CONTENT

1. What is Biology

Biology is a branch of science that deals with the origin and development of living organisms, that is study of living things like plants and animals.

BOTANY : The branch of biology that deals with the study of Plants.

ZOOLOGY : The branch of biology that deals with study of Animals.

Existing living species are classified into 5 king- doms. They are:

1. **MONERA :** The kingdom of Prokaryotes (Those without having a definite nucleus)

   Eg. Bacteria

   Moneran cells are Microscopic and do not contain nucleus and other membrane-bound organells. They have rigid cell wall:

2. **PROTISTA :** The kingdom of Unicellular Eucaryotes

   These are primarily aquatic (living in water). Protistens are chief producers in oceans and many fresh water environment. They are collec- tively called PHYTOPLANKTON (or) Microscopic floating photosynthetic organisms. Some protists are predatory, feeding on other protists - those are called Protozoans.

   Eg : Protozoans and some Algal Members.

3. **PLANTAE :** Multicellular Producers with Com- plex body, organisation

   Eg : All Photosynthetic Plants.

4. **FUNGI :** Kingdom of Multicellular decomposers. Predominently Multicellular heterotrophic organ- isms. Mode of. nutrition is absorption of organic matter made soluble by decay.

5. **ANIMALIA :** Multi cellular consumers with complex body organisation, they are also known as META20A: The mobile way of life is made possible by the development of cells with ability to contract (or) to transmit impulses.

Before going into the details of the above 5 kingdoms'we should know the basic .difference between Prokaryotic cell and Eukaryotic cell.

In Prokaryotic cell (Bacterial cell) J^eriditary Material is not surrounded by a membrane. But in the cells of Eukaryotes the Heriditary Material is surrounded by a membrane to form the 'NUCLEUS'.

Eggs are single celled and the egg of Ostrich is probably the largest Eukaryotic cell.

Until the discovery of Electron Microscope, all the living organisms were believed to be com- posed of either Eukaryotic (or) prokaryotic cells. But the Electron Microscope has re- vealed the , existence of a third type of organisms w.hich cannot be called either Proca- ryotes or E-ukaryotes. They are nothing but VIRUSES which are much smaller than Bac- teria, infecting plants, animals, and Fungi.

It is not yet clear, whether viruses are early forms (Primitive) of living things or highly evolved super parasites.

2. KINGDOM MONERA

It is a kingdom of Prokaryotes. Moneran cells are microscopic without a nucleus and rigid cell wall. . Monerans are important decomposers and mineralisers in the biosphere.

Eg : BACTERIA

Bacteria were discovered by Leeweenhock (1676). They are omnipresent (present every where)

Based on their shape bacteria were devided into four types.

(i) Coccus - Spherical bacteriumi
(ii) Bacillus - rod shaped bacterium
(iii) Spirillum - Long and spirally coiled bacterium
(iv) Vibrio - Bacterium with a slight bent cell and appears like, comma.

Bacteria are considered as plants due to the presence of rigid cell wall (A cell wall is invariably found in all plant cells). There is no definite nucleus in bacterium. DNA is in the form of circular chromosome. Bacteria are devided into "Gram Positive" and "Gram Negative" types based on "Gram Staining Technique". The reagent used in this staining is "crystal violet dye". Those bacteria which take crystal violet dye during gram staining technique are called gram positive, those which do not take are gram negative.

ECONOMIC IMPORTANCE OF BACTERIA :

Uses :

1. Nitrifying and nitrogen fixing bacteria increase soil fertility
2. Bacteria decompose dead bodies of plants & animals, thus acting as natural scavengers.
3. A number of drugs like streptomycin, terramycin are extracted from the genus streptomyoes.
4. Bacteria are useful for curdling of milk, tanning of leather, curing of tea & tobacco leaves.
5. Many organic compounds & Vit B are manufactured industrially with the help of bac- teria.
6. Bacteria are used to clean water, polluted with oil because these break down hydrocarbons.

Harmful effects : They'are responsible for rot of fruits & Vegetables during storage.

	Plant diseases	**Human diseases**
1.	Blight of Paddy .	1. Pneumonia
2.	Citrus canker	2. Throat infection
3.	Angular leaf spot of cotton	3. Whooping cough
4.	Tumors in Plants	4. Tetanus
5.	Rot: of vegetables	5. Typhoid
7.	Tuberculosis	6. Cholera
8.	Leprocy	
9.	Diphtheria	
10.	Plague	
11.	Wound infection	
12.	Syphilis	

3. KINGDOM PROTISTA AND FUNGI

KINGDOM PROTISTA

It is a kingdom of unicellular Eukaryotes. It includes unicellular, primarily aquatic Eukaryotes. Many protistian organisms are photcsynthetic autotrophs & are chief producers of oceans and many fresh water environments.

Eg : Phyto Plankton (Unicellular Algae, Diatoms) Protozoans (Proto - first; zoan - animals). It is the kingidom which, links procaiyotic monera and the complex multicellular kingdoms of plants, fungi, & animals.

Protists reproduce asexually by Mitosis, & sexu- ally by a process involving cell fusion (Syngamy), zygote formation, and meiosis.

Photo synthetic protists - Dinoflagellates, Dia- toms; Euglena like Flagellates.

Protozoan Protists - Zoo flagellates, amoeba, sporozoans & ciliates.

Diatoms are the chief producers in the oceans. They have no flagella and float because of lipids in them.

Euglena like flagellates are common in fresh water. They can lead 'animal - like' or 'plant-like' life.

Zoo flagellates resembles cell wall-less Euglena like protists but are not photosynthetic.

Amoebae are predatory protozoans which pro- duce body extentions called pseudopodia, (false foot) to engulf the prey or for locomotion

Sporozoans are parasitic protozoans. Malarial parasite is a well studied sporozoan".

Ciliates, those which possess cilia (locomctory structures)

Eg :Paramecium, Plasmodium Material Para- site)

KINGDOM FUNGI

Fungi are important decomposers in the bio- sphere, recycling its inorganic resources. They obtain energy by extra cellular digestion (digestion out side" cell) and. absorption.

Fungi cells grow as elongated filaments called Hyphae. The enmeshed filaments are also called Myceliums. Fungi reproduce asexually by frag- mentation of mycelium or by special vegetative cells, called spores or Conidia.

Some lower fungi, (mainly aquatic) reproduce sexually by producing motile garnets which fuse in water. Terrestrial fungi occur as separate mating types. Two haploid hyphae of different mating types fuse during sexual reproduction to eventually form sexual spores.

The spore is typical reproductive unit of a fungus. It may be produced sexually or asexually. Spores produced by aquatic fungi may possess flagella for swimming. They are called zoo spores.

Terrestrial fungi, produce light spores which are dispersed by. wind. After being lodged in a favourable place, they germinate and the emerg- ing hypha produces a new organism.

FUNGI CLASSIFICATION:

Fungi are classified on the basis of their lifecycle and the way the, spores are .produced.

Zygomycetes. Eg: Common bread mould Rhizopus.

Ascomycetes - (The Sac Fungi) includes yeast, Edible morels etc.

Yeasts are single celled Ascomycetes which norfrlally reproduce asexually through budding. They can live anaerobically (in the absence of Oxygen) by fermentation.

Yeasts are economically important in the brewing and baking industries. Alcoholic fermentations of sugars (glucose and fructose) by yeast produces ethyl alcohol used industrially and alcoholic breverages such as beer, toddy, and wine. The fermented product may be further distilled to produce whisky, rum etc.

4. CELL BIOLOGY

All organisms in the universe are made up of cells. CELL is basic unit of life. It was first descovered oy Robert Hooke.

All cells are basically alike in chemical compo- i s'or aro metabolic activities. The function of an a^ar sr. as a whole is the out come of the activities and interactions of the constituent-cells.As the cell is microscopic, it can be viewed with the help of instruments which magnify the object several times. Among those compound micro- scope can magnify the object 1,00,000 times. Instead of using ordinary light, electrons are passed through, the object. These electrons are condensed by EI§ctro-Magnets, and the image is made to fall on flourescent screen. The only defect is, one can not see living objects by this microscope.

To see the object under Microscope, jt must be very thin sometimes 1/100th m.m. 7b cut into minute thin slices, an instrument called Microtone is used and to measure the Microscope objects, an instrument called Micrometer is used.

Each cell acts as an autonomous unit. It inde- pendently carries out all fundamental biological processes. It oxidises food molecules to produce energy and utilises that energy and some nutrient molecules to synthesize complex molecule. The cells use these molecules to build up new struc-, lures and to replace those worn out. For example blood cells are continuously destroyed and re- placed by fresh one produced in the bone marrow.

In a multicellular organism, cells do not normally live a totally independent existence. They interact and co-operate with one another. Thus they develop a division of labour. The human body has trilions of cells. All divide from the fertilised ovum and carrying the same genetic material

The ultra structure of a cell, can be revealed with the help of an electron Microscope. A typical euncaryotic cell consists of a mass of jelly like translucent protoplasm, enclosed by a plasma membrane. In plants the plasma membrane is surrounded by a rigid and porus cellulose cell wall. It is absent in Animal cell.

The general fluid mass of the cell outside the nucleus makes cytoplasm. The cytoplasm contains several organella.

Cell Wall:

Gives rigidity, shape and mechanical support to the cell. It is permeable to water, gases, and mineral salts. It is present in plant cells, bacteria, fungi. It is composed of cellulose material.

PLASMA MEMBRANE:

It is selectively permeable that is, it regulates the movement of materials across it. This membrane consists of two outer layers of proteins and a middle layer of phospholipids. It is termed as "Unit membrane".

PROTOPLASM:

It is the physical basis of life. It consists of 75 to 85% of water.

NUCLEUS:

It is the principal organelle of the cell. .It, is the dynamic centre of the cell. It is a dense, round or irregularly shaped body. It controls all. cellular metabolic activities. It intiates cell division. It is responsible for heridity.,

Nucleus is surrounded by a double membrane layer called the nucleuar envelope. It consists of two layers seperated by peri nuclear space. It is continous with lumen of the Rough Endo- plasmic reticulum. Nuclear envelope disappears during cell division and again reappears around two daughter nuclei.

There is a semifluid substance called nudoplasm or karyoplasm, one or more round bodies called nucleoli and a net work of dark staining fibres called the Chromatin reticulum is present in Nucleoplasm.

During cell division, this chromatic reticulum condenses to distinct threads called Chromo- somes.

Chromosomes are largely made of proteins. Every chromosome shows a constricted part called centromere. Chromosomes bear the genes. Each gene is composed of one,or more DNA (Deoxy Ribo Nucleic Acid).

The nucleus has two major functions:

1. The contained genetic information is passed to the daughter cell.
2. Controling cellular activities.

It dictates what enzymes are to be formed through the formation of RNA. Nucleolus is the site of extensive RNA synthesis. It is also concerned with the synthesis of Ribosomes.

Cytoplasm :

The term cytoplasm is used for the jelly-like fluid general mass of protoplasm excluding the nu- cleus. It contains cell organells vitamins, enzymes, minerals, sugars, aminoacids etc.The various cell organelles are Endoplasmic reticulum, Ribosomes, Golgicomplex, Lysosomes, lentrioles (only in Animal cell) Mitochondria, plastids (Only in plant cells).

Endoplasmic Reticulum (ER):

It consists of an inter communicating system of channels made of membrane sacs (cisternae), tubules and vesicles. It extends from nuclear envelope to plasma

membrane thus giving me- chanical support to the colloidal cytoplasm; It -Acts as a circulatory system for intra cellular (with in the cell) transport of various substances.

It contains many enzymes and other proteins. Two kinds of endoplasmic reticulums are ob- served in cells. One is Smooth Endoplasmic Reticulum (SER) and other Rough Endoplasmic Reticulum (RER)). RER has membranes with ribosomes attached to the cytoplasmic surface. The function of S'ER is to synthesize lipids and sterols and RER is concerned with synthesis of proteins as it posseses Ribosomes.

Golgi Complex or Dictyosomes:

It consists of one or more stacks af flat inter communicating, cisternae. A cisterna is a fluid r ed lumen enclosed by a single smooth mem- Drane. Cisternae are curved, shallow Lovwls. lt is abundant in glandular cells. Endoplasmic reticu- um is the seat of origin of Golgicomplex.

Secretion is the main function of- golgibodies. It synthesizes cell wall materials, glycoprotein, -: .cc pds, gums etc. Golgi vesicles also form the ce p ates after cell division in plants.

