolution of base whose pH value is 7.4
- There is an average of 5-6 litres of blood in human body.

Female contains half litre of blood less in comparison to male.

Blood is consist of two part–

(A) Plasma and (B) Blood corpuscles.

(A) Plasma : This is the liquid part of blood. 60% of the blood is plasma. Its 90% parts is water, 7% protein, 0.9% salt and 0.1% is glucose. Remaining substances are in a very low quantity.

Function of plasma : Transportation of digested food, hormones, exeretory product etc. from the body takes place through plasma.

➢ Serum : When Fibrinogen & protein is extracted out of plasma, the remaining plasma is called *serum*.

(B) Blood corpuscles : This is the remaining 40% part of the blood. This is divided into three parts –

(i) *Red Blood Corpuscles* (RBCs)

(ii) *White Blood Corpuscles* (WBCs) and (iii) *Blood Platelets.*

(i) Red Blood Corpuscles (RBC) : Red Blood Corpuscles (RBC) of a mammal is biconcave.

➢ There is no nucleus in it. Exception – Camel and Lama.
RBC is formed in Bone marrow.
(At the embroynic stage its formation takes place in liver).

➢ Its life span is from 20 days to 120 days.

➢ Its destruction takes place in liver & spleen. Therefore, liver is called grave of RBC.

➢ It contains haemoglobin, in which *haeme* iron containing compound is found and due to this the colour of blood is red.

➢ *Globin* is a proteinous compound which is extremely capable of combining with oxygen and carbon dioxide.

➢ The iron compound found in haemoglobin, is *haematin.*

➢ The main function of RBC is to carry oxygen to all cells of the body and bring back the carbon dioxide.

➢ *Anaemia* disease is caused due the deficiency of haemoglobin.

➢ At the time of sleeping RBC reduced by 5% and people who are at the height of 4200 meters RBC increases by 30% in them.

(ii) White Blood Corpuscles (WBC) or Leucocytes : In shape and constitution this is similar to Amoeba.

➢ Its formation takes place in Bone marrow, lymph node and sometimes in liver and spleen.

➢ Its life span is from 1 to 2 days.

➢ Nucleus is present in the White Blood Corpuscles.

➢ Its main function is to protect the body from the disease.
The ratio of RBC and WBC is 600 : 1.

(iii) Blood Platelets or Thrombocytes : It is found only in the blood of human and other mammals.

➢ There is no nucleus in it.

➢ Its formation takes place in Bone marrow.

➢ Its life span is from 3 to 5 days.

➢ It dies in the Spleen.

➢ Its main function is to help in clotting of blood.

Functions of blood :

(i) To control the temperature of the body and to protect the body from diseases.

(ii) Clotting of blood.
(iii) Transportation of O_2, CO_2, digested food, conduction of hormones etc.
(iv) To help in establishing coordination among different parts.

Clotting of Blood : Three important reactions during clotting of blood.

(i) Thromboplastin + Prothrombin + Calcium = Thrombin.
(ii) Thrombin + Fibrinogen = Fibrin.
(iii) Fibrin + Blood Corpuscles = Clot.

The formation of Prothrombin and Fibrinogen of the blood plasma takes place with the help of Vitamin K. Vitamin K is helpful in making clots of blood. Normally clotting takes the time from 2 to 5 minutes.

The compulsory protein in making clots of blood is *Fibrinogen.*

Blood Group of human : Blood Group was discovered by Landsteiner in 1900. For this, he was awarded with Nobel Prize in the year 1930.

- The main reason behind the difference in blood of human is the glyco protein which is found in Red Blood Corpuscles called *antigen.*

Antigen are of two types – Antigen A and Antigen B.

- On the basis of presence of Antigen or Glyco Protein, there are four group of blood in human :
  (a) That contains Antigen A – Blood Group A.
  (b) That contains Antigen B – Blood Group B.
  (c) That contains both the Antigens A and B - Blood Group AB.
  (d) That contains neither of the Antigens - Blood Group O.

An opposite type of protein, is found in blood plasma. This is called *antibody.* This is also of two types – Antibody 'a' and Antibody 'b'.

Therefore, with the four groups of blood division of antibody is as under–

	Blood Group	Antigen (In Red Blood Corpuscles)	Antibody (In plasma)
1.	A	Only 'A'	Only 'b'
2.	B	Only 'B'	Only 'a'
3.	AB	Both 'A' and 'B'	Absent
4.	O	Absent	Both 'a' and 'b'

Blood Transfusion : Antigen 'A' and antibody 'a', Antigen 'B' and antibody 'b' cannot live together. In case of so happened these get most sticky, which spoils the blood. This is called *agglutination of blood.* Therefore, in blood transfusion adjustment of Antigen and Antibody should be done carefully so that agglutination of blood do not takes place.

Blood Group O is called Universal Donor because it does not contain any antigen.

Blood Group AB is called Universal Receptor because it does not contain any antibody.

Rh factor : In the year 1940, Landsteiner and Wiener discovered a different type of antigen in the blood. They discovered it in the *Rhesus*

monkey; therefore, it is called *Rh-factor*. In the blood of that person it is found, their blood is called Rh-positive and in the blood of that person it is not found, is called *Rh-negative*.

At the time of blood transfusion Rh-factor is also tested. Rh+ is given to Rh^+ and Rh^- is given Rh-blood only.

If the blood of Rh+ blood group is transmitted to a person with Rh-blood group, then due to the less quantity for the first time there does not seem any bad effect but if this process is repeated then due to agglutination the person with Rh- blood group dies.

Erythroblastosis Foetalis : If the father's blood is Rh+ and the mother's blood is Rh- then the child to be born dies at the pregnancy or short span of time after the birth. (This happens in the case of second issue).

The possible blood group of the child on the basis of blood group of mother and father.

Blood group of Mother and father	Expected blood group of the child	Unexpected blood of the child
O × O	O	A, B, AB
O × A	O, A	B, AB
O × B	O, B	A, AB
O × AB	A, B	O, AB
A × A	A, O	B, AB
A × B	O, A, B, AB	None
A × AB	A, B, AB	O
B × B	B, O	A, AB
B × AB	A, B, AB	O
AB × AB	A, B, AB	O

Haemolymph : Body fluid of arthropoda is a colourless made of plasma and haemocytes. It donot contain any respiratory pigment Ex–Cockroach.

4. System of the Human Body

(a) Digestive System

The complete process of nutritioin is divided into five stages :

1. Ingestion 2. Digestion 3. Absorption
4. Assimilation 5. Defecation

1. **Ingestion :** Taking the food into the mouth is called *Ingestion*.

2. **Digestion :** Conversion of nonabsorbable food into absorbable form. The digestion of the food is started from the mouth.

- Saliva is secreted by salivary gland in mouth in which two types of enzymes are found, *ptyalin* and *maltase*. They convert starch into simple sugar and make it digestible.
- In human secretion of saliva is approximately 1.5 litre per day.
- The nature of saliva is acidic (pH 6.8).
- From the mouth the food reach into stomach through food pipe.
- No digestion takes place in food pipe.

Digestion in Stomach

- The foods lies approximately for four hours in stomach.
- After reaching the food in stomach gastric glands secretes the gastric juice. This is a light yellow acidic liquid.
- Hydrochloric acid secreted from the Oxyntic cells of the stomach kills all the bacteria coming with food and accelerates the reaction of enzymes. Hydrochloric acid makes the food acidic by which ptyalin reaction of the saliva end.
- The enzymes in the gastric juice of stomach are – Pepsin and Renin.
- Pepsin breaks down the protein into peptones.
- Renin breaks down the Caseinogen into Casein.

Digestion in Duodenum

- As soon as the food reaches the duodenum bile juice from liver combines with it. Bile juice is an alkaline and it turns the acidic medium of food into alkaline.
- Here, pancreatic juice from pancreas combines with food. It contains three types of enzymes :

(i) Trypsin : It converts the protein and peptone into polypeptides and amino acid.

(ii) Amylase : It converts the starch into soluble sugar.