LYSOSOMES:

Lysosomes are Enzyme filled small spherical bodies originate from golgi complex. Lysomoes are concemed with intracellular digestion. It c not orrty food materials and foreign particles but also various useless cells organelles.

Plastids :

These are concerned with synthesis and storage cr feod materials. It is of 3 types.

(a) Luecoplasts - colourless plastids which store food materials.

(b) Chromoplasts - Coloured plastids meant for attraction, present in petals and ripe fruits.

(c) Chloroplasts - Green plastids which syn- thesize food materials by photosynthesis.

Chloroplast contains the- green .pigment chlorophyll. Chloroplasfs are covered by double membrane, containing a. space filled with a col- ourless proteineceous matrix called stroma. The stroma contains a small circular double helical DNA, Ribosomes and several enzymes. Many flat, membranous structures, called Thylakoids occur.in stroma. They are .placed'one above.the other like a stack of coins to form a granum. The main fuction of the chloro'plast is to trap solar energy and convert it into chemical bond energy in photosynthesis.

Mitochondria:

Also called as power houses of the cell or cellular furnaces, since energy, is generated in it. It is mainly concerned with transduction of energy from food materials to energy rich ATP (Adeno- cine tri phosphate) which stores it and it releases energy whenever, the cell requires.

Mitochondria is enclosed by a double membrane envelope. The two membranes of the envelope are separated by a narrow fluid filled space called outer compartment which contains some en- zymes. The inner membrane surrounds a central cavity or matrix filled with fluid.

Inner membrane projects into finger like appear- ances called CRISTAE which bear numerous particles called F_1 particles.

Mitochondria serve as compartments -for aerobic respiration.

Ribosomes:

Cell organell concerned with protein synthesis Ribosomes are synthesized in the nucleolus and enter into the cytoplasm where they remain freely in the cytoplasm or attached to the Endoplasmic Reticulum. About 6 to 8 ribosomes become attached to an mRNA (messenger Ribo Nucliec acid) molecule to form beaded string called polysome or polyribosome.

Micro bodies:

These are spherical or oval vesicles enclosed by a membrane and are filled with a fluid matrix.Peroxisomes are microbodies in liver ceils. They prevent peroxides from acting on the cellular contents. Glyoxisomes are microbod es in the cells of germinating fatty seeds.

Centrjoies :

These are non-membrane organelles found in animal-and in flagellated plant cells. These occur in pairs, at right angles to one another near one pole of the nucleus. Each centriole is made of nine triplets of microtubules. The - centrioles separate and migrate to opposite poles during cell division from where they function as centres for the organisation of the spindle.

Centrioles are involvedin the organisation and development of cilia and. flegella.

Vacuoles :

These are sap filled vesicles in the cytoplasm , covered by a membrane called "TONOPLAST". This sap contains .minerals, sugars, aminoacids, protein, esters water soluble pigments and waste products in solution. In mature plant cells, vacuoles fuse to form one large central vacuole. Some protozoan cells contain contractile vacuoles which are meant for excretion and Osmoregulation.

Ergastic Substances:

The non-protoplasmic inclusions of a cell which are non-living are called ' ergastic substances. They are

formed either as end-product during metabolic activities or of reserved secretory materials,

Mote :

1. The reserved food materials like carbohy- drates, nitrogenous matters, fats and oils are stored in the cells for futureuse.
2. Secretory materials include pigments, nectar and enzymes.
3. Excretory materials produced as a by product during metabolic activities of the cell.

CHROMOSOME

The rod like bodies found in nuclear region during cell divi- sion are called chromosomes. Man has 23 pairs of Chromo- somes or 2 sets of genomes or 46 chromosomes.

In Eucaryotic cells 2 types of chromosomes are present. Sex chromosomes which de- termine sex of the organism and second one is autosomes or somatic chromosomes.

Each chromosome consists of 2 Chromatids which remain attached to a point called centro- mere. Each chromosome basically consists of DNA and basic proteins called histones.

DNA (Deoxy Ribonucleic Acid) :

DNA is mainly found in nucleus'and it.also occurs in chloroplast and mitochondria. It is the genetic material and contains all the information needed for the development and existence of an organism.

It is located by means of Feulgen staining tech- nique which Is specific for DNA.. "Watson, and Crick" were able to corordinate all the known facts of DNA into a model and proposed a right handed double helix model.

DNA consists of two poly nucleotide strands which are coiled helically in clock-wise direction. DNA is a linear polymer of "PURINE" and "PYRAMiDINE" nucleotides. A . nucleotide is nothing but a nucleoside attached to a nitrogen base. A nucleoside is inturn a linkage of sugar and phosphate radical. In DNA, the sugar molecule is deoxy ribose sugar. It is different from RNA in not having an oxygen molecule (in RNA, the sugar molecule is ribose sugar).

Sugar molecule + Phosphate radical $\rightarrow$ Nucleoside

Nucleoside + Nitrogen base $\rightarrow$ Nucleotide.

Such nucleosides in large numbers form a poly nucleotide strand.. Such two strands which are anti parallel coil together to form DNA.

There are 4 nitrogen- bases in. DNA.

(a) Adenine. (A) (b) Thymine (T)
(c) Guanine (G) (d) Cytosine (C)

Adenine and guanine- are purines ehd Thymine and cytosine are pyramidines. A purine is always paired with pyramidine. That is Adenine always pairs, with Thymine- and Guanine is always pairs with Cytosine. This complementary is known as Base - pairing rule.

A polynucleotide strand of sugar and phosphate radicals are linked alternately to form external back bones. In between the sugar molecules of two back bones, nitrogen bases are arranged in the form of steps. The nitrogen bases are inter connected by week hydrogen bonds.

The DNA molecule is the most unique molecule in the living world. It is the only molecule that can replicate itself.

RNA (Ribo Nucleic Acid) :

It is found in all living cells. RNA, is synthesized mostly in nucleus but moves out into the cyto- plasm. RNA is responsible for transmitting the information from the nucleus to the ribosomes where protein - synthesis occurs. RNA is single stranded, consists of only one polynucleotide strand.

There are 3 types of RNA

(a) Ribosomal RNA or Y RNA found in the Ribosomes where protein synthesis occurs-
(b) Messenger RNA or'm' RNA which is produced in the nucleus and carries the information,for the synthesis of proteins. For each protein there is specific 'm' RNA.
(c) Transfer RNA is RNA. Its role is to collect aminoacids from the cytoplasm for protein synthesis.

The Golgi Apparatus : It is a membranous cell organelle composed of flattened sac-like cisternae stacked on one another. These cisternae resemble the smooth endoplasmic reticulum. While most of the eukaryotic cells posses Golgi apparatus, many fungi and some protozoans L-tck well-formed golgi bodies. The important function of the Golgi apparatus is to prepare for secretions. The material to be secreted moves from the ER to the Golgi apparatus during which vesicles arc budded off from the endoplasmic reticulum. Most proteins iliat are syntnesised at the endoplasmic reticulum 'are glycoproteins. These glycoproteins are transported to the Golgi apparatus and are modified there. The Golgi apparatus then sends the modified proteins to different locations by enclosing these proteins in vesicles that bud off from the Golgi apparatus.

Lysosomes: These are small vesicles that bud off from the Golgi apparatus. They contain some digestive enzymes. The Lysosomes are bound by a single membrane. These digestive enzymes are synthesised on the rough endoplasmic reticulum (RER) and packed into the Lysosomes. Sometimes, the cell may also digest a part of its own cytoplasm in a type of secondary lysosome called autophagic lysosome. Since the autophagic lysosomes sometimes digest a part of their own cell and its cytoplasm, they are called the suicide bags of the cell.

Sphaerosomes: The are spherical structures bounded by a single membrane and are present in the cytoplasm. They develop from ER. They are associated with synthesis and storage of lipids.

Microbodies : These are single membrane organelles and are associated with oxidation reaction (except oxidation reactions in association with respiration).

Differences between Prokaryotic and Eukaryotic cells: 1. Nuclear membrane is absent in p'ok?"-yot:c celh but is present in Eukaryotic cells. 2. The DNA in prokaryotes is not packed into chromosomes. In Eukaryotes, the DNA is packed into well defined chromosomes. 3. Prokaryotes do not have membrane bound organelles (like Endoplasmic Reticulum, Golgi Apparatus, Lysosomes etc) but Eukaryotes have them. 4. Prokaryotes lack an organised nucleus. The genetic material is present in the. form of a nucleoid. The nucleus is well organised in Eukaryotic cells and the genetic material is-also.packed within their nucleus. 5. Die Prokaryotic cells do not have chloroplasts. In the Eukaryotic cells of plant cells, thechloroplast is present.

Lipids : These are complex hdrocarbon chains which are not polar solvent (i.e., do not dissolve in water) but dissolve in non-polar solvents like benzene, ether and chloroform. The main categories of lipids are :

(i) Triglycerides : These are stored lipids and include fats and oils. The Triglycerides are composed of a single molecule of glycerol which is bound to three fatly acids. Glycerol is a three-carbon alcohol with three hydroxyl (OH) groups. Fatty acids are long chain hydrocarbon molecules with a carboxvl group (COOH) atone end which is free to bind to one of the OH groups of the glycerol, forming a bond called the ester bond. The fats in fatty acids may be saturated or unsaturated. The fat is saturated if the carbons in the chain are single-bonded. The fats are unsaturated if there is at least one carbon (C-C) double bond. It may be noted that solid fats are saturated and oils are unsaturated.

(ii) Phospholipids : This class of lipids form a major component of cell membranes Phosphdipids have two similarities with triglycerides i.e.. they also contain glycerol and fatty acids. The differences between triglycerides and phospholipids is that phospholipids contain two fattv acids attached to the glycerol, while in triglycerides the glycerol is bound to three fatty acids.

(iii) Steroids : These are compounds found in animal hormones and in cell membranes. For e.g., cholesterol is a steroid which- reinforces the structure of a cell membrane in animal cells and a group of bacteria called Mycoplasmas. The cell membrane of fungi contains a sterol called ergpsterol. Prostaglandins are a class of steroids which are deriyed from fatty acids and function in inflammatory and allergic reaction, blood clotting and smooth muscle contraction.

Proteins: These are the most dominant organic molecules in a cell. These are also physically and chemically the most diverse. The structure, behaviour and unique qualities of all living beings are a consequence of the proteins they contain. Amino acids are the building blocks of all proteins. All amino acids are made up of a . . . . . $_2$), a carboxyl group (i.e., COOH) and a hydrogen atom. The amino group of one amino acid is joined to the carboxyl group of another amino, acid by a peptide bond. The peptides, themselves are short chains of amino acids. A protein is the largest peptide group containing a minimum of 50 amino acids. Proteins are formed on the ribosome as linear sequences of amino acids. After its generation, the protein folds into a specific 3-dimensional form. Based on the type of folding, four different levels of protein organisation are recognised. These are primary, secondary, tertiary and quaternary protein structures. The functional 3-dimensional form of a protein is described as the native state. The most important outcome of intra-chain bonding / folding of proteins is that, a protein can react only with molecules that complement or fit the surface features of the folded protein.

Nucleic Acids : Nucleic acids occur in all known cells and viruses i.e., they not only occur in cells with a cell nucleus but also in cells with no defined nuclei like bacterial cells and in viruses. The two nucleic acids are deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). Both are polymers made up of nucleotides. Each nucleotide is made up of three units which are a nitrogen base, a pentose (a 5-carbon) sugar, and a phosphate. The nitrogenous base is a cyclic compound occurring as purines (two ring stnicture) and pyrimidine (one ring). The two purines are adenine (A) and guanine (G) while the three pyrimidines are thymine (T) cytosine (C) and uracil (U). One important difference in the composition of DNA and RNA is that in DNA, the nitrogen base is bonded to deoxyribose, while in RNA, the nitrogen base is bonded to the sugar ribose. The sugar molecules in RNA and DNA are linked by phosphate. The DNA is a long molecule formed by two long polynucleotide strands held together by hydrogen bonds. The hydrogen bonds occur between complementary pairs of nitrogen bases. The nitrogen bases are paired in a predictable manner so hat Adenine pairs with 1 hymine with the help of two hydrogen bonds while Guanine pairs with Cytosine with the help of three hydrogen bonds. RNA also is a long

chain of nucleotides but it is a single strand. The three major types of RNA are messenger RNA (mRNA) which is a copy of a gene from DNA and which gives to the sequence a type of amino acid to be incorporated into a protein, Transfer RNA (tRNA), which is a carrier which delivers the correct amino acids for protein assemhling, and ribosomal RNA (rRNA), which is a major component of ribosomes.

Adenosine Triphosphate (ATP) : This is alsu a nucleotide Containing three phosphates, adenine and ribose. It releases energy when phosphate bonds within it are broken. The presence of the high energy bonds in ATP makes it possible for ATP to ctore and release energy for ceiiuiai chemical reactions. When energy is released, the ATP is changed to Adnosine Diphosphate (ADP) which can be converted back to ATP when the phosphate bond is restored.

Enzymes: These are biological catalysts synthesised by the cells. The DNA of each cell has all the necessary, information for the production of all the enzymes required by it. Though enzymes are synthesised bv living cells, they retain their catalytic ability even after they are isolated from the cells. Though enzymes are mostly proteins, all proteins are not enzymes. A majority of the enzymes contain a non-protein part called the prosthetic group. Some Organic and inorganic ions are required by the enzymes for their activity, ihese are called co-factors and are bound to the ezyrnes. Enzymes function in a narrow range of temperature.

Hormones : These are substances that are synthesised in minor amounts in one tissue or organ (i.e., the effects) and transported to another tissues or organs (i.e., the targets). Hormones are classified into l<?cal and general. Local hormones have specific local effects while general hormones are secreted by the various endocrine glands and transported via the blood to cause physiological action elsewhere. Hormones perform a variety of functions like growth, sexual development, cellular oxidation, and metabolism of carbohydrates, proteins and fats. The plant hormones are called phvtohormones [like auxins, gibberellins, cytokinins, abscise acid (ABA) and ethylene].

Vitamins: These are organic molecules in food that are required in minute quantities for metabolism. These cannot be synthesised in adequate amounts in animals and humans. The vitamins are synthesised on a large scale by bacteria and plants. The two classes of vitamins are water soluble vitamins (which include vitamin C and B-Complex group of Vitamins) and fat soluble vitamins (like A, D, Eand K. These are present-in fats). In general the vitamins function as co-enzvmes or co-factors and are required in very small quantities for normal metabolism.

CELL DIVISION OR CELL REPRODUCTION:

Every multicellular organism starts as a single cell called the egg. It divides and produces billions or trillions of cells as we see in human being. The celi division is fundamentally similar in all organisms and thus emphasizes the. unity, of life.

All cells are produced by divisions of pre-existing cells. Somatic cells divide by a process called, mitosis and the germ cells divide by the process of meiosis or Reductional division.

Each cell'is capable of division, passes through a cycle, the "cell cycle". For a somatic cell there is a long interphase followed by a short mitotic phase. .

DNA molecule of each chromosome replicates by the synthesis of a new DNA molecule. So, each chromosome is now composed of two sister Chromatids held together by a centromere. So, the cell which has origin. diploid (2n) Chromo- some: number, now has a duplicate set also i.e (4n). Now it has to undergo Mitosic division giving, rise to two ceils having diploid number (2n) of Chromosomes each.

That is Why, the Mitotic division is also called as Equational division.

Meiosis or reductional division

In all sexually reproducing diploid organisms the male and female germ cells divide meiotically to produce the respective garnets. Meiosis com- prises two sucessive divisions Meiosis I and Meiosis II and results in the formation of 4 daughter'cells. Meiosis II is identical to Mitosis.

GENETICS :

It is well known fact that "like begets like" i.e living things tend to produce offspring that resemble them. It is due to "inheritence" or heridity.Heridity may be defined as "the transmission of characters from one generation to other". Though the offspring resemble the parents, they are not identical. 'It is due to variations. Hence variations may be defined as "differences among the living things".

The study of above two, heridity and variations is nothing but genetics.

Note : variations are raw materials for evolution

The mechanism of inheritance is first demon- strated by "Mendel" an Austrian Monk with his Garden pea experiments. He suggested that every cell of an organism contains two "Factors" (later called them as genes) for each character. These factors separate during gametogenesis (Formation of : garnets) and are passed on to different progeny,

Mendel (the father of genetics) established 3 principles

a) Law of Dominence
b) Law of Segregation
c) Law of. Independent assortment.

In the first law, mandel' established that among the two factors which , controls a character, one is dominant

over other. For exmple, if we take the height of a plant, there may be tallness or dwarfness but the gene responsible for tallness is dominent over owafness.

In his second law, the law. of segregation, he states that, the two alleles are separated and segregated in the gamete formation during 2nd generation.

In his 3rd Law, Law of Independent assortment, he states that, the "factors" of different, pairs cf contrasting characters behave independent of each other at the time of gamete formation and during fertilisation they bring about all possible combina- tions of characters.

Linkage and crossing over:

In most of the cases, the two pairs of genes present on homologus, chromosomes stay to- gether during sexual recombination. Such genes are said to be linked genes. The_ characters controlled by linked genes will appear together in F2 generation. Sometimes they,are separated during meiosis by a process called crossing over- Then they exchange the genetic material.

Sex determination:

In general,.chromosomes of somatic cells appear as homologus pairs. In human beings, the somatic cell of a female contains 23 pairs of chromosomes including two sex chromosomes x,x but in males, the somatic cells contains 22 pairs of homologus chromosomes and two unpaired chromosomes x and y.

Half of human male gametes consists of 'x' chro- mosomes and another half contains y chromosomes. At fertilisation, the male gamete containing V' chromosome unites with female garhete (All fe- male garnets contain 'x' chromosomes), a female organism is produced. If a 'y' chromosome containing male gamete unite with female gamete, a male organism is produced, Hence, the male parent is said to determine the sex of the offspring.

Sex Linkage:

Traits controlled by genes present on sex chro- mosomes x and y are said to be sex linked traits. Recessive traite appear more in male organisms than female organisms. In males only one 'x' chromosome is present hence even one gene is sufficient to be expressed phenohypically (exter- nally) but in case of females there are two 'x' chromosome. So, two recessive genes are required to express the trait.

Hence disease like, haemophilia, colour blindness are expressed in males more frequent than in female.

HERIDITARY DISEASES :

Congenital diseases of human being may be inherited by the offspring, a defect due to the chromosomal error in "Mongolism". In human Leiiiys, the well known heriditory disorders are colour blindness, harelip, cleft palates, absence of hands, feet arms, club foot, hole in the heart etc.

- **Erythro blastosis foetalis :** This is the haemo- lytic disease of new born infants that can occur as a result of blood group difference between mother aind foetus, if a Rh negative woman marries Rh positive man and the foetus happens to be Rh positive, there occurs because intra uterine death Of the foetus. It is Rh positive erythrocytes from the baby cross the placenta and immunize the Rh negative mother,' so that, she produces Rh negative which cross the placenta and kill the foetus.
- **Congenital heart disease :** Normally, the atrium is separated by Atrial septum. This pos- sess holes, in this disease. Sometimes inter ventricular septum also possesses holes. These holes allow inter mixing of blood. It is eliminated by suturing synthetic material around the hole.
- **Colour blindness :** The genetic defect causing imperfect perception of colours' is colour blind-ness. It is because of absence or defect of three visual pigments red, green and blue.

  Normal vision gene is dominant over colour blindness gene. If mother has colourblindness, the male offspring should definitely have colour blindness. Females don't have, but they are carriers and this colourblindness is expressed in next generation.
- **Down's Syndrome (Mongolism) :** It is due to an abnormality of chromosomes either in number or in structure. It is known by the characteristic appearance of the almond shaped rounded skull: The common abnormality in Down's sydrome is presence of one extra chromosome (47 instead of 46 chromosomes).
- **Haemophilia :** This disease is restricted to males and is characterised by excessive bleeding.
- **Harelip :** It is marked by clefts between upper, lip and base of nose. Because of this, speech is effected and hence surgery should be under- taken in infant stage.
- **Cleft palate :** It is. characterised by incomplete closure of palate or . roof of mouth during early embryomic. stage. Due to this and nasal cavities are incompletely separated.
- **Sickle Cell Anemia :** It is due to an inheritance of a defective allele coding for Beta globin which results in the production of sickle haemoglobin (RBC attain sickle shape in the absense of oxygen). Affected blood cells are removed from circulation leading to Anaemia.
- **Albinism :** Due to the presence of autosomal recessive gene, mammals fail to develop the skin pigments. This is called Albinism.

5. PLAINT KINGDOM

The plant kingdom comprises multicelluar, pho- tosynthetic producers. They are primarily acqUatic red, brown and green algae and the land plants - bryophytes, ferns, gymnosperms and angio sperms.

Except algae & bryophyta all are vascular plants (Vascular system consists of xylum and phloem Xylum is water conducting tissue and phloem is the food conducting tissue of the Vascular plant)

Most vascular plants are flowering plants. They form seeds within a fruit. So, they are called angio spejms (Covered Seed). Some vascular plants produce seeds but no fruit. They are called gymnosperms (unprotected seed). Ferns pro- duce neither flowers nor seeds but only spores in sporangia on their leaves.

The body or Thallus of an algae is simple with no vascular tissue. There are different types of Algae based on nature of their photosynthetic and accessory pigments and storage material.

Green Algae are chiefly fresh water forms. They contain chlorophyll 'a' and 'b', store starch, and have cellulose cellwall like in land plants. Eg: Chamydomonas, Spirogyra.

Red Algae (Rhodophyta) mainly marine forms. Some Red alga are Coralline alga. They secrete and deposit calcium carbonate over their walls. Eg: Gracilaria.

Brown Algae (Phaeophyta). mostly marine, soma of them are world's largest sea plants. Eg: Dictyota.

Blue Green Algae - mostly marine. Eg: Nostgc, Anabaena

BRYOPHYTES (BRYON-MOSS, PHYTON-PLANT)

It comprises mosses and liver worts. These are small plants that grow densely together in moist shady places. They form green carpets on damp soils, rocks, walls and on barks of trees.

Bryophytes have no vascular tissues for conduc- tion of water and food. Due to the absense of true roots, their cells absorb moisture directly from the ground (or) the atmosphere. Transportation of materials is done from cell to cell.

They inhabit land but they need water for their sexual reproduction. They show regular hetero- morphic alteration of generations, (i.e) gametophyte (gamete bearing plants) and sporophyte (spore producing plant). Eg: Riccia, Funaria.

PTERIDOPHYTES (or) FERNS

(Pterins = fern, phyton = plant)

(Vascular plants without seeds)

Ferns are prized as ornamental piants because of their graceful and delicate leaves. The char- acteristic of fern is the coiled nature of young leaves.

These are terrestrial plants. Plant for the first time divisible into root, stem and leaf. Eg: Adiantum (walking fern), pteris.

GYMNOSPERMS (NAKED SEEDED PLANTS)

(Gymno = naked, sperms = seed) (Vascular Plants with seeds but no fruit)

There are speed plants without flowers, Gymnosperms are naked seeded plants because they are having freely exposed ovulfes (because, of absence of ovary). Hence they do not produce fruit.

Coniferous trees seen in cooler northern region of Europe, Asia and North America belong to this group.

ANGIOSPERMS (FLOWERING PUNTS)

(Angio = Enclosed, Sperm = seed)

Angiosperm means 'enclosed seed', because seeds of these plants develop in an organ called the ovary in the flower.

Plant body consists of two main systems namely Root system and shoot' system.

Root System : Usually underground, it fixes the plant in the soil. It absorbs and conducts minerals :and water.

Shoot System : it is aerial part of the plant bearing branches, leaves, buds, flowers etc.

Leaf : Vegetativ.e appendage of the stems. It prepares food materials by photosynthesis and expefe excess water by transpiration.

Bud : Undeveloped shoot consisting of highly condensed axis with many immature leaves arch- ing over its apex.

Inflorescence : A group of flowers born on a common axis.

Flower : A typical flower consists of stalk called pedicel which ends with thalamus.

The distinctive reproductive structure of the Angiosperms is the flower. Flower is basically a shoot with limited growth containing sporophylls (Spore bearing leaves). A complete flower has 4 groups of structures, one group with in the other. They are SEPALS, PETALS, STAMENS and CARPELS.