(iii) Lipase : It converts the emulsified fats into glycerol and fatty acids.

Small Intestine

- Here, the process of digestion completed and absorption of digested foods start.
- From the wall of small intestine, intestinal juices secretes. The following enzymes contain :

(i) *Erepsin* : It converts the remaining protein and peptone into amino acids.

(ii) *Maltase* : It converts the maltose into glucose.

(iii) *Sucrase* : It converts the sucrose into glucose and fructose.

(iv) *Lactase* : It converts the lactose into glucose and galactose.

(v) *Lipase* : It converts the emulsified fats into glycerol and fatty acids.

Intestinal juice is alkaline in nature.

In a healthy people approximately 2 litres of intestinal juice secretes every day.

3. **Absorption** : Reaching of digested foods into blood is called absorption.

- The absorption of digested foods takes place through small intestinal villi.

4. **Assimilation** : Use of absorbed food in the body is called assimilation.

5. **Defecation** : Undigested food reaches into large intestine where bacteria turns it into *faeces*, which is excreted through anus.

Summary of Digestion

Gland juice		Enzyme	Edible substance	After reaction
1. Saliva	(i)	Ptylin	Starch	Maltose
	(ii)	Maltase	Maltose	Glucose
2. Gastric Juice	(i)	Pepsin	Protein	Peptones
	(ii)	Rennin	Casein	Calcium paracasein
3 Pancreatic juice	(i)	Trypsin	Protein	Polypeptides
	(ii)	Amylase	Starch	Sugar
	(iii)	Lipase	Fat	Fatty acid and glycerol
4. Intestinal juice	(i)	Erepsin	Protein	Amino acid
	(ii)	Maltase	Maltose	Glucose
	(iii)	Lactase	Lactose	Glucose and fructose
	(iv)	Sucrase	Sucrose	Glucose and glactose
	(v)	Lipase	Fat	Fatty acid and glycerol

The main organs participating in digestion :

Liver : This is the largest gland of the human body. Its weight is approximately 1.5 – 2 kilogram.

- Bile is secreted through liver only. This bile accelerate the reaction of enzymes present in the intestine.
- Liver convert excess of amino acid into ammonia by deamination. These ammonia are further converted into urea by ornithine cycle. Urea comes out from body through kidney.
- Liver converts some quantity of protein into glucose during deficiency of carbohydrate.
- In carbohydrates metabolism liver converts the excess of glucose found in blood into glycogen and stores it into hepatic Cell as reserve nutrients. If the necessity of glucose arises the liver convert reserve glycogen into glucose. Thus, it regulates the quantity of glucose in the blood.
- In case of decrease of fat in food liver converts some of the parts of the carbohydrates into fat.
- The production of fibrinogen protein takes place by liver which helps in clotting of blood.
- The production of Heparin protein takes place in liver which prohibit the clotting of blood inside the body.
- The dead RBC is destroyed by the liver only.
- The liver reserve some quantity of iron, copper and vitamin.
- It helps in regulating the body temperature.
- Liver is an important clue in investigating a person's death that has been due to poison in food.

Gall Bladder :Gall bladder is a pear shaped sac, in which the bile coming out of liver is stored.

- Bile comes into the duodenum from gall bladder through the bile duct.

- Secretion of bile into the duodenum takes place by reflex action.
- Bile is a yellowish-green coloured alkaline liquid, whose pH value is 7.7
- The quantity of water is 85% and the quantity of bile pigment is 12% in water.

The Main functions of bile are as under :

(i) It makes the medium of food alkaline so that pancreatic juice can worked.
(ii) It kills the harmful bacteria coming with food.
(iii) It emulsifies the fats.
(iv) It accelerates the bowel movement of intestine by which digestive juices in the food mix well.
(v) It is helpful in the absorption of vitamin K and other vitamins mixed in fats.

In case of obstruction in bile duct, liver cells stop taking bilirubin from blood. As a result, bilirubin spreads throughout the body. This is called *jaundice*.

Pancreas : This is the second largest gland of the human body. It acts as simultaneously endocrine and exocrine type of gland.

- Pancreatic juice secretes out of it in which 9.8% water and the remaining parts contain salt and enzymes. It is alkaline liquid, whose pH value is 7.5 – 8.3. It contains the enzymes which can digest all the three types of food materials (like carbohydrates, fat and protein), therefore it is called complete digestive juice.

Islets of Langerhans : This is a part of the Pancreas.

- It was discovered by the medical scientist Langerhans.
- From its β cell- insulin, from α cell-glucagons and from δ cell-somatostaintin hormones are secreted :

Insulin : It is secreted by β-Cell of islets of Langerhans which is a part of the pancreas.

- It was discovered by Banting and Best in the year 1921.
- It controls the process of making glycogen from glucose.
- Diabetes is caused due to the deficiency of insulin.
- Excessive flow of insulin causes Hypoglycemia in which one loses the reproducing capacity and vision deterioration.

Glucagon : It re-converts the glycogen into glucose.

Somatostatin : This is a polypeptide hormone which increases the duration of assimilation of food.

(b) **Circulatory System**

The discovery of blood circulation was done by *William Harvey* in the year 1628.

There are four parts under it –

(i) Heart (ii) Arteries (iii) Veins and (iv) Blood.

Heart : It remains safe in the *pericardial membrane*. Its weight is approximately 300 grams.

Heart of the human is made up of four chambers. In the anterior side there is a *right auricle* and a *left auricle*. In the posterior side of the heart there is a *right ventricle* and a *left ventricle* persist.

- Between the right auricle and the right ventricle there is a *tricuspid valve*.
- Between the left auricle and left ventricle there is a *bicuspid valve*.
- The blood vessels carrying the blood from the body towards the heart is called *vein*.
- In the vein there is impure blood i.e. carbon dioxide mixed blood. Its exception is pulmonary vein, which always carry pure blood.
- Pulmonary vein carries the blood from lungs to left auricle. It has pure blood.
- The blood vessels carrying the blood from the heart towards the body is called *artery*.
- In artery there is pure blood i.e. oxygen mixed blood. Its exception is pulmonary artery.
- Pulmonary artery carries the blood from right ventricle to lungs. It contains impure blood.
- In the right part of the heart, there remains impure blood i.e. carbon dioxide mixed blood and in the left part of the heart there remains pure blood i.e. oxygen mixed blood.
- The artery carrying blood to the muscles of the heart are called *coronary arteries*. Any type of hindrance in it causes heart attack.

Course of circulation : Mammals have double circulation. It mean blood have to cross two times from heart before circulating throughout the body.

- Right auricle recieve impure blood from the body which goes into right ventricle. From here the blood went into pulmonary artery which send it to the lung for purification. After purification it is collected by pulmonary vein which bring it back to heart in left auricle. From auricle it went into left ventricle. Now this purified blood is went into aorta for different organ of body.

This circulation is done is a cardiac cycle.

- **Cardiac cycle** : Rhythmic systole (Contraction) and diastole (relaxation) of auricle and ventricle constitutes a cardiac cycle.
- **Heart beat** : Heart keeps beating rhythmically throughout the life. There is a node from which originate contraction of heart.

(i) Sino auricular node (SA node) : It is a specialised area of cardiac muscle fiber in right auricle. SA node is also known as *pace maker* as it generates each wave of cardiac impulse.

(ii) Auriculo – Ventricular node (AV node) : AV node is present close to the interatrial septum near the right AV aperture. Wave of contraction is picked up by AV node which spread through.

- Wave of excitation is picked up by AV node which spread through AV bundle of muscles fibers present on inter artrial septum as well as inter-ventricular septum.

- Artificial pace maker : When SA node becomes defective or damaged, the cardiac impulses do not generate. This can be cured by surgical grafting of an artificial pace maker an electric device in the chest of the patient. It stimulate the heart electrically at regular intervals.
- Systole and diastole of the heart are collectively called *heart beat*. In the normal condition the heart of the human beats 72 times and in a single beat it pumps approximately 70 ml blood.
- The blood pressure of a normal human is 120/80. (Systolic – 120 and Diastolic – 80).
- Blood pressure is measured by *sphygmomanometer*.
- *Thyroxin* and *adrenaline* are the hormones which independently controls the heart beat.
- The CO_2 present in the blood accelerates the heart beat by reducing the pH.

(c) Lymph Circulatory System

- The light yellow fluid found in the inter-cellular intervals between different tissues and cells is called *lymph*.
- Lymph is a fluid whose composition is like blood plasma, in which nutrient, oxygen and various other substances are present.
- The corpuscles found in lymph are called *lymphocytes*. In fact, these are White Blood Corpuscles (WBC).
- Lymph flows only in one direction from tissue towards heart.

Functions of lymph :

(i) The lymphocytes present in lymph helps to prevents the body from diseases by killing the harmful bacteria.

(ii) Lymph form the lymphocytes.

(iii) The node found in lymph vessels are called *lymph node* works as a filter in the human body.

(iv) Lymph helps in healing the wounds.

(v) Lymph circulates different material from tissues to veins.

(d) Excretory System

Excretion : Removal of nitrogenous substances formed during metabolism from the body of human is called *excretion*. Normally excretion means the release of nitrogenous excretory substances like urea, ammonia, uric acid etc.

The main excretory organs of human are as follows –

(i) Kidneys, (ii) Skin, (iii) Liver and (iv) Lungs.

(i) Kidneys : The main excretory organ in human and other mammals is a pair of kidneys. Its weight is 140 grams. There are two parts of it. Outer part is called *cortex* and the inner part is called *medulla*. Each kidney is made up of approximately 1,30,00000 kidney ducts which are called *nephrons*. Nephron is the structural & functional unit of the kidney. There is a cup like structure in the every nephron called *Bowman's capsule*. Glomerulus of thin blood vessels are found in the Bowman's capsule which is made up of two types of arterioles.

(i) Afferent arteriole : Which carries the blood to the glomerulus.

(ii) Efferent arteriole : By which the blood is taken out of the glomerulus.

- The process of filtration of liquids into the cavity of Bowman's capsule, is called *ultra filtration.*
- The main function of the kidneys is purification of blood plasma i.e. to excrete the unwanted nitrogenous waste substances through urination.
- The supply of blood to kidneys takes place in large quantity in comparison to other organs.
- In the kidneys average 125 ml per minute blood is filtrated i.e. 180 liters per day. Out of it 1.45 liters urine is formed daily and the remaining is absorbed back by the cells of nephron and mix into the blood.
- In the normal urine there is 95% water, 2% salt, 2.7% urea and 0.3% uric acid.
- The colour of the urine is light yellow due to the presence of *urochromes* in it. Urochrome is formed by the dissotiation of haemoglobin.
- Urine is acidic. Its pH value is 6.
- The stone formed in the kidneys is made up of calcium oxalate.

(ii) Skin : Oil gland and sweat glands found in the skin respectively secretes *sebum* and *sweat.*

(ii) Liver : Liver cells play the main role in excretion by converting more and more amino acids and ammonia of blood into urea.

(iii) Lungs : The lungs excretes two types of gaseous substances carbon dioxide and water vapour. The excretion of some substances like garlic, onion and some spices in which vapour component excreted by the lungs.

Different Animals and excretory parts

Animal	Excretory parts
1. Unicellular animal	By diffusion through general body surface
2. Animals of Porifera Phylum	By general body surface contractile vocoule
3. Coelenterates	Directly by cells.
4. Flat worm	By flame cells.
5. Animals of Annelida Phylum	By nephridia.
6. Arthropods	By Malpighian tubules.
7. Curstaceans	Antennal gland
8. Mollusca	By urinary organ.
9. Vertebrate	Mainly by kidneys

Hemodialysis : Process of removal of excess urea from the blood of patient using artificial kidney.

(e) Nervous System

Under this system thin thread like nerves are spread throughout the body. After receiving the information of environmental changes from

the sensitive organs, it spreads them speedly like electrical impulses and establishes working and coordination among different organs.

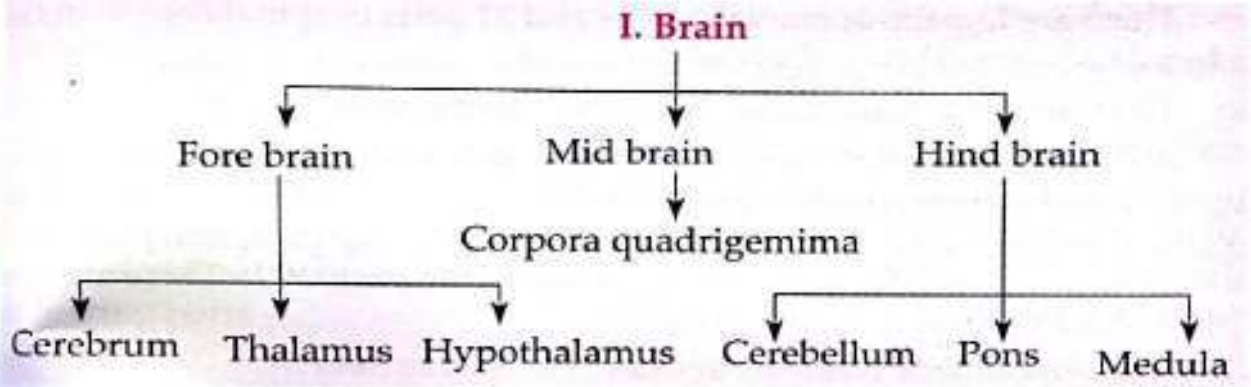
Nervous System of human is divided into three parts :

(1) Central Nervous System (2) Peripheral Nervous System

(3) Autonomic Nervous System.

1. Central Nervous System – Part of the nervous system which keeps control on the whole body and on nervous system itself is called *Central Nervous System*. The Central Nervous System of human is made up of two parts - *Brain* and *Spinal Cord*.

Brain is covered by membrane called *meninges*. It is situated in a bony box called *craninum* which protect it from external injury.



(A) Fore Brain : The weight of the brain of the human is 1350 grams.

(i) The function of the Cerebrum : This is the most developed part of the brain. This is the centre of wisdom, memory, will power, movements, knowledge and thinking. The analysis and coordination of muscular movement received from sense organs.

(ii) The function of thalamus : It is the centre of the pain, cold and heat.

(iii) The function of hypothalamus : It controls the hormonal secretion from endocrine glands. Hormones secreted from posterior pituitary gland secrete through it. This is the centre of hunger, thirst, temperature control, love, hate etc. Blood pressure, metabolism of water, sweat, anger, joy etc. are controlled by it.

(B) The function of Corpora quadrigemina : This is the centre of control on vision and hearing power.

(C) Hind Brain

(i) Function of cerebellum : It is some what at the back of head and consist of two cerebellar hemisphere like cerebrum. It is large reflex centre for coordination of muscular body movements and maintenance of posture.

(ii) Pons : It act as bridge carrying ascending and descending tracts between brain and spinal cord.

(iii) Medulla : It is posterior most part of brain and continuous into the spinal cord. It connect and communicate the brain with spinal cord. It contains the cardiac respiratory and vasomotor centres that control complex activity like heart action, respiration, coughing, sneezing etc.

➢ The brain of the human is covered in the cranium which protects it from external injury. Brain is covered by membrane called *meanings*.

➢ Spinal cord : The posterior region of the medulla oblongata forms the spinal cord. Its main functions are :

(a) Coordination and control of reflex actions i.e. it works as the centre of the reflex actions.

(b) It carries the wave coming out of brain.

Note : *Reflex action was first discovered by the scientist, Marshall Hall.*

2. Peripheral Nervous System : Peripheral Nervous System is made up of the nerves arising from brain and spinal cord. These are called cranial and spinal nerves respectively. There are sensory, motor and mixed nerve.

➢ There are 12 pairs of cranial nerves and 31 pairs of spinal cord found in a human.