Sepals are the outer most whorl usually small and green and protect the other floral parts in bud conditions and the carpels are in the centre of a flower. Carpels bear the ovules. In Angiosperms the carpels of a flower are closed to form an ovary. With in carpels ovules are

enclosed. Ovary is extended to form style and stigma. Stigma has sticky tip which traps the pollengrains.

Stamens bear anther which form pollen. A pollen grain germinating on the stigma grows down the stigma through the ovary and into the ovule where fertilisation takes place,

After fertilisation ovule develops into seed, while the ovary forms the fruit.

The flower, with showy petals, sugar secreting nectaries is a device to attract several kinds of pollinators like insects, birds, etc.

Pollen is carried by pollinators between flowers, effecting pollination. In return they obtain food in the form of Nectar.

A few Angiosperms have leaves modified into variously shaped devices to entrap insects or other small animals. Eg: Nepanthes {pitcher plant)

Flowering plants were classified into monocotyledons and dicotyledons.

Cotyledons are nothing but embryonic storage, Monocots have single cotyledon and dicots have two cotyledons.

NOTE :

Venation : Arrangement of veins (vascular bun- dles - xylum and phloem) on the leaf.

LICHENS:

Lichens are the pioneers of vegetation. In Lichens symbiotic relationship (mutual benefit) occurs be- tween Fungi and Algae. Main body is made up of Fungus. Alga occupies inside the main body. Alga is concerned with photosynthesis, that is preparation of food material which is used by fungus. Fungus in turn gives protection to the Alga. The Algae that inhabit Lichens usually are blue green algae. (Nostoc)

PLANT PART	DICOTS (Eg: Pulses)	MONOCOTS (Eg: Grass, Sugarcane)
Leaf	Reticulate (net) venation	Parallel venation
Stem	Vascular bundles arranged in a ring	vascular bundles scattered
Root system	Tap root system	Adventitious root system
Flower parts	usually sets of 5	usually sets of 3
(sepals, petals,	5 sepajs	3 sepals
stamen and	5 petals	3 petals
carpels)	5 stamens and few carpels	3 stamens and few carpels

6. ANIMAL KINGDOM

Animals are multicellular heterotrophs (depend on other plants' or animals for food) Animal groups were characterised by mobility because of the presence of sensory and nervous systems.

Like plant life, early Animal life arose in the sea. Animals living in the sea are Marine Acquatic animals, They may live on the sea floor as BENTHIC forms Eg: Corals, PELAGIC forms (Swimming) Eg: Fishes and Plankto'nic forms (Floating)

Kingdom animalia shows enormous diversity. The two major groups of animals are non-chordates and the chordates. It is based on absence or presence of Notochord (Stiff flexible rod of tissue along the mid dorsal line of the body. It is changed to vertebral column in higher animals).

PORIFERA

Sponges are the most primitive group. Most of them are marine, attached to rocks. Adults are sessile with the cell-aggregate body plan. There are numerous pores on their body surface con- nected by way of canals to a central hollow chamber.

Sponge is a republic, of cells which identify one another, aggregate and grow together. Eg: SYCON

CPIIDAKIA (OLD NAME IS COELENTERATA)

These are mainly marine. Cnidariaris exhibit a blind sac body plan and are radially symmetrical. They are more advanced than sponges in having true tissues. The body wall consists of two cell layers (Diploblastic)-outer ectoderm inner endo- derm, separated by jelly like mesoglea.

Fentacles are present round the mouth inorder to capture the prey. Tentacles contain nematocysts. They are usually tfigerred by contact, and inject poision and paralyse the prey. They are unique to cnidarians.

Living corals are developed over dead coral below, giving rise to coral reefs. Coral reefs form .stable marine ecosystems. Eg:,Physalia (Portu- guese man of war), Hydra, Corals.

PLATYHELMIrtTHES (FLAT WORM)

The platyhelminthes are mostly parasites (Ani- mals living on other animals). Here the body wall consists of 3 layers (Triploblastic) outer ectoderm, inner endoderm and middle mesoderm.

These animals have specialised cells called TLAMf CELLS" for excretion and Osmoregula-tion. Parasitic tape worms contain no digestive sac of their own bbcauso they absorb nutrients through' their body wait.

Eg: Tape Worm (Taenia Solium) present in human intestine.

Fasciola Hepatlca. present in liver of sheep.

NEMATHELMINTHES (Round Worm or Nematodes)

Several Nematodes infect, plant roots, where as others live on parasites in animals. Vast quan- tities of microscopic free-living nematodes thrive in soil rich in organic matter.

The hook worm, filarial'worm, guinea worm, are notorious nematode parasites in man which are spread through insanitary conditions.

ANNELIDA

Annelidans are segmented animals with a trui coelome (upto nematodes there is false coelome or pseudo coelome) (coelome = Fluid filled body cavity between body wall and"the digestive tract)

Annelids have more complex digestive system than the Nematodes. It consists of muscular pharynx, a stomach, (where food is churned and digested) a long intestine'(to absorb digested food material) and anus (to expel out undigested waste material).

A closed circulatory system of blood vessels, a heart to move the blood is found forjhe first.time in Annelids in the evolution of animals.

Oxygenation of blood (Respiration) occurs through the moist skin. The excretory organs are paired Nephridia in each segment.'

Eg: Earth worm (Farmers friend). Blood Sucking Leech.

ARTHROPODS

Arthropods constitute tHe largest group of animals. It includes scorpions, spiders, crabs,-prawns, and all insects. The success of Arthropods is to a large extent due to their unique chitinous cuticle, [cuticle covers body surface]

The cuticle originally developed .in marine arthro- pods as a protection against predators (one who depends on other). Being impervious to water, it protects the body from drying.

Insects are able to fly because of chitinous wings. Arthropods have a segmented body covered by a jointed exoskeleton.

SENSORY STRUCTURES IN ARTHROPODS ARE: CHORDATES

(a) Antennae for perceiving odpur,
(b) Eyes,
(c) Statocysts for balancing,
(d) Receptors for taste located in the feet of Insect.

insects communicate with chemicals, called 'PHEROMONES'. Some pheromones are sex attractants.

The Arthropodah eyes are simple or compound. The compound eyes are made of several identical units called OMMATEDIA, each with a lens. So, several separate

images are formed. This ena- bles the detection of even the slightest movement in the object being seen.'

Most of the Arthropods are egg laying animals (oviparous), some like scorpion, are viviparous (giving birth to young ones)

In most of the Arthropods, Trachea are respiratory organs and malpighian tubules are for excretion.

MOLLUSCA (Moluscus = soft bodied)

It is the 2nd largest animal phylum after arthro- pods. Most Molluscans have a protective hard shell. The body has. a soft muscular loot' on the ventral side. On the dorsal side of the foot is 'viseeral hump' which is covered, by MANTLE. This mantle secretes shell.

The inner calcareous surface of the several bivalve shells (two hinged shells) is iridescent and pearl like in appearance. Natural pearl formation is induced by factors like foreign substance, parasites or injuries. At the site of irritation shell secreting mantle cells begins secreting the shell material. The pearl grows in size as more layers are secreted over its surface. Eg: Snail, Oysters.

ECHINODEKMS

This phylum consists of only marine animals such as Starfishes, Brittle Stars, Sea Urchins, Sea Cucumbers, Sand dollars and Sea lilies.

The spiny skin of the echinoderm contains cal- careous plates. The starfish has 5 arms radiating from the centre. They have mouth on the lower side and anus on the upper side. Their most distinctive feature is the water vascular system. It consists of radiating canals and tube feet. Tubefeet main {unction is locomotion and capture of food.

The main features of Cfiordates are:

PISCES (Fishes)

All living members of jaw-less vertebrates are parasites[1] on some fishes.v. These fishes attach themselves to some fishes and suck blood from them. Eg: Lamprays

Ail Cartilaginous fishes are marine. They have no bones but only cartilage, these fishes have 5 pairs of gilt slits which are not covered by gill cover. Eg: Sharks, Sting rays, Electric rays..

The bony fishes have a spindle shaped-body with Head, Trunk and Tail, gills are covered by gill covers. Gills are the respiratory organs. Heart is two chambered with one auricle and one ventricle.

Tail fin helps to propel the fish, lateral fins are the balancers. The swim bladder (present above the alimentary canal) acts as buoyancy regulator. The "lateral line" sense organs on each, Side of the body are useful to detect the vibrations. There is no sound perception in fish.

Note : Sharks are viviparous (giving birth to young, ones)

AMPHIBIANS (Dual Life)

Most amphibians have two phases in their lives. In the larval stages they are fish like; adults live on land with their 4 limbs.

(a) Adult amphibians are tetrapods with 4 limbs:
(b) Their hind limbs are long and powerful and are used for jumping and swimming.
(c) Skin is kept moist.
(d) tongue is attached in front of the mouth.
(e) Frogs and toads are noisy during the breeding season, each species communicating with its distinctive vocal signals.
(f) Heart is 3 chambered.

REPTILES

(Reptile = Creeping animal) Eg: Lizards, Snakes, Turtles, tortoises, crocodiles, etc.,

200 million years ago, gigantic reptiles (Dino- saurs) roamed the earth. But they became extinct due to climatical variations. Present day reptiles are readily distinguished by their dry, horny, scale covered skin.. Respiration is only through lungs. The heart is 3 chambered, but single ventricle is improved by a septum which partially separates the ventricle. The only exception is crocodile which possesses chambered heart as. in birds and mammals.

Reptiles are truly land animals. This can be made sure by the following features:

(a) Development of internal fertilisation.
(b) Presence of a special membrane in the yolk filled egg called "AMNION". The Amnion encloses the embryo and provides it with a watery environment during development.

AVES (Birds)

Birds characteristic feature is presence of feathers and power of flight. The entire body is streamlined and covered by feathers. The forelimbs were modified into wings. They are powered by flight muscles.

The bones of the skeleton are hollow and con- nected by air passages. This reduces the, weight of the body. The lungs also have air sacs inorder to have double respiration or continuous respira- tion.

Heart is four chambered. - two auricles & two ventricles. This allows complete separation of the oxygenated blood from the de-oxygenated blood. Birds

have a keen sense of sight. Eyes posses 'PECTEN' in order to have a better view.

MAMMALIA (milk -sucking mammals)

The unique characteristic feature in mammals is milk producing "Mammary Glands" by which the young are nourished.

Other features are, pesence of hair, and sweat glands. - They have constant body temperature (birds also), and high rate of metabolism.

Heart is 4 chambered/lungs are well developed and Breathing is enhanced by the 'diaphram'

Eg: Kangaroo (common in Australia), man,. bat, mole.

The mammals, are classified into 3 groups

a) Egg-laying mammals

b) Pouched mammals like Kangaroo

c) True placental mammals which nourish their young in the wombs through the placenta:

PLACENTA : It is a special structure connecting foetus in the womb and the uterus of the mother.

Whales and dolphins are acquatic mammals with forelimbs modified as flippers. They lack hind limbs.

The distinctive feature of man is the grasping limb with opposable thumb.

NOTE:

Pisces, amphibians and reptiles are Poikilothermous or cold blooded animals (body temperature according to the environmental temperature) but Birds and Mammals are warm-blooded animals or Homiotherms (body temperature is kept con- stant).

NOTE:

Reptiles, aves and mammals are called Arimiotes because they possess Amnion Rest of the chor- dates are called Anamniotes (lack Amnion).

7. ANIMAL PHYSIOLOGY

NUTRITION

Nutrition is the procurement of substances nec- essary for growth, maintanerice and activities of Tig body. Energy is required for running life process. Green plants can directly utilise sunlight energy and they prepare their own food material. It is catod Autotroph mode of nutrition. - In ge: their energy in the form of Dord erergy e£ organic molecules synthesized by Heterotropic mode of rutribon . Ultimately all animals get their energy from sunlight through plants.

Heterotrophic nutrition is of 2 types

Holozoic - eating v/holo animals or their parts.

Saprophytic - Living organisms feed on decaying organic materials of plants and animals.

DIGESTION :

The complex and large organic molecules have to be converted into simpler molecules in order to enter into the protoplasm of each and every cell for its rhetabolic activities.

Digestion is carried out by breaking the bonds of nutrient molecules by using a molecule of water for cleavage. This digestion is carried out by enzymes called Hydrolases

For unicellular protistans like Amoeba, the diges- tion is carried out within the animal (intra cellular digestion) but in multicelular animals, the diges- tion takes place outside the cell (extra cellular digestion).