➢ The unit of nervous tissues is called *Neuron* or *nerve cell.*

3. Autonomic Nervous System : Autonomic Nervous System is made up of some brain nerves and some spinal cord nerves. It supplies nerves to all the internal organs and blood vessel of the body. *Langley,* first presented the concept of Autonomic Nervous System in the year 1921. There are two parts of Autonomic Nervous System :

(i) Sympathetic Nervous System

(ii) Parasympathetic Nervous System.

Function of Sympathetic Nervous System :

(i) It narrows the blood vessels in the skin.
(ii) By its action hair gets erected.
(iii) It reduces the secretion of salivary glands.
(iv) It increases the heart beat.
(v) It increase the secretion of sweat glands.
(vi) It stretches the pupil of eye ball.
(vii) It relax the muscles of urinary bladder.
(viii) It reduces the speed of contraction & relaxation of intestine.
(ix) The rate of respiration increase.
(x) It increases the blood pressure.
(xi) It increases the sugar level in the blood.
(xii) It increases the number of Red Blood Corpuscles in the blood.
(xiii) It helps in clotting of blood.
(xiv) Collective impact of this affects fear, pain and anger.

Functions of Parasympathetic Nervous System :

The functions of this system is normally the opposite of Sympathetic Nervous System. For example :

(i) It widens the lumen of blood vessels but except the coronary blood vessels.
(ii) It increases the secretion of saliva and other digestive juices.
(iii) The contraction of pupil is caused by this.
(iv) It creates contraction in the other muscles of the urinary bladder.
(v) It creates contraction and motion in intestinal walls.
(vi) The effect of this nervous system collectively creates the occasion of rest and joy.

(i) Skeletal System

The skeletal system of human is made up of two parts :

(a) Axial skeleton and

(b) Appendicular skeleton.

(a) Axial skeleton : The skeleton, which makes the main axis of the body is called *axial skeleton*. Skull, vertebral column and bones of chest comes under it. There are 80 bones in axial skeleton.

(i) Skull : There are 29 bones in it. Out of these, 8 bones jointly protect the brain of the human. The structure made up of these bones is called *forehead*. All the bones of the fore head remain joined strongly by the sutures. There are 14 bones in addition to this which form the face. Six ear ossicles and one hyoid bone.

(ii) Vertebral Column : The vertebral column of the human is made up of 33 vertebra. All the vertebra are joined by intervertebral disc. Vertebra is made flexible by these intervertebral disc. We divide the whole vertebral column into the following parts –

1.	Cervical region	7 vertebras
2.	Thoracic region	12 vertebras
3.	Lumber region	5 vertebras
4.	Sacral region	(1) 5 vertebras
5.	Caudal region	(1) 4 vertebras
		Total – 33

- Its first vertebra which is called *atlas vertebra* holds the skull.

Functions of vertebral column :

(i) Holds the head.
(ii) It provides the base to the neck and body.
(iii) It helps the human in standing, walking etc.
(iv) It provides flexibility to the neck and body by which a human can move its neck and body in any direction.
(v) It provides protection to spinal cord.

(b) Appendicular skeleton : The following are the parts of it –

(i) Foot bones – Both hands and feet have 118 bones.
(ii) To hold the fore limb and hind limb on the axial skeleton in human there are two girdles.

- The girdle of fore limb is called *pectoral girdle* and girdle of hind limb is called *pelvic girdle*.
- Pectoral girdle joined with forelimb is called *humerus* and the bone from pelvic girdle join to hindlimb is called *femur*.

Functions of the skeletal system :

(i) To provide a definite shape to the body.
(ii) To provide protection to soft parts of the body.
(iii) To provide a base to the muscles for joining.
(iv) To help in respiration and nutrition.
(v) To form Red Blood Corpuscles.

- The total number of bones in a human's body - 206
- The total number of bones during childhood - 300

- The total number of bones of head - 29
  (fore head-8, facial-14, ear-6 ,hyoid -1)
- The total number of bones in vertebral column, initially-33
  After development - 26(5 sacral fuse into 1 and 4 caudal fuse into 1)
- The total number of bones of ribs 24
- The largest bone of the body *Femur* (bone of thigh)
- The smallest bone of the body *Stapes* (bone of ear)

The name and number of bones of some specific regions –

Ear bones	*Maleus*	(2)	Upper arm	*Humerus*	(2)
	Incus	(2)	Fore arm	*Radio ulna*	(2)
	Stapes	(2)	Wrist	*Carpals*	(16)
Palm	*Meta carpals*	(10)	Fingers	*Phalanges*	(28)
Thigh	*Femur*	(2)	Hind limb	*Tibia-fibula*	(4)
Knee	*Patella*	(2)	Ankle	*Tarsal*	(14)
Sole	*Meta tarsal*	(10)			

Note : *(i) The muscles and bones are join together by tendon.*
(ii) The muscle which join bone to bone is called ligaments.

(g) Endocrine System

(a) Exocrine glands : Gland which have duct are called *exocrine gland.* Secretion of enzymes pass through it. Example – *Lactic gland, Sweat gland, Mucous gland, Salivary gland* etc.

(b) Endocrine gland : These are *ductless gland.* Hormones are secreted by these gland. Hormones are sent to the different parts of the body through blood plasma. Example – *Pituitary gland, Thyroid gland, Parathyroid gland* etc.

Functions and effect of the main endocrine system of the human body and hormone secreted by them –

1. Pituitary gland : It is situated in a depression of the sphenoid bone of the fore head. This is called *sella – tunica.*

- Its weight is approximately 0.6 grams.
- This is also known as *master gland.* Pitutary gland is controlled by hypothalenus.

The functions of the hormones secreted by Pituitary gland :

(i) STH hormone (Somatotropic hormone) : It controls the growth of the body especially the growth of bones. By the excessiveness of STH *gigantism* and *acromegaly* are caused, in which height of the human grows abnormally. Lack of STH causes *dwarfism* in human.

(ii) TSH hormone (Thyroid Stimulating Hormone) : It stimulates the thyroid gland to secrete hormone.

(iii) ACTH Hormone (Adrenocorticotropic Hormone) : It controls the secretion of adrenal cortex.

(iv) GTH Hormone (Growth Hormone) : It controls the functions of gonads. This is of two types :

(a) FSH Hormone (Follicle - Stimulating Hormone) : In male it stimulates spermatogenesis in the seminiferous tubules of the testis. In female, it stimulates the Graffian follicles of the ovary to secret the hormone *Oestrogen.*

(b) LH Hormone (Luteiniging Hormone) : Interstitial cell stimulating hormone –, secretion of *testosterone* hormone takes place in male and in case of female *estrogen* hormone secreted.

(v) LTH Hormone (Lactogenic Hormone) : Its main function is to stimulate secretion of milk in breasts for infants.

(vi) ADH Hormone (Antidiuretic Hormone) : It causes increase in blood pressure. It is helpful in maintaining the water balance in the body and reduce the volume of urine.

2. **Thyroid gland** : This is situated below the larynx on both side of respiratory trachea in throat of human.

➢ The hormones secreted by it are Thyroxine and Triiodothyronine. Iodine is secretes in more quantity.

Functions of Thyroxin :

(i) It increases the speed of cellular respiration.

(ii) It is necessary for the normal growth of the body particularly for the development of bones, hair etc.

(iii) The normal functions of reproductive organs depend on the activeness of thyroid gland.

(iv) It controls the water balance of the body in coordination with the hormones of pituitary gland.

Diseases Caused by the Deficiency of Thyroxin :

(i) Cretinism : This disease affects the children. The mental and physical retardness of the child.

(ii) Myxedema : In this disease which normally attack during youth the metabolism does not take place properly which causes reduction in heart beat and blood pressure.

(iii) Hypothyroidism : This disease is caused due to a chronic deficiency of thyroxin hormone. Due to this diseases the normal reproduction is not possible. Sometimes due to this disease human becomes dumb and deaf.

(iv) Goitre : This disease is caused by the deficiency of iodine in food. In this disease the shape of the thyroid gland enlarges abnormally.

Diseases caused by the Excessiveness of Thyroxin :

Exopthalmic Goitre : In this disease eyes get bulging out of the eye socket with increased metabolic rate.

3. **Parathyroid gland** : This is situated in the right back of the thyroid gland of the throat. Two hormones are secreted by it :

(i) Parathyroid hormone : This hormone is secreted when there is a deficiency of calcium in the blood.

(ii) Calcitonin: This hormone is released when there is excess of calcium in the blood is present.

Hence, hormone secreted by parathyroid gland controls the quantity of calcium in blood.

4. Adrenal gland : There are two parts of this gland – (i) outer part is cortex and (ii) inner part is medulla.

Hormones secreted by cortex and their function –:

(i) Glucocorticoids : This controls the metabolism of carbohydrate, protein and fat.

(ii) Mineralocorticoids : Its main function is reabsorption of ion by kidney ducts and to control the quantity of other on in the body.

(iii) Sex hormone : It controls the sexual behaviour and secondary sexual characters.

Note : *(i) Cortex is essential for life. If this is extracted completely from the body; human will remain alive only for a week or two.*

(ii) In case of deformation of cortex, the process of metabolism gets disturbed; this disease is called Addison's disease.

Hormones secreted by Medulla and their function :

(i) *Epinephrine* – This is an amino acid.

(ii) *Nor epinephrine* – This is also an amino acid.

- The work of both the hormones is similar. These equally increase the relaxation and contraction of heart muscles. As a result, blood pressure increases and
- In case of sudden stop of heart beat, epinephrine is helpful in re-starting the heart beat.
- The hormone secreted by Adrenal gland is called fight flight, fright fight hormone.

5. Gonads :

(1) Ovary : The following hormones are secreted by this :

(i) Estrogen : It completes the increase of oviduct.

(ii) Progesterone : It stimulates the thickening of uterus lining during ovarien cycle.

(iii) Relaxin : During pregnancy it is found in uterus and placenta. This hormone smoothens the pubic symphysix and it widens the uterine cervix so that a child is delivered easily.

(2) Testes: The hormone secreted by it is called *testosterone*. It motivates the sexual behaviour and growth of secondary sexual characters.

(h) Respiratory System

- The most important organ of the respiratory system of human is lungs where the exchange of gases takes place.
- All those organs comes under respiratory system which help in exchange of gases are – Nasal passage, Pharynx, Larynx or Voice box, Trachea, Bronchi, Bronchioles, Lungs etc.
- Nasal passage : Its main function is related to sniffing. Its inner cavity is lined with mucous membrane. This secretes approximately ½ litre

of mucous everyday. This prevents the particles of sand, bacteria or other small organisms from entering into the body. It makes the air wet entering into the body and equalises it with the temperature of the body.

- **Pharynx** : It is situated behind the nasal cavity.
- **Larynx or Voice box** : The part of the respiratory way which connects the pharynx with trachea is called *Larynx* or *voice box*. Its main function is to produce sound. At the larynx entrance gate there is a thin blade-like door, which is called *epiglottis*. When any food particle is swallowed it closes the glottis, as a result food does not enter into respiration pipe.
- **Trachea** : It enters into the thoracic cavity. The two main branches of trachea are called *bronchi*. Right bronchi enters into the right lungs after being divided into three branches. Left bronchi enters into the left lungs after being divided into only two branches.
- **Lungs** : There is a pair of lungs in the thoracic cavity. Its colour is red and looks like sponge. Right lung is larger in comparison to left lung. Each lung is surrounded by a membrane which is called *pleural membrane*. There is a network of blood capillaries . Here Oxygen enters into the blood and CO_2 comes out.

The process of respiration can be divided into four parts :

1. External respiration.
2. Transportation of gases.
3. Internal respiration.
4. Cellular respiration.

1. **External respiration** : This is divided into two parts –
   (a) Breathing (b) Exchange of gases.

(a) Breathing : In lungs air is taken and given out at a certain rate which is called *breathing*.

Mechanism of Breathing :

(i) Inspiration : At this stage, air from the environment enters into the lungs through the nasal passage, due to increases in the dimension of thoracic cavity a low pressure is formed in the lungs and air enters into the lungs from environment. This air continues to enter until the pressure of air inside and outside the body became equal.

(ii) Expiration : In this process air comes out of the lungs.

Constitution of air in Breathing

	Nitrogen	Oxygen	Carbon dioxide
The air inhaled	79%	21%	0.03%
The air exhaled	79%	17%	4%

Every day approximately 400 ml water is excreted through breathing.

(b) Exchange of gases : The exchange of gases takes place inside the lungs. This gaseous exchange takes place on the basis of concentration gradient through normal diffusion.

The exchange of oxygen and carbon dioxide gases takes place due to their difference in partial pressures. The direction of diffusion of both.

2. **Transportation of gases** : The process of reaching of gases (oxygen

and carbon dioxide) from lungs to the cells of body and coming back again to the lungs is called the *transportation of gases.*

- Transportation of oxygen takes place by haemoglobin present in blood.
- Transportation of carbon dioxide from cells to lung takes place by haemoglobin only to the extent of 10 to 20%.
- Transportation of carbon dioxide takes place through circulation of blood :

(i) By mixing with plasma : Carbon dioxide forms carbonic acid after mixing in plasma. Transportation of 7% carbon dioxide takes place in this form.

(ii) In the form of bicarbonates : 70% part of carbon dioxide in the form of bicarbonates is transported. It mixes with potassium and sodium of blood and forms potassium bicarbonate and sodium bicarbonate.

3. Internal respiration : Inside the body, gaseous exchange takes place between blood and tissue fluid which is called *internal respiration.*

Note : *The gaseous exchange in lungs is called external respiration.*

4. Cellular respiration : Glucose is oxidised by oxygen reached into the cell. This process is called *cellular respiration.*

Types of cellular respiration :

Respiration is of two type

(a) Anaerobic respiration : If the oxidation of food takes place in absence of oxygen. During this only 2 ATP molecules are produced from one molecule of glucose. Final product of anaerobic respiration in animal tissue like skeletal muscle cell is lactic acid.

In yeast and certain bacteria ethyl alcohol or ethanol is produced.

$$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3 + \text{Energy (in animal)}$$
(Lactic acid)

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2 + \text{Energy (in plant)}$$
(Ethyl alcohol)

(b) Aerobic respiration : It takes place in the presence of oxygen. The complete oxidation of glucose takes place. As a result CO_2 and H_2O is formed and energy is released in huge amount.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 2870 \text{ KJ energy. (38 ATP)}$$

The complex process in cellular respiration is divided into two parts–

(i) Glycolysis (cytoplasm) (ii) Kreb's cycle (Mitochondria)

(i) Glycolysis : Its study was first done by *Embden Meyorh pathway.* Therefore, it is also called *EMP path*

- Glycolysis is present in both types of respiration, Aerobic and Anaerobic. This process takes place in cytoplasm.
- As a result of decomposition of one glucose atom in glycolysis two atoms of pyruvic acid is formed.
- To start this process 2 atoms of ATP (Adenosine Triphosphate) takes part but at the end of the process 4 atoms ATP are obtained. Therefore,

as a result of glycolysis 2 atom ATP are obtained i.e. 16000 calorie (2 x 8000) energy is obtained.

- There is no need of oxygen in glycolysis. Hence, this process is similar in anaerobic respiration and aerobic respiration.
- In this, four molecules of hydrogen formed which is used in converting NAD to $2NADH_2$.

(ii) Kreb's Cycle : It was described by *Hens Krebs* in 1937.

- This is also called *Citric Acid Cycle* or *Tricarboxylic Cycle.*
- This process is completed inside the Mitochondria in the presence of specific enzymes.
- Two atoms of each ADP and ATP are formed.
- In this cycle 4 pair of hydrogen atom are released.
- The complete cycle is of 2 atom pyruvic acid, produce total 4 atoms of carbon dioxide.
- In our system maximum ATP atoms are formed during Kreb's Cycle.