The multicellular animals have a cavity called 'Alimentary canal'. In that enzymes are poured in by the cell. There, the food is digested and it is absorbed by the cells.

DIGESTIVE SYSTEM (MAN)

Food is taken into the Alimentary canal through the mouth and is propelled along by the move- ments of the muscles on its wall. Glands located in its wall (gastric glands) and in associated organs like liver and pancreas secrete enzymes into the lumen of the canal.

Alimentary system consists of a muscular tongue in the floor of the buccal cavity which helps in ingestion and teeth helps in mastication of food. The chewed food is mixed with saliva in the mouth secreted by 3 pairs of salivary glands.

Saliva contains a starch digesting enzyme and mucons which lubricate the food for swallowing.

Mouth leads the pharynx which communicates with long oesophagus which opens into stomach. Stom- ach is a large muscular sac which secretes hydrochloric acid and protien digesting enzyme Pepsin.

After digesting the protiens the food goes in to smali intestine.

Ruminant animals like cattle have a compound stomach. Some parts of the stomach ciive shelter to numerous bacteria and protozoa wiich carry out fermentation of cellulose.

The small intestine of mammals is a long, coiled, narrow tube. The inner walls project into finger like structure called "VILLI" which increase the surface area for absorption of digested materiai.

The first part of the small, intestine called Duo- denum is very important because bile duct, opens into it. Small intestine opens into large intestine. At the point of junction, a' small finger like projection called appendix is present. It is a vestigial organ. The undigested waste material is sentout through anus after absorbing water in the large intestine.

Liyer, the largest gland of the body secretes Bile juice containing Bile salts which help in digesting and absorbing fat. Pancreas secretes pancratic juice rich in enzymes for digesting starch, lipids, proteins.

DIGESTION OF CARBOHYDRATES

For herbivorous (plant eating) animals cellulose of plant food is the principle source of carbohy- drates but vertebrates- have no enzymes to digest cellulose. So, they have to depend on micro organismis like bacteria (symbiotic digestion) whic[h] live in their digestive tracts., Man subsisting on cereal grains, tubers etc. consumes carbohy- drates mainly in the form of starch and also some disaccharides like sucrose and lactose.

Man secretes a starch hydrolysing enzyme in saliva called salivary amylase or ptyaiin. If we chew a piece of bread, it will taste sweater after some time because, starch is broken down into maltose (which is sweet) by ptyaiin.

The gastric juice contains no carbohydrate digest- ing enzyme. The pancreatic and intestinal juice digest carbohydrates in the small intestine. The pancreatic juice contains pancreatic Amylase, which hydrolySes the remaining starch into mal- tose. The enzyme Maltase hydrolyses maltose into glucose. Besides Maltase, intestinal juice contains sucrase and lactase, which converts sucrose and lactose into glucose.

Main Carbohydrates ⟶
Startch (Poly saccarides)
Sucrose (Disaccharide)
Lactose (Disaccharide)

Starch —ptyalin or salivary amylase⟶ Maltose (in mouth about 30%)

Starch —pancreatiric⟶ Maltose (in intestine)

amylase
Malase
maltose ⟶ Glucose

Sucrase
Sucrose ⟶ Glucose

Lactase
lactose ⟶ Glucose

Note : Maltase, Sucrase, Lactase - secreted by Intestinal wall.

DIGESTION OF PROTIENS

Food protiens are ultimately broken down Into aminoacids by gastro-intestinal enzymes. Protein digestion starts in stomach. Gastric juice-contains Hydrochloric acid (HCI) and pepsinogens. The inactive pepsinogen is converted into active pepsin by Hcl. Hcl provides Acidic P^h in stomach for the action of pepsin on proteins. Pepsin hydro- lyses proteins into peptones. Pepsin also hydrolyses casein (milk protein) into para casein.

Pancreas secretes Trypsinogen and Chymot- rypsinogen which are activated by enterokinase an intestinal juice e.nd transformed them into active trypsin arid chymotrypsin.

Trypsin acts best at alkaline pH- It is provided by Bile juice. Trypsin hydrolyses proteins into peptides. Amino peptidases of intestinal juice hydrolyse the peptides into aminoacids.

The following reactions take place in stomach (acidic medium)

Inactive pepsinogen ⟶ Pepsin (Active)
Hcl
Proteins Proteins ⟶ peptides
Casein (milk protein) ⟶ para casein
(pepsion)

The following reactions takes place in intastine (Alkaline Medium)

Trypsinogen ⟶ Trypsin
(Enterokinase)
Chymotrypsinogen ⟶ Chymotryspin
(enterokinase)
Trypsion
Proteins ⟶ peptides
Chymotrypsin
Peptides ⟶ Aminoacids
Aminopeptidases

DIGESTION OF FATS

Lipases are enzymes for hydrolysing fats and oils. Lipases are soluble In water. Fats are largely digested in small intesiine. Bile salts emulsify the fatty acids and these emulsified fats are converted into monoglycerides by pancreatic lipase and intestinal lipase.

Lipase
Fats ⟶
fatty acids, monoglycerides and glycerol

Absorption of digested food is taken up in villi of intestine either by simple digesion (passive ab- sorption) or energy dependent (active absorption).

NOTE

End products of Carbohydrate — Glucose
End products of Proteins — Aminoacid
End products of Fats — Fattyacids,
glycerol monoglycides.

NOTE

1 gram of Carbohydrate will yeild 4k.cal of energy
1 gram of Protein will yeild 5.65 to 4 k.cal of energy
1 gram of Fat will yeild 9.45 k.cal of energy. NOTE

The excess glucose is converted into glycogen by liver. It is reconverted into glucose when ever the body needs.

VITAMINS

Vitamins are organic substances which are sup- plied through diet. A dificiency in the food produces diffeciency symptoms.

There are 2 types of Vitamins

Water soluble vitamin - Vitamin 'B' complex and Vitamin 'C'

Fat soluble vitamin - A, D, E, K

RESPIRATION

Oxidation of nutrients releases their bond energy utilisation in the body. The released energy is trachea temporarily stored in ATP.

In some lower organisms like bacteria, yeast, nutri- ents are oxidised without using oxygen. This proces is called Anaero- bic metabolism or fermentation.

In most of the animal tissue, oxidation is carried out by Aerobic Respiration. It-is carried out in two phases.

(a) External respiration - uptake of oxygen and release of carbondioxide into surrounding medium.
(b) Internal respiration - Oxygen uptake by tissues and tissue oxidation by enzymes and carbondioxide elimination from tissue cells:

The mammalian respiratory system (Man) con- sists of the external nostrils, nasal cavity, Naso pharynx, larynx, Trachea, bronchi, bronchiolus, and lungs.

Nasopharynx communicates with larynx through a long wide cartilaginous tube called trachea. Trachea runs through the neck infront of the oesophagus, enters the thorax and divides into right and left bronchi. They enter into elastic iungs and divide repeatedly into small branchioles. This branchiol opens' into thin walled sac called "Alveoli". Each alveolus., is supplied with blood capallaries. The pulmonary'artery which; is poor in

oxygen and rich in carbondioxide supplies blood to the alveoli. The oxygenated blood (after exchange of gases) is returned to pulmonary veins.

Lateral walls of thorax (ribs and intercoastal muscles), diaphragm (which seperates thorax from abdomen) help in respiration by contracting and relaxing.

GAS TRANSPORT IN BLOOD

Most of the oxygen that enters into the,blood is carried in chemical combinations in the erythro- cytes or Red Blood Corpuscles (RBC), Oxygen combines loosely with Fe^{+2} (Iron). Ions of Haemo- globin thus forms oxyhaemoglobin. This oxyhaemoglobin is carried to tissues and there molecular oxygen is released out. The carbondioxide ($CO_{2)}$ produced in'the tissues ehters the RBC by diffusion, reacts with water to form carbonic, acid (H_2CO_3). On reaching the lungs, blood is oxygenated. Here H_2CO_3 cleaved into water and CO_2 and this CO_2 is removed from the lungs during expiration.

CIRCULATORY SYSTEM

All parts of the body require nourishment and oxygen and metabolic wastes need to be re- moved from the body. This is carried out by blood through circulatory system.

HEART

It'is a pumping organ of the blood vascular system. It is hollow muscular organ made of cardiac, muscles. It consists of chambers, the chamber which receives blood is called Auricle and from there it goes to ventricle and it gives out blood to the lungs and body parts.

The Human heart'Is situated in the thorax between the lungs. It consists of two auricles and two ventricles. The deoxygenated blood from body parts is received in right auricle. The left atrium orauricle receives oxygenated blood from lungs. The two auricles open into the respective ventricles. The right ventricle which receives deoxygenated blood pumps into the pulmonary arteries, from there it goes to lungs for purification. The left ventricle which receives oxygenated blood from left Auricle pumps to all body parts.

The contraction and relaxation of cardiac Cham- bers are respectively known as systole and diastole. The systolic and diastoic pressure of a normal human beng is 120/80. The difference between systolic and diastolic pressure is called the "Pulse Pressure"

The Human heart beats at the rate of 70 per minute in the resting condition. Heart beat results from a wave of electrical potential called cardiac impulse spreading over the cardiac chambers. The impulse is myogenic in origin. It originates from cardiac muscle tissue that is from the "Sinoatrial Node".. In mammais it is called "Pace Maker" of the heart because it determines the rate of heartbeats. '

Circulations of blood from the left ventricle to the tissues and back to the right atrium is called the "systematic circulation", the circulation from the right ventricle to the lungs and back to the left atrium is called "Pulmonary Circulation". Some times a vein returning blood from cap- illaries breaks again into second set of capillaries in a tissue to form a "Portal systems". For example a hepatic portal vein returns blood from the intestine and; breaks into a portal system of capillaries in the liver. This enables the liver cells to take up from the portal blood, nutrients brought by it from the small intestine.

Blood flow is maintained in the veins largely, by the compression of veins by contracting muscles. The valves lodated in veins allow blood to flow in a single direction to the heart ,and block any reverse flow.

LYMPH

In the spaces between the cells of a tissue there occurs a fluid called the Interstitial fluid. Under the. pressure of blood,, in the capillaries, some of the water and dissolved solutes are filtered but from blood plasma into tissue spaces to form the tissue fluid. The composition of the fluid is similar to plasma except proteins. This is because the plasma' wall is impermeable to plasma proteins. This fluid enters into tiny channels called lymph channels;: and the fluid collected in them is called Lymph. They ulti- mately drain into two farge lymph vessels open into veins. Thus, it combines with general circulatory system.

BLOOD

Blood is a fluid connective tissue composed of blood cells, blood platelets and an extra cellular fluid called plasma. Blood is slightly alkaline and the volume of blood in an adult person is about 5 litres.

Plasma

It ia s viscous aqueous solution containing many organioc and inorganic substances. Plasma contains 92% water and 8% solids. The solutes include glucose, aminoacids, fatty acids, vitamins, enzymes, harmones, antibodies, oxygen, carbondioxide, and waste products such as urea, uric acid and creatinine.

Plasma contains 3 types of proteins namely albumin, globulin, and fibrinogens. Albumin and globulins retain water with their osmotic effects. Also they transport substances like thyroxine and iron Ions.

Immunoglobulins, a class of globulins act as Antibodies which inactivate invading microorgan- isms.

Erythrocytes (Red Blood Corpuscles)

They are numerous in blood. They contain haemoglobin. [Jhe red, oxygen carrying pigment] Mature RBC are dead cells. The entire volume of RBC is filled with Haemoglobin. In the foetus, RBC are mainly formed in the liver and spleen but in adults, RBC formed from bone marrow. RBC have an average life span of .120 days.

Old and damaged RBC. are. phagocytosed (eaten away by macrophages). The haemoglobin ca- tabolised

into the yellow pigment called Bilurubin which, is excreted in bile. The skin and mUcous membranes of eyes assume a yellowish colour, if all the bilurubin cannot creted from the body. This condition is called Jnundice.

LEUCOCYTES OR WHITE BLOOD CORPUSCLES (V/.B.C)

These are nucleated, colourless. Some of them posses cytoplasmic granules (called as granulocytes) and some do not posses granules (Arganulocytes)

Neutrophils and monocytes, of W.B.C protect the body against microbes by phagocytosing them. Lymphocytes of W.B.C secrete antibodies in the blood.