Production of energy :By the oxidation of pyruvic acid one atom of ATP, five atoms of NADH and one atom of $NADH_2$ are formed. From one atom of NADH three atoms of ATP and from one atom of $NADH_2$ two atoms of ATP are obtained. Hence, from one atom of pyruvic acid 1 + (3 x 5) + (2 x 1) = 18 atoms of ATP are formed. From one atom of glucose two atoms of pyruvic acid are formed, by which 36 atoms of ATP are released. During the glycolysis, two atoms of ATP are obtained. Hence, during respiration of one atom of glucose total 2 + 36 = 38 ATP atoms are obtained.

Respiratory substances : Carbohydrate, fat and protein are the main respiratory substances. At first, oxidation of glucose takes place, then fat. After the consumption of carbohydrate and fat oxidation of protein start.

Note : *Respiration is a Catabolic Process. It also reduces the weight of the body.*

5. Nutrients

To maintain life organisms performs some basic function is called *nutrition*. Nutrition is one of the basic function of life in which intake of food, digestion, absorption, assimilation and egestion of undigested foods are included.

Nutrient :Nutrient are the substance by which an organism get energy or it is used for biosynthesis of its body.

For example carbohydrate and fat are the source of energy. Whereas proteins and minerals are the nutrient used for biosynthesis.

Carbohydrate : Carbohydrates are organic compounds in which the ratio of Carbon, Hydrogen and Oxygen is 1 : 2 : 1. Carbohydrate in the form of sugar and starch are major intake in animals and human. 50 to 75% energy is obtained by oxidation of carbohydrate. Carbohydrate containing aldehyde group is called *aldose* and with ketone group is called *ketose*. Carbohydrates are derivatives of polyhydroxy alcohols.

Classification of carbohydrate :Carbohydrates are classified into three major group.

(a) Monosaccharides : These are the simple sugar made up of single polyhydroxy or ketone unit. Most abundant monosaccharides found in nature is glucose containing six carbon atom. *Triose, tetrose, pentoses, heptoses* are the type of monosaccharides.

(b Oligosaccharides : When 2 to 10 monosaccharides join together they form oligosaccharides. They are usually crystalline in nature and sweet in test. *Maltose, sucrose, lactose* are disaccharides made up of two monosaccharides.

(c) Polysaccharides : These are the compound of sugar which are formed due to joining large number of monosaccharide. There are insoluble and tasteless. Some example of polysaccharides are *starch, glycogen, cellulose, chitin* etc.

Function of Carbohydrate

1. Carbohydrate works as fuel. During the process of respiration, glucose break into CO_2 & H_2O with the release of energy. One gram of glucose gives 4.2 kilo calories energy.
2. Nucleic acids are polymers of nucleosides and nucleotides and contain pentose sugar.
3. Lactose of milk is formed from glucose and glactose.
4. Glucose is used for the formation of fat and amino acid.
5. Carbon skeleton of monosaccharides is used in the formation of fatty acid, chitin, cellulose etc.

Source of Carbohydrate : Wheat, rice, maize, sweet potato, potato and other plant and animals are the sources of carbohydrate.

2. Protein : Protein word was first used by *J. Berzelius*. This is a complex organic compound made up of 20 type of amino acids. Approximately 15% of the human body is made up of protein. Nitrogen is present in protein in addition to C, H & O.

Twenty two types of protein is necessary for human body, out of which 12 are synthesized by body itself and remaining 10 are obtained by food are called essential amino acid.

Types of proteins :

On the basis of chemical composition

It is divided into three types.

(1) Simple Protein : It consists of only amino acid.

Example : *Albumins, Globulins, Histones* etc.

(2) Conjugated Protein : Having some another chemical compounds in addition to amino acid.

Example : *Chromoprotein, Glycoprotein* etc.

(3) Derived Protein : It is derived from the partial digestion of natural proteins or its hydrolysis.

Example : *Peptone, Peptide, Proteinase* etc.

Function of Protein :

(i) It takes part in the formation of cells, protoplasm and tissues.

(ii) These are important for physical growth. Physical growth hampers by its deficiency. Lack of proteins causes *Kwashiorkor* and *Marasmus* diseases in children.

(iii) In case of necessity these provide energy to the body.
(iv) These control the development of genetic characters.
(v) These are helpful in conduction also.

Kwashiorkor : In this disease hands and legs of children get slimmed and the stomach comes out.

Marasmus : In this disease muscles of children are loosened.

3. **Fats** : Fat is an ester of glycerol and fatty acid.

In these carbon, hydrogen and oxygen are present in different quantities, but proportionally less oxygen than carbohydrate.

Normally *fat* remains as solid at 20°C temperature, but if it is in liquid form at this temperature, this is called *oil*.

Fatty acids are of two types – Saturated and unsaturated. Unsaturated faty acids are found in fish oil and vegetable oil. Only coconut oil and palm oil are the examples of saturated oil.

9.3 kilo calorie energy is liberated from 1 gram fat.

Normally an adult person should get 20-30% of energy from fat.

Main functions of fat :

(i) It provides energy to the body.
(ii) It remains under the skin and prevents the loss of heat from the body.
(iii) It make the food material testy.
(iv) It protects different parts of the body from Injury.

Due to the lack of fat skin gets dried, weight of the body decreases and the development of the body checked.

Due to the excessiveness of fat the body gets fatty, heart disease takes place and blood pressure increases.

4. **Vitamins** : Vitamin was invented by Sir F. G. Hopkins. The term vitamin was coined by Funk.

Vitamins are organic compound required in minute quantities. No calorie is obtained from it, but it is very important in regulating chemical reactions in metabolism of the body.

On the basis of solubility, vitamins are of two types :

(i) Vitamin soluble in water : Vitamin-B and Vitamin-C.
(ii) Vitamin soluble in fat : Vitamin-A, Vitamin-D, Vitamin-E and Vitamin-K.

The diseases caused by the deficiency of vitamins and their sources

Vitamin	Chemical name	Deficiency diseases	Sources
Vitamin-A	Retinol	Colour blindness, Xerophthalmia	Milk, Egg, Cheese, Green vegetable fish liver oil
Vitamin-B_1	Thymine	Beriberi	Ground nut, Rapseed, Dried Chilli, Pulses, Liver, Egg, Vegetables etc.

Vitamin	Chemical name	Deficiency diseases	Sources
Vitamin-B_2	Riboflavin	Cracking of skin, red-dish eye, cracking of tongue	Meat, Green vegetables, Milk etc.
Vitamin-B_3	Pantothenic acid	Whitening of hair, mentally retardness	Meat, Milk, Nut, Tomato, Sugarcane etc.
Vitamin-B_5	Nicotinamide or Niacin	Pellagra or 4-D Syndrome	Meat, Ground nut, Potato, Tomato, Leafy vegetables etc.
Vitamin-B_6	Pyridoxine	Anaemia, skin disease	Liver, Meat, Grains etc.
Vitamin-B_7	Biotin	Paralysis, body pain, hair falling	Meat, Egg, Liver, Milk etc.
Vitamin-B_{12}	Cynocobalamin	Anaemia, jaundice Teroile Glutemic	Meat, Milk etc.
Folic acid	–	Anaemia, diarrhoea	Pulses, Liver, Vegetables, Eggs etc.
Vitamin-C	Ascorbic acid	Scurvy, Swelling of gums	Lemon, Orange, Tomato, Sour substances, Chilly, Sprouted grain etc.
Vitamin-D	Calciferol	Rickets (in children), Osteomalasia (in adults)	Fish liver oil, Milk, Eggs etc.
Vitamin-E	Tocopherol	Less fertility	Leafy vegetables, Milk, Butter, Sprouted wheat, Vegetable oil etc.
Vitamin-K	Phylloquinone	Non-clotting of blood	Tomato, Soybean oil Green vegetables, etc.

- Cobalt is found in Vitamin-B_{12}.
- Synthesis of vitamins cannot be done by the cells and it is fulfilled by the vitamin foods.
- However, synthesis of Vitamin-D and K takes place in our body.
- Synthesis of Vitamin-D takes place by the ultra violet rays present in the sunlight through cholesterol (Irgesterol) of skin.
- Vitamin-K is synthesized in our colon by the bacteria and from there it is absorbed.

6. Minerals : Mineral is a homogenous inorganic material needed for body. These control the metabolism of body.

Important Minerals and their functions

Minerals	Daily quantity	Main sources	Functions
Sodium (as sodium chloride)	2 – 5 gram	Normal salt, fish, meat, eggs, milk etc.	It normally found in external fluid of cell and is related to following functions : Contractions of muscles, In the transmission of nerve impulses in nerve fiber. Control of positive electrolyte balance in body etc.

Minerals	Daily quantity	Main sources	Functions
Potassium	1 gram	Approximately all edibles	It is normally found in protoplasm. It is important for following different chemical reactions in cells : Muscular contraction, nerve conduction. maintenance of positive electrolyte in body etc.
Calcium	Approx. 1.2 gram	Milk, cheese, eggs, grains, gram, fish etc.	This provides strength to bones and teeth with vitamin, Important role in blood formation, Related with muscular contruction. Help in clotting the blood etc.
Phosphorus	1.2 gram	Milk, cheese, Bajra, green leaf vegetables, etc.	This provides strength to bones and teeth, in coordination with calcium.
Iron	25 mg (boy) 35 mg (girl)	Albumen of egg, bread, Bajra, Banana, Spanich apple	Iron is important in formation of Red Blood Corpuscles and haemoglobin. This is important for tissue Oxidation.
Iodine	20 mg	Sea fish, sea food, green leaf vegetables, Iodized salt.	This is important for synthesis of thyroxin hormone secreted by Thyroid gland.
Magnesium	Very small quantity	Vegetables	For functioning of muscular system and nervous system.
Zinc	Very small quantity	Liver and fishes	For insulin functioning.
Copper	Very small quantity	Meat, fish, liver and grains.	Formation of haemoglobin and bones and as a conductor of electron.
Cobalt	Very small quantity	Meat, fish and water	For synthesis of RBC and Vitamin B_{12}.

7. **Water** : Human gets it by drinking. Water is the important component of our body. 65-75% weight of the body is water.

Main functions of water :

1. Water controls the temperature of our body by sweating and vaporizing.
2. It is the important way of excretion of the excretory substances from the body.
3. Maximum organic chemical reactions in the body perform through hydrolysis.

Balance Diet : That nutrition, in which all the important nutrients for organism are available in sufficient quantity, is called *Balance Diet.*

Balance nutrition is obtained from Balance Diet, which is given in the chart below :

Edibles	Adult male			Adult female			Children		Boy	Girl
	N	M	Hard	N	M	Hard	1-3 yrs.	4-6 yrs.	10-18 yrs.	10-16 yrs.
Grain (wheat, rice)	400 g	520 g	670 g	410 g	440 g	575 g	175 g	270 g	420 g	380 g
Pulses	40 g	50 g	60 g	40 g	45 g	50 g	35 g	35 g	45 g	45 g
Leafy vegetables	40 g	40 g	40 g	100 g	100 g	50 g	40 g	50 g	50 g	50 g
Vegetables (other)	60 g	70 g	80 g	40 g	40 g	100 g	20 g	30 g	50 g	50 g
Milk	150 g	200 g	250 g	100 g	150 g	200 g	300 g	250 g	250 g	250 g
Tuber root	50 g	60 g	80 g	50 g	50 g	60 g	10 g	20 g	30 g	30 g
Sugar	30 g	35 g	55	20 g	20 g	40 g	30 g	40 g	45 g	45 g
Fat and oil	40 g	45 g	65 g	20 g	25 g	40 g	15 g	25 g	40 g	35 g

Necessary calorie for a human being :

	Nature of work	Male	Female
1.	Light worker	2000 calorie	2100 calorie
2.	Eight hours worker	3000 calorie	2500 calorie
3.	Hard worker	3600 calorie	3000 calorie

6. Human Diseases

Diseases caused by Protozoa :

	Disease	Affected organ	Parasites	Carrier	Symptoms Mosquito
1.	Malaria	RBC & Liver	*Plasmodium*	Female Anophelies	Fever with shivering
2.	Pyorrhoea	Gums	*Entamoeba gingivelis*	—	Bleeding from gums.
3.	Sleeping sickness	Brain	*Trypanosoma*	Tse-Tse flies	Fever with severe sleep.
4.	Diarrhoea	Intestine	*Entamoeba histolytica*	—	Mucous & Diarrohea with blood.
5.	Kala-ajar	Bone marrow	*Leismania donovani*	Sand flies	High fever.

Charles Leveran discovered the Malaria Parasite, *plasmodium* in the blood of the affected person in the year 1880.

Ronald Ross (1897) confirmed the Malaria is caused by malaria parasite and told that mosquito is the carrier of it.

Diseases caused by Bacteria :

Disease	Affected organ	Name of Bacteria	Symptoms
Tetanus	Nervous system	*Clostridium Tetani*	High fever, spasm in body, Closing of jaws etc.
Cholera	Intestine	*Vibrio cholerae*	Continuous stool and vomiting.
Typhoid	Intestine	*Salmonella typhosa*	High fever, headache.
Tuberculosis	Lungs	*Mycobacterium tuberculosis*	Repeated coughing.
Diphtheria	Respiratory tube	*Corynebacterium diphtheriae*	Difficulty in respiration and suffocation.
Plague	Lungs, area between the two legs	*Pasteurella pesties*	Very high fever, muscular eruptions on the body.
Whooping cough	Respiratory system	*Hemophilis pertusis*	Continuous coughing.
Pneumonia	Lungs	*Diplococcus pneumoniae*	High fever, swelling in lungs.
Leprosy	Nervous System Skin	*Mycobacterium leprae*	Spots on body, nerves affected.
Gonorrhea	Urinary Path	*Neisseria Gonorrhoeae*	Swelling in urinary path.
Syphilis	Urinary path	*Treponema pallidum*	Wounds in urinogenial tract

Note : *In the year 1882, German scientist Robert Koch discovered the bacteria of Cholera and T.B.*

Louis Pasteur discovered the vaccine of Rabies and pasteurization of milk.

Diseases caused by Viruses

	Disease	Affected organ	Name of virus	Symptoms
1.	AIDS	Defensive system (WBC)	HIV	Immune system of body became weak.
2.	Dengue fever	Whole body particularly head, eyes and joints.	Billions of virus	Pain in eyes, muscles, head and joints
3.	Polio	Throat, backbone Nerve.	Pilio virus	Fever, body pain, backbone and intestine cells are destroyed.
4.	Influenza (flu)	Whole body	Mixo virus	Suffocation, sneezing, restlessness.
5.	Chicken Pox	Whole body	Variola virus	High fever, redish eruption on body.

Disease	Affected organ	Name of virus	Symptoms
6. Small pox	Whole body	Varicella virus	Light fever, eruption of bile on body.
7. Goitre	Parathyroid gland	—	Difficulty in opening the mouth with fever.
8. Measles	Whole body	Morbeli virus	Redish eruptions on body.
9. Trachoma	Eyes	—	Reddish eyes, pain in eyes.
10. Hepatitis or Jaundice	Liver	—	Yellow urine, Eyes and skin become yellow.
11. Rabies	Nervous system	Rabies virus	The patient becomes mad with sever headache & high fever.
12. Meningitis	Brain	—	High fever.
13. Herpes	Skin	Herpes	Swelling in skin.

Note : *AIDS – Acquired Immuno Deficiency Syndrome.*

Elisa Test : *Test of HIV Virus (AIDS)*

Diseases caused by Protozoa :

(i) Diarrhoea : The reason of this disease is the presence of internal protozoa namely *Entamoeba histolytica* which is spread through house flies. It causes wounds in the intestine. Protein digesting enzyme, trypsin is destroyed in this. This disease is mostly found in children. Disease caused by helminthes.