BLOOD PLATELETS OR THROMBOCYTES

They are non-nucleated, biconvex disc like bodies. Their life span is about a week. When any blood vessel raptures, platelets gets clumped at the injured spot and release certain chemicals called platelet factors. It promote blood coagulation.

BLOOD COAGULATION

When a blood vessel ruptures a gel sets in with in minutes. It is called coagulation. It is brought about by hydrolysis of soluble fibrinogen into' insoluble fibrin. It is catalysed by Thrombin enzyme.

The network of fibrin traps blood cells particularly RBC to form a red solid mass called the blood clot The clot stops bleeding. The straw coloured fluid left after clotting is called Serum.

Blood normally contains an anti coagulant 'Heparin' which .prevents the activation of prothrombin which is an inactive globulin of thrombin.

EXCRETION

Excretion is the elimination of waste products from the body. Large volume of carbondioxide (CO_2) and water are produced by the metabolism of carbohydrates, fats, and proteins. CO_2 is easily eliminated as a gas by respiration. The by products of metabolism have to be eliminated from the body in aqueous solution. Principle among them, are Nitrogenous substances like Ammonia, Urea, Uric Acid. All these are end products' of protein metabolism.

KIDNEY

The mammalian urinary system consists of two kidneys which form the Urine, two ureters which conduct the urine from kidneys to the urinary bladder (for storage of urint)) and urethra, through which the urine is sent out by. urinary bladder. The kidney contains many minute tubular Nephrons which form urine.

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Accessory excretory organs include skih which excretes water and sodium chloride in the Sweat and small amounts of lipids and sterols in the sebum (secreted by sebacious glands located in the skin in order to soften the skin).

Note : Basic unit of Kidney - Nephron

LOCOMOTION

Movement is an important characteristic feature of living organisms. It distinguishes the plants from animals. Most animals have developed contractile muscle fibres for carrying out the movements and this muscle contraction moves bones of the skeleton like levers to produce body movements.

Skeleton also forms the supporting frame work for the body and protects its softer internal organs. It is made up of calcium and phosphorus and houses the red bone marrow where the blood cells are formed.

Joints are the structures where two bories are fitted to each other. According to the mobility, joints are of three types

(a) Fixed or fibrous joints where dense bands of fibrous tissue held firmly together Eg: Skull bones.

(b) Slightly movable or cartilaginous joints which are seen in vertebral column. Here limited movement is possible.

(c) Movable or Synovial joints where articulating bones move upon each other. Here acticulating surface is covered with hyaline cartilage and a viscous slippery synovial fluid fills the space between these cartilages and lubricates the joints. These sinovial joints are of two types

i) Ball and socket joints - Shoulder and Hip Joints.

ii) Hinge Joints - Elbow joint, ankle, knee joint.

Each muscle fibre requires a specific minimum intensity of nery_e impulse or stimulus for stimu- lation. This is called muscle twitch. If a muscle is in. continued state of contrations caused by many repeated stimuli, then it is called 'Tetanus'.

Note : Fatigue occurs on repeated contraction of muscle due to the accumulation of lactic acid

NERVOUS SYSTEM

With the evolution of multicellularity, it is neces- sary to develop some system for coordinating the qptivities qf numerous cells in the body. For such co-ordination information- has to be exchanged between cells situated at a distance from each other. For co-ordination of all systems, nervous system has been developed.

In mammals, the nervous system consists of central nervous system (comprises brain & spinal cord) peripheral nervous system (coursing be- tween the central nervous system & different parts of the body) and the 3rd one is. autonomous, nervous system (has connections with central nervous system). It works independently to regu- late involuntary activities like heart beat etc.

Both brain & spinal cord are covered-by connec- tive tissue membrane called as Meninges. An extra cellular fluid called cerebro spinal fluid is present in the meninges-

it affords some protec- tion to the central nervous system, against injury & shock.

Braki is situated inside the cranium. The Brain s divided into Forebraini Midbrain & Hind brain. The Hind brain continues into spinal cord.

Brain is be easily differentiated into two regions. G'ey matter containing neive cells is situated on He surface and white matter containing nerve fibres located deep inside the brain.

The fore brain consist of CEREBRUM, the largest zar. cf tne human brain. The cerebrum consists of two central hemispheres joined by thick band csf nerve fibres called "Corpus callosum". The surface of cerebrum shows many convulasions called "GYRI" separated by depression called "sulci".

At the base of the brain, Hypothalmous is present. It contains nerve centres for temparature regu- lation, hunger, thirst & emotional reactions.

Mid brain consists of many groups of nerve cells. Some of these are involved in controlling muscle tone etc. The Hind brain consists of a cerebellum which is concerned with maintainance of posture & equilibrium of the body and for the muscle tone.

The brain stem consists, of pons yaroli and medulla oblongata. . **It** is the centre for" controlling respiratory centers, vaso motor centers, salivary centers etc. Medulla oblongata continues into spinal cord.

Spinal cord is a cylindrical cord like structure situated in vertebral column. From the lateral sides spinal nerves emerge & go to supply the peripheral tissue. The nerves coming out from different parts of the brain are called 'cranial' nerves.

The peripheral nervous system includes the nerves runnig outside the central nervous system. Each nerve is'compoed of many fibres enclosed in a connective tissue sheath.

Neuron is the basic unit of nervous system. Nerve fibres carry nerve impulses in a relay. The junction between two neurons is called "SYNAPSE". Basically a neuron consists of a cell body, long axon and a short, profusely branched dendrides. The axon is covered with myelin sheath. The axon of one neuron attaches with dendrides of other neuron.

The axon terminal contains membrane bound vesicles called synaptic vesicle in its cytoplasm. In this chemical substances like adrenaline & acetyl choline remain stored. When a nerve impluse passes the axon terminal, the synaptic vesicle releases stored chemicals. The chemical diffuse through synaptic cleft & reach the mem- brane of next neurons. This cause the nerve impulse to be transmitted along the next neuron.

EYES

Eyes are the sense organs of vision. They contain 2 types of photoreceptors called rods & cones. These cells, convert the energy of specific wave lengths of light into action potentials of nerve
fibres.

Eye ball is spherical & is located in ORBIT. It is capable of movement with the help of recti & oblique muscles. Wall of the eye ball consists of 3 layers, the outer opaque sclerotic coat but in front side of the eye it becomes transparent CORNEA. It is covered extenally in a thin membrane called CONJUNCTIVA.

The middle cloriod coat supplied with blood vessels in the front side it continuous with a muscular curtain called 'IRIS'. In the center of the Iris there is "small opening called PUPIL.

Retina is the innermost layer which is specialised for receiving the jmage. It consists of rods and cones named according to their shapes. Optic nerve is formed by the union of all the sensory cells of the retina.

Lens is behind the Iris. It divides the eye ball into two chambers anterior aqueous chamber & pos- terior vitreous chamber. Former is-filled with water fluid & the later is filled with jelly like fluid called vitreous humor.

Blind spot is a spot on the retina where optic nerve enters the eye ball and slightly, above it, ah acute vision spot is present called Fovea cantralis. There is presence of Lacrimal glands which secrete watery substance inorder to lubri- cate the eye.

Light rays from an object pass through cornea & aqueous humor. The intensity of light is regu- lated by pupil. It contracts in strong light and vice versa. Light rays passing through the .lens fall on Retina. The sensory cells of Retina (Rods & Cones) are stimulated and the light impulses are converted into nervous impulses which are re- ceived by the brain through optic nerve.

Comparision of eye with a Camera :

Eye ball	**Camera**
Retina	Photographic film
Convex Lens	convex lens.
Pupil	diaphragm.

ENDOCRINE SYSTEM

Endocrine glands are ductless glands which secrete harmones. This is secreted into the blood which distributes all over the body. Harmones are secreied in response to changes, in the environ- ment inside and outside the body. There is a co-ordination between nerves & hormones. The synthesis and release of hormones is regulated by nerves.

PITUITORY GLAND

There are several Endocrine glands spread over the body. Among them the most important one is pituitary gland. It is termed as a master gland because it controls the remaining Endo- crine glands. Pituitary is situated in Hypothalamus of the Brain.

The anterior Pituitary secretes growth harmone Thyrotropin which stimulates body growth.

Corticotropins secreted by pitutary gland stimulates the Adrenal cortex (Present in Kidney) to'secrete gluco carticoid harmones. Follicle stimulating harmone, & Lutenising harmones of pituitary regu- lates the gonads and finally Prolactin increases milk secretion.

The posterior Pituitary, releases vasopresin which increases renal reabsorption of water from the urine to make it hypertonic (high concentrated) & also increases the Blood perssure by constrict- ing arterioles.

Oxytosin, another harmone contracts the smooth muscles of uterus. (useful in Pregnancy)

THYROID

Gland situated in the neck close to the trachea secretes thyroxine. It enhances metabolic rate and promotes body growth. Failure' of thyroid secretion,, produces cretinism in young age and Myxedema in adults. The excess cf thyroid harmone leads to Graves desease. (Bulging of eye balls)

PARA THYROIDS

Para thyroids are 4 small glands situated very close to thyroid, secrete Parathormone which increases blood calcium level by increasing the mobilisation of bone calcium and renal reabsorp- tion of calcium from the urine. The deficiency of parathormone leads to muscle cramps or tetanus.

ADRENALS

Adrenals are two conical pyramid shaped glands. Each adrenal is made up of outer layer calledAdrenal cortex and a central portion called Adrenal Medulla. Adrenal cortex secretes:

(a) Mineralo Corticoids which increse the retention of Na' ions in the body & elimination of K^+ ions from the body."

(b) Gluco Corticoids regulate Metabolism of Car- bohydrates, Proteins & Fats.

(c) Sex Corticoids develop external male sex characters. Adrenal medulla secretes Adrenalin and nor- ,adrenalin. They act on heart beat, blood pressure etc.

PANCREAS A

Pancreas is situated along witfi the liver at deodenum it also secretes harmones in addition to the enzymes for digestion. The harmones Insulin and glucagon are secreted by Islets of Langerhans. Insulin lowers the blood sugar in increasing the utilization of glucose in the tissues. Its deficiency produces a disease called DIABETES MELLITUS with high blood sugar, usually excreted in the Urine. On the contrarary glucagon increses the blood sugar level. When ever the blood sugar level drops glucagon is produced & released which converts the glucagon into glucose.

GONADS

The GONADS, testes in males and ovaries in females secrete harmones which control repro- ductive organs. The harmones are collectively called sex harmones. Male sex harmone TesU> sterone is secreted by testis. It stimulates growth and secondary male sex organs. Failure of testosterene results in undeveloped external sex harmones.

Female sex harmones are of two types Estrogens and Progestrone. The ovary contains numerous sacs called ovarian follicles each with a mature ovum. Cells of a mature ovarian follicle, called Graph an follicle, secrete estrogen. This is acti- vated by follicle stimulating harmone of anterior Ptuitaty

These estrogens are responsible for development of sex organs & external sex characters and another harmone progesterone is responsible for pregnancy changes in female .sex organs.

REPRODUCTION

Reproduction is an important characterstic of living Organisms inorder to propagate its species, (ie) maintains continuity of the species.

The male reproductive system of human beings consists of 2 testes, suspended in the pouch of 'scrotum', a paired duct system consisting of epididymis, vas deference, ejacuiatpry duct, and male urethra and secordary sex organs including a prostrate, two seminal vesicles, two cowper's glands and a penis.

Testes form sperms and secrete testosterone. Prostate, cowpers glands secrete fluid which mixes with sperms to form the semen.

The female repoductive system consists of 2 ovaries and a duct system of two fallopian tubes, a uterus and a vagina. Ovaries produce ova and secrete esterogens & progesterones, The fallopian tubes conduct the ovaries towards the uterus. The uterus lodges the growing foetus and opens to the exterior through the VAGINA.

The menstrual cyclic consists of cyclic changes in the reproductive tract of primate female culmi- nating into a menstrual flow of blood from the vagina. It consists of two phases.

In the first/phase, growth and proliferation of tissues on the walls of uterus, .fallopian tubes and vagina.

The ovnm ejceted from the follicle near the end of the 1st phase (proliferative phase). The rup- tured follicle changes into a corpus luteum which secretes progesterone in the second phase, the utrine walls grow further and the glands secrete a fiuid in the uterus. If the ovum is fertilized with a sperm, it leads to pregnency. If fertilisation of eggs does not take place, uterus simply degenarates, progesterone secretion stops. The uterus breaks down and menstruation takes place.