(ii) Filaria : This disease is caused by *Wuchereia baoncrofti.* This worm is circulated by the stings of culex mosquitoes. This disease causes swelling in legs, testes and other parts of the body. This disease is also known as *Elephantiasis.*

Diseases caused by Fungus

(i) Asthma : The spores of the fungi, namely *Aspergillus fumigatus* reaches the lungs of the human and constitutes a net like formation, thus, obstructs the function of lungs. This is a infections disease.

(ii) Athlete's foot : This disease is caused by the fungi namely *Tenia Pedes.* This is a infections disease of skin which spreads mainly due to the cracking of feet.

(iii) Scabies : This disease is caused by the fungi namely *Acarus scabies.* In this disease the skin itches and white spots found on the skin.

(iv) Baldness : This is caused by the fungi namely *Taenia capitis.* Due to this hair of the head falls.

(v) Ringworm : This disease spreads through the fungi namely *Trycophyton Lerucosum.* This is a infections disease. Round red spot found on the skin.

Some Other Diseases

1. Paralysis or Hemiplegia : In this disease within a few minutes half of the body is paralyzed. The nerves of the paralyzed part become inactive.

The reason of this disease is due to high blood pressure bursting of any nerve of brain or insufficient supply of blood to brain.

2. Allergy : Some substance like sand, smoke, chemical, clothes, cold are dangerous to some persons and there are reactions in their body, which causes various diseases. Itching, pimples, swelling in body, black spot, eczema etc. are the examples of allergy.

3. Schizophrenia : This is a mental disease which usually found in youth. The patient considers the imagination as a truth, not to the facts. These patients are lazy, emotionless etc. Electropathy is helpful in this disease.

4. Epilepsy : This disease is caused by the internal disturbance of brain. In this disease, foam coming out of the mouth and the patient falls down unconscious.

5. Diplopia : This disease is caused by the paralysis of muscles of the eyes, in which double image is formed.

6. Bronchitis : It is caused by the inflammation of tubes leading from the wind pipe to lungs.

7. Colds : This is highly infections disease and is caused by a virus which result in bad throat, headache and watery nose.

8. Colic : Severe pain in the abdomen caused by spasm of the internal organs usually the intestines.

9. Delirium : It is a serious mental disturbance occuring under the influence of poisonous drugs.

10. Hydrophobia : A disease cause by bite of a mad dog.

11. Hyper metropia (long sightedness) : One can see the object of longer distance but not the object of nearer one. It can be corected by convex lens.

12. Myopia (short sightedness) : In this disease person can see the object of nearer distance but can not see the object of longer distance. It is corrected by using concave lens.

13. Leukaemia : There is a great increase in the number of white blood corpuscles in system. Swelling of spleen takes place. Death occur within few days.

14. Migrain : An allergic disease in which there is a periodic attack of headache takes place. It is an incureble disease.

15. Obesity : Excessive fatness is called *obesity*.

16. Piles : There are a various vein in the rectum. Due to extra pressure on vein it prevent the free flow of blood creating problem. It is caused due to constipation.

17. Rheumatism : The symptiom of this disease is fever with joints pain.

Other Disease

Atherosclerosis : Deposition of cholesterol particles in the lumen of arteries which prevent the flow of blood is called atherosclerosis.

Arteriosclerosis : Due to deposition of cholesterol and calcium salt arteries became stiff and rigid. It loses the property of elasticity due to which wall of arteries may rap fun.

Uremia : Presence of excess of urea in blood is called uremia, This is caused by malfunctioning of kidney.

Glgcosuria : Presence of excess of glucose urine is known as glycosuria.

Arthritis : It is disease in which inflammation of joints takes place.

Osteoporosis : It is a age dependent disorder of bone in which low bone mass and increased fragility takes place.

Hyperglycemia : It is disorder in which the concentration of glucose in the blood is high.

Hypoglycemia : It is a condition in which the concentration of glucose in the blood is very low.

Pneumonia : Acute inflamation of alveoli of lung.

Emphysema : It is the abnormal distension of alveoli which result in the loss of elasticity. Cigarette smoke and chronic bronchitis are two main causes.

7. Miscellaneous

Medicinal Discoveries

Inventions/Discoveries	Inventor/Discoveries
Vitamin*	F. G. Hopkins, Cosimir Funk
Vitamin-A	Mc. Collum
Vitamin-B	Mc. Collum
Vitamin-C	Holst
Vitamin-D	Mc. Collum
Sulpha drugs	Dagmanck (Dogmanck)
Streptomycin	Selman Waksmann
Heart Transplantation	Christian Bernard
Homoeopathy	Hahnemann
Malaria parasite and treatment	Ronald Ross
Diarrhoea and treatment of plague	Kitajato
Sex hormone	Stenach
Open heart surgery	Waltallilehak
Contraceptive pills	Pincus
First test tube baby	Edwards and Stepto
Electrocardiograph	Iwanyaan
Antigen	Karl Landsteiner
RNA	James Watson and Arther Arg
DNA	James Watson and Crick
Insulin	Banting

* *Funk named it 'Vitamine' (in 1912)*

Inventions	Inventor
Chloroform	Harrison and Sympson
Vaccine of chicken pox	Edward Jenner
T.B. bacteria	Robert Koch
Diabetes	Banting
Penicillin	Alexander Flemming
Polio vaccine	Johan E. Salk
BCG	Guerin Calmatte
Bacteria	Luvenhauk – Leeuwenhock
Blood transfer	Karl Landsteiner

Important Informations :	
Largest and heaviest mammal	Blue whale
Largest land mammal	African elephant
Largest living reptile	Sea turtle (Tortoise)
Largest living bird	Ostrich
Largest snake	Python
Largest monkey	Gorilla
Smallest bird	Humming bird
Smallest mammal	Shrew
Largest egg	Ostrich's egg.
Fastest animal	Cheetah (Panther)
Fastest flying bird	Spine tailed Swift
Egg lying mammal	Echidna and Duckbiled Platypus
Tallest mammal	Giraffe (Africa)
Busiest human organ	Heart

Some Important facts

1. The study of dreams is called Oneirology.
2. The study of the beauty of human is called Kalology.
3. At the time of creation of life there was no oxygen.
4. The strongest part in the body is the enamel of teeth.
5. The sex determination of human depends on male chromosomes not on female chromosomes.
6. The fastest nervous speed is 532 kmph.
7. The internal area of the lungs of human is 93 sq. m. which is forty times of the external area of the body.
8. The bones are as strong as concrete and as hard as granite.
9. Inside the body approximately 150 lakh cells are destroyed every second.

10. The weight of the uterus of the woman who has not given birth to a child is 50 grams and after giving birth to a child the weight becomes 100 grams.
11. The weight of the kidney is approximately 150 grams.
12. In a single inhaling, a normal adult takes 500 ml air inside the body.
13. The capacity of heart to pump the blood is 4.5 liters per minute.
14. The length of the small intestine is approximately 7 meter and its diameter is 2.5 centimeter.
15. The blood circulation inside the body takes approximately 23 seconds.
16. The antibiotic namely, penicillin is obtained from penicillium fungus.
17. Human is the most intelligent hominid of the universe.
18. Albatross is the largest sea bird, whose spread of feather is 10-12 ft.
19. There are approximately 50 lakhs hair in the body of human.
20. In the initial stage of formation of placenta, H.C.G. hormones flow at a large quantity and excreted through urine. At this time, in the testing of urine due to presence of this hormone pregnancy test is carried out.
21. The heart beat of a child is more than that of an adult.
22. A single respiration completes in 5 seconds i.e. 2 seconds of inspiration and 3 seconds of expiration.
23. Everyday blood in the body of the human carries approximately 350 liters of oxygen to the cells of the body. Out of this 97% oxygen is carried by haemoglobin and remaining 3% is circulated by blood plasma.

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