8. CHROMOSOMAL BASIS OF INHERITANCE

Each species possesses a specific and a characteristic number of chromosomes in its somatic cells. In a diploid cell, the chromosomes occur in pairs . called homologous pairs. The two chromosomes of a pair resemble in structure and genetic content. One member of a chromosome pair is derived from the mother while the other is derived from the father. Each chromosome is a double structure consisting of a pair of chromatids. During mitosis, the two chromatids separate into two daughter nuclei and then into cells.

The two alleles of an allele pair of the gene are also equally distributed in the daughter cells. At Meiosis, the members of a chromosome pair are separated and are distributed equally in daughter cells. Similarly, each member of an. allele pair goes to each haploid cell (gamete). Hence, a gamete contains onlv one allele. When the two haploid gametes unite during fertilisation, the diploid chromosome number and the allele pair are restored. It was William Flemming who discovered the chromosomes in the nuclei- of Salamander cells.

The Concept of Linkage : This deals with the seggregation and recombination of chromosomes. When genes are located on the same rhromosoni^s, there can be c[r]ossing over between them or no crossing over. Crossing over simply means exchange. When two non-sister chromatids undergo a crossing over, two new allele combinations can be created. Only two "non-sister chromatids participate in crossing over at any given point The crossing ever takes place during Meiesis-[r]. When the crossing over takes place, each member of a homologous pair consists of two sister chromatids. When crossing over takes place two types of gametes are formed. If there is no crossing over between genes, $_0$they are transmitted intact: This will lead to the formation of only parental gametes. Tliis is called complete linkage. The gametes that result from crossing over are called the recombinant gametes..

If two genes are located on the same chromosome, and if they are very far from each other, crossing over is possible in all meiotic cells. In such cases, 50% of the gametes are recombinants and 50% are parental. If the two genes are located on the same chromosome and are very close to each other, crossing over takes place. But in the gametes that result from this, the parentals dominant over the recombinants. All genes located on the same chromosome show some linkage between them. The strength of the linkage is determined by the distances between them. The more farther apart they are, the weaker the linkage. Genes located on the same chromosome constitute, a linkage group.

Recombination : This is a meiotic process that generates a haploid product whose genotype is different from the two haploid genotypes constituting the diploid. Recombination occurs due to crossing over during Meiosis-I. The rejoining takes place between non-sister chromatids. The recombination frequency is governed by the distance between the genes. That is, closer the distance between the two genes, less is the probability of crossing over and recombination.

Sex-Linked Inheritance : In many sexually differentiated organisms, each cell contains a pair of chromosomes known as sex chromosomes. The other chromosomes are called autosomal chromosomes or autosomes. In humans, the male produces only two types of gamete while the female produces only one type of gamete. The chromosome of the male carries a gene called SRY (sex determining region) which codes for a product called testis-determining factor (TDF) which is required for the development of male sexual characters. However, in the fly Drosophila. the sex determining factor is the ratio between x-chromosomes and autosomes.

Genetic Variation: These result due to different mechanisms such as recombination, gene-mutation, gene-environment interactions and by chromosomal observations. Gene mutation was a term introduced by Hugo de Vries to explain the variations in the plant Evening Primrose (Oenothera Lamarckina). Gene mutation is a sudden discrete change in the genetic material which is heritable. Mutation serves as the source of most of the genetic variability, in a population. This variability provides the basis for natural selection and hence biological evolution. Mutations in gametic cells can get transmitted to the next generation but those iri the somatic cells are confined only to the individual.

Chromosonir.-l Aberrations : In addition to gene mutations, alterations in chromosomes can also occur. In gene mutations, there is no change in the chromosome. In chromosome aberrations, there can either be a change in the structure of the chromosome or a change in the chromosome number. The alterations in me chromosome can be in the nature of deletion, duplication, inversion, and translocation. When a part of the chromosome is lost, it is known as deletion. Duplication is the repetition of a chromosome. When a segment of the chromosome breaks but later rejeins after rotating by loO degrees, it is called inversion. If a segment of a chromosome breaks and

relocates within a non-homologous chromosome it is called translocation.

There can be changes in the chromosome number. Each species has a characteristic number of chromosomes which is a reflection of a monoploid number. Those individuals having multiples of monoploid number are called euploids. Euploids having more than twice the number of monoploid are called Polyploids! Organisms with changes that involve individual chromosomes are referred to as Aneuplolds.

Prokaryotic Chromosomes: The prokaryotic celi lacks a nuclear membrane and the genetic material is found in a compact structure called the nucleoid. The chromosome is made up of DNA with associated proteins.- These proteins have close similarities with histones found in Eukaryotes.

Eukaryotic Chromosomes: Unlike the prokaryotic chromosome, the eukaryotic chromosome **is** complex in structure because of greater amounts of DNA per chromosome, more number of chromosomes and the large number of DNA related proteins. The DNA of eukaryotes is associated with postiively charged histones. The .histones and DNA form linear arrays of spherical structures called nucleosomes.

Genetic Disorders in Humans: In 1902, Archibald Garrod and William Bateson reported several disorders that appeared to be inherited. Some of these disorders are :

1. **Sickle Cell Anaemia** : This is caused by the expression of a recessive gene. It is linked to an autosomal chromosome (chromosome 11). In individuals afflicted by this disorder, the red blood cells become elongated and curved- a condition called sickling of the erythrocytes. The red blood cells in such individuals aggregate in the capillary systems of veins and several tissues suffer damage due to shortage of oxygen. These erthrocytes are destroyed more rapidly than the normal red blood cells hence leading to anaemia.
2. **Phenylketonuria** : This is also due to the expression of a recessive gene. It is autosomal and the disorder leads to metabolic errors. It leads to failure of brain to develop in infancy and hence mental retardation. The metabolism in affected individuals fails to convert the amino acid, phenylalanine into the amino acid, tryosine. This leads to overproduction of phenylalanine. This accumulates in the cerebrosopinal fluid leading to mental retardation.
3. **Down**'s **Syndrome** : This is due to imbalance in the chromosome number, first described by Langdon Down in 1866. The afflicted individuals display prominent folding at the corner of the eyes and have short statures. They have small round heads and protruding tongues which causes the mouth to be partially open. They have short, broad hands. In such individuals, the physical, psychomotor ancl mental development is retarded and the life expectancy is shortened. These individuals have an additional chromosome on chromosome 21. That is, there are three copies of chromosome 21 instead of the normal two. Such a condition is called Trisomy. This disorder is produced due to a rare meotic abnormality and hence does not run in families.
4. **Alzheimer's Disease:** It results due to the accumulation of amyloid proteins in the brain leading to degeneration of the neurons. The individuals suffer loss of memoiy as well as general physical impairment. The disease is common among individuals with Down's Syndrome.
5. **Genetic Disorders linked to Sex-Chromosomes :** These are Klinefelter's Syndrome and Turner's Syndrome. In Klinefelter's Syndrome, there, can be 47 or 48 chromosomes. If it is XXY (47 chromosomes) or XXXY (48 chromosomes) sexual differentiation leads to development of males. The males with XYY type of Klinefelter's Syndrome show above average height and subnormal intelligence and are prone to psychopathic tendencies. If the chromosome composition is XXX or XXXX (i.e., 47 and 48 chromosomes) sexual differentiation leads to the development of females who have short statures, poor development of breasts and rudimentary ovaries. If the chromosomes composition is XO (i.e., only 45 chromosomes) the sexual differentiation leads to development of females. This condition is called Turner's Syndrome. Females with Turner's Syndrome have short stature, webbed-neck, lack of secondary sexual characteristics and sterility.

9. NATURE OF THE GENE

DNA or deoxyribose nucleic acid was first described by Friedrich Miescher in 1868. The DNA consists of four nucleotides. Each nucleotide is made up of a pentose sugar (deoxyribose type), a phosphate group and a nitrogenous base. A subunit of a nucleotide is the nucleoside. This is made up of only sugar and a nitrogen base. The four nucleosides differ from each other in the type of base which could be adenine (A), guanine (G), thymine (T) or cytosine (C). The Adenine and Guanine are purines while Thymine and cytosine are pyrimidines. In chemical terms, each nuceotide is a deoxy-5-monophosphate i.e., DNA is a polynucleotide.

Structure of DNA : In 1953, Maurice H.F. Wilkins and Rosalind E. Franklin suggested that the DNA is a long molecule consisting of two similar" strands running in parallel and in a helical manner. Watson and Crick proposed that the DNA is a double helix. That is, the DNA consists of two strands which are helically coiled. Each strand consists of a backbone made up of alternating deoxyribose sugar and phosphate. The phosphate joins the two deoxyribose sugars through a phosphouiester bond. (This is a phosphate group forming a bridge between two hydroxyl (i.e., - OH) groups of two adjacent sugars. The base pair of one strand are joined to the base pair of the opposite through hydrogen bonds. The pairing is always such that Adenine pairs with Thymine and Guanine with Cytosine. That is, the pairing is always between the purine and pyrimidine bases.

RNA and its Structure : RNA or ribonucleic acid is another nucleic acid and like DNA, is a polynucleotide. However in RNA. the pentose sugar is ribose but not deoxyribose. It contains Uracil but not Thymine **as** the pyrimidine. RNA serves **as** the genetic material in many viruses. The three major classes of cellular RNA are ribosomal RNA (rRNA), messenger RNA (mRNA) and transfer RNA (iRNA.). All these three moiecuies originate as complementary copies of one of the two strands of a DNA segment that constitutes **a** gene during the process of transcription. That is, each gene (a DNA strand) will throw up an identical R.NA sequence of the nucleotides except that uracil will replace thymine in the RNA sequence. Messenger RNA carries the genetic message from the DNA to the ribosome. Transfer RNA, carries amino acids to the ribosomes during translation. Transfer RNA contains many modified bases.

DNA Replication: According to Watson and Crick, each DNA strand of a helix acts as a template for the synthesis of a daughter strand. The resulting daughter strand will be complementary to the template. The copying of DNA. to make more DNA is called DNA replication. The daughter helix contains one old and one new strand. This mode of DNA replication is called semiconservative replication. In DNA replication, the first requirement is the separation of the two strands making up a DNA helix. The two separated strands can then act as templates for replication.

The most important DNA synthesising enzymne is DNA Polymerase-III. This along with the other DNA polymerases has the capability to elongate an existing DNA strand but cannot initiate the synthesis. To initiate DNA synthesis, a small . segment of RNA called the RNA primer, which is complementary to the template DNA is synthesised by a unique RNA polymerase called primase. To primase, the DNA p'olymerase-III adds the five deoxyribose nucleotides and extends the DNA. Since the two strands of DNA run anti-parallel to each other, DNA synthesis on both strands differs. While on one strand, the DNA synthesis continuous, on the other, the DNA is synthesised in small stretches of DNA, synthesized with the help of RNA primers. The RNA primers are them removed and the gap is then filled by DNA synthesis. That is, the stretches of DNA are joined by the enzyme Ligase. The process of replication ensures accuracy in order to maintain the nucleotide sequence of the original DNA.

Gene Expression: After replication, the second most important attribute of the gene is to store and express the genetic information that will contribute towards the phenotype which will be passed on to successive generations. The idea that genes control the metabolism was put forward by Garrod in 1902.

Genes and Proteins : A specific sequence of four bases in the DNA serves as the storehouse of all genetic information and hence the basis of all life an earth. The unique way the bases are arranged constitutes the genetic code. The genetic code determines "the basic structure and hence function of the whole variety of proteins. The expression of the genetic material generally occurs through the production of proteins. This involves the steps of transcription and translation, hi the process called transcription, the genetic information stored in the DNA is transferred to an RNA. The RNA uses this information to direct the manufacture of proteins during translation.

In 1970, H.M. Temin and D. Baltimore described a process called Reverse Transcription, hi this, the RNA replicates by synthesizing a complementary DNA. This is carried out by a RNA- dependent DNA polymerase called Reverse Transcriptase. Many tumour virus that

contain RNA as the genetic material replicate by synthesising a complementary DNA with the help of Reverse Transcriptase. These viruses are known as reteroviruses. Transcription therefore involves the production of a single-stranded RNA identical in sequence to one of the strands of DNA. Transcription is accomplished by an enzyme called RNA polymerase which gets physically associated with DNA.

Translation : This is a process by which the genetic message carried by mRNA from the DNA is concerted in the form of a polypeptide chain having a specific; sequence . of amino acids. In addition to mRNA, the other entities involved in translation are ribosomes, amino acids and tRNA's. Ribosomes are the ribonucleoprotein particles that provide the site for protein synthesis. It may be noted that the prokaryotic and eukaryotic ribosomes are different in terms of their proteins and also the RNA. In protein synthesis involved in the translation process, twenty naturally occurring amino acids participate. In translation, a tRNA is specifically linked to an amino acid, a process called charging. This is brought about by an enzyme (called aminoacyl tRNA synthetase) which recognises only one amino acid.

Molecular Basis of Mutation: In DNA, a specific sequence of bases forms the genetic code for a gene. Mutations in the genetic code can be by a) Substitution - in which one base is replaced by another base like for e.g., the substitution of purine to purine or pyrimidine to pyrimidiie (a substitution called transition) and purine to pyrimidine or pyrimidin to purine substitution (called transversion). b) Frame shift Mutation - in which there is addition or deletion of a few bases. Since a specific base sequence within a gene is. crucial for it to express a particular phenotype, any change in the base sequence may change the codon and thus lead to mutation or altered expression. Base substitutions can also create mismatches. However, each living cdi possesses repair mechanisms to rectify such mistakes. Only when these mechanisms fail or are defective, that mutations take place.

Regulation of Gene Expression : We know that the genetic information stored in a gene is expressed through the process of protein synthesis. Studies have shown that while some proteins may be produced **in** five to,ten molecules, Others may be produced in as many as 1,00,000 copies per cell. This suggests that gene expression is regulated.

Inducible Control as a Method of Gene Expression: Francois Jacob and Jacques Monod suggested that a group of genes are expressed and regulated together as a unit. This unit was termed by them as the operon. The RNA produced by the operon is polycistronic mRNA

Repressibte control As a Method of Gene . . . . . Jacob and Monod suggested that an operon can be repressed hence stopping all its transcriptional activities. This is not only a form of gene regulation but is also an example of negative control.

Gene expression is extensively regulated based on the environment. In multicellular organisms, regulations can take place at the tissue level. That is, different genes are expressed in different urgans. Hcwevei, some genes ore expressed in all cells. These are called house-keepmg genes.

GENETIC BASIS OF INHERITANCE

Genetics owes its development to Mendei's experiments on :the garden pea (_ Pisum Sattuum). Based on his experiments, Mendel postulanted four principles of inheritance. These are : .

1. Each genetic character is controlled by a .pair of alleles (the allomorphic pair),
2. When two dissimilar alleles are present in a single individual, only one can express itself, called the dominant gene and the one that fails to express itself is called the recessive gene.
3. When any individual produces gametes, the alleles seggregate and each gamete receives oniy one member of the pair of alleles. This is'called the Principle of Segregation or Purity of Gametes. It may be noted that the paired condition is restored by random fusion of gametes during fertilisation.
4. If two pairs of contrasting traits are inherited independently, then according to the Principles of Independent Assortment of Factors, when two independent events occur simultaneously, the combined probability of two outcomes is equal to the product of their individual probabilities of occurrence.

Genetic Terminology:

1. **Allele :** Each gene consists of an allele pair. The alleles represent two alternative forms of a gene.
2. **Phenotype :** The observable morphological appearance of an individual is called the phenotype. The phenotype of an individual is determined by different combinations of alleles.
3. **Genotype :** This is the genetic constitution of an individual representing a single character or a set of characters.
4. **Homozygous Alleles :** When the two alleles of a gene are similar, they are said to be in homozygous combination.
5. **Heterozygous Alleles :** When the two alleles in a gene are dissimilar, they are in heterozygous combination.

6. **Dominant Alleles :** An allele .that influences the appearance of the phenotype even in the presence of an alternative allele is a dominant allele.
7. **Recessive Allele:** An allele that influences the appearance of the phenotype only in the K presence of another identical allele is a recessive allele.

Developments in Gcnetics After Mendel : Three botanists viz Hugo devries, Carl Correns and # Erich Tshermak-Seysenegg carried out hybridisation experiments similar to those of Mendel. This led to the rediscovery of Mendel's principles and also led to the discovery of new principles in genetics. These new concepts are :

1 **Incomplete Dominance :** Ot the two alleles of a gene, one is dominant over the other and hence does not allow this recessive allele to express itself in the heterozygote. However, the recessive allele may sometimes express itself in a heterozygote. This leads to tb« development of a different phenotype. When the recessive allele also expresses itself in the heterozygote, it is called partial dominance or incomplete dominance. For e.g., in plants like Fcur-o-Clock (Mirabilis Jalapa) 'f red flowered plants are crossed with white flowered ones, the first generation offspring plants produce pink flowers (i.e., a combination of red and white).

2. **Codominance:** When both the alleles of a gene express themselves in the offspring, it is called codominance.
3. **Polygenic Traits :** When the phenotype shows no distinct alternative forms (like for e.g., either dark-skinned humans or white-skinned humans), it is a ease of polygenic traits, i.e., all the different variations of the phenotype can be produced. The polygenic traits are generally controlled by three or more genes where the phenotype reflects the contribution of each allele. Inheritance of polygenic traits reflects the principle of continuous variation of traits.
4. **Pleiotropy :** When one gene controls several phenotypes, it is called a pleiotropic gene and the phenomenon Is called pleiotropy.

10. VIRUSES (VIRUS-POISON)

CONNECTING LINKS BETWEEN LIVING &r NON-LIVING ORGANISMS

Viruses are the. smallest Ultra Microscopic organisome, which live as parasites. They were discovered by Iwanowsky and the term 'virus' was coined by Beijernick.

Viruses show different shapes. Based on the type of host, viruses are of 5 types.

- **Rant Virus :** Principally attacks plants. It contains single stranded RNA.
- **Animal Virus :** It attacks Animals. It contains double stranded DNA.
- **Bacteriophages :** Viruses which infect bacteria. It contains DNA.
- **Cyanophages :** Viruses infecting blue-green algae.
- **Zymophases :** Viruses infecting yeast.

Note : RNA - Ribo-Nucleic Acid
DNA - Deoxy Ribo Nucleic Acid

STRUCTURE OF VIRUS :

Viruses are nothing but nucleoproteins. They lack cellular organisation. They do not have metabolic activity of their own. They reproduce by using the metabolic machinery of the host cell they infect. A virus consists of just a nucleic acid &'protein. Nucieie acid forms the central core of'virus

Protein coat of virus is called CAPSID

Viruses have both living & non living characters.

LIVING CHARACTERS

1. Viruses live as obligate parasites
2. They can reproduce
3. They can undergo mutations (Sudden changes in heriditary materials are mutations)

NON-LIVING CHARACTERS

1. They exist as crystals outside the cell of host.
2. They do not show cellular organisation
3. They do not show respiration and other metabolic activities

Some important diseases caused by VIRUSES ;

PLANT Diseases

1. Tobacco Mosaic Virus (TMV)
2. Tobacco nucrosis
3. Swollen shoot of cocoa
4. Leaf roll of Potato
5. Leaf curl of papaya
6. Spike disease of Sandal Wood
7. Bunchy top of Banana

ANIMAL Diseases

1. Chicken Sarcoma disease
2. Chicken Polyoma.
3. Foot & Mouth disease of cattle

HUMAN DISEASES

1. Small Pox
2. Chiken pox
3. Rabies
4. Cold
5. Polio
6. Measles
7. Mumps
8. Encephalitis
9. Conjuntivitis
10. AIDS.
11. Dengue Fever
12. SARS

TRANSMISSION OF DISEASES :

Virus transmitting agents are called carriers

Eg : 1. Flies 2 Mosquitoes. They simply carry virus from one place to other place, without being infected by that virus.

Polluted air, water & food stuffs help the dissemi- nation of virus.

VARIOUS HUMAN DISEASES AND THEIR DIAGNOSTIC INSTRUMENTS

Electro Cardio Graph (ECG):

It senses the electrical forces produced by the heart muscle during contraction and relaxation & records them from the body surface.

Electro Encephalo Graph (EEG):

It represents spontanious electrical activity of the drain as recorded from the electrodes placed on the scalp. Normal EEG wave form shows- certain characterstic features which can be described in terms of the frequencies, amplitude, morphlogy of the signals. The changes in these varieties show the disease of brain. EEG is an index of brain function.

Auto Analysers :

These are to estimate the various bio-chemical substances like Glucose, Urea, Cholesterol, En- zymes arid other proteins.

COMPUTED TOMOGRAPHY SCANNING (CT Scanning) :

X-ray images do not sufficiently differentiate soft tissue structures. These draw backs have been eliminated to a large extent by CT Scanning which uses X-rays but employs a computer for recon- structing the image instead of directly recording it an a photographic film. It is extremely useful in detecting tumours and monitoring the extent of their spread to neighbouring tissues and, organs.

Position Emission Tomographic Scanning (PET):

It is also a computerised imaging technique. Unlike the static anatomjical images, produced by CT scan, PET

images give quanitative regional information on the metabolic and physiological process.

Nuclear Magnetic Resonance Imaging (NMR):

The Magnetic resonance generated by the Nuclear Hydrogen; atoms present in abundance • in all biological tissues subjected to an externai mag- netic field is the basis of this Imaging technique.

GENETIC ENGINEERING, CLONING AND GENOMICS

Genetic Engineering : It is essentially the alteration of the genetic make-up of cells deliberately. It involves tools and technologies of molecular biology for cleaning and rejoining DNA sequences from two or more different organisms. These genetically modified DNA fragments are called recombinant DNA molecules.

Recombinant DNA Technology : The various steps involved in recombinant DNA teclinology are briefly discussed in the following account. At first, a useful DNA segment (i.e., a gene) is_ isolated from an organism. The usefulness is evaluated by studying the functions of various genes, a process called sequencing. The specific segment of the DNA can be obtained by cutting the double-stranded DNA at specific sites with the help of enzymes called Restriction Enyzmes.°The enzyme separates the DNA molecules lengthwise containing a specific, sequence of base pairs. The next step is to obtain a DNA segment from another organism which is a vector (or a carrier). These two DNA segments (i.e., genes) are then spliced (i.e., joined) with the help of an enzyme called Ligase. The hybrid molecule is called the recombinant DNA. The recombined DNA molecule is then inserted into a cell. The recombinant DNA then multiplies in the ceil as the cell divides.

In the course of inserting the recombined DNA into a cell, phsmids arc considered to be good carriers or vectors. Plasmids are small circular DNA molecules of bacteria. A plasmid is isolated and split by restriction enzymes. This split part of the plasmid is then joined or spliced to a DNA fragment of anothei organism using ligase. These hybrid DNA plasmids are then mixed with bacterial cells which then take up the hybrid molecule. The genetically modified bacterial cells multiply. The bacteria are then inserted into the desired organism (say a human being) and they now infect the human cells. The human cells will, now have the desired gene and hence will manufacture the desired proteins. It may also be noted that in recombinant DNA technique, DNA sysnthesising enzymes called DNA Polymerase or Reverse Transcriptase are used to make a DNA complement to an existing DNA or RNA. These DNA polymerases can transcribe (i.e., write), a DNA sequence from one organism to another organism.

Applications of Recombinant DNA Technology :

1. Manufacture of useful chemical compounds cheaply and efficiently. Genetic engineering using recombinant DNA technique has been used on a very large scale to alter microbes which can produce a wade variety of biochemicals. For e.g., E. Coli bacteria have been genetically altered to produce human insulin, human growth factor interferons, interleukins, injectible hepatitis vacine and so on.
2. To understand molecular events in the biological processes such as aging and cellular differentiation.
3. To spell out the complete nucleotide sequence of the genome of various organisms including Man.
4. To diagnose diseases using DNA probes.. In this method of diagnosis, short segments of single stranded DNA attached to radioactive or fluorescent markers are constructed. These are called ,DNA probes. These DNA probes are introduced in blood or other cell samples of the infected . person to identify a particular pathogen.
5. **DNA Fingerprinting** : Since no two individuals have an identical genetic make-up (except in identical twins), the DNA sequence is unique to an individual. DNA fingerprinting can be used to identify criminals, to determine paternity of children, to verify whether a hopeful immigrant is really a close relative of an established immigrant as claimed, and to identify racial groups to rewrite biological evolution.
6. **Applications in Transgenics:** Recombinant DNA technique is being increasingly used to produce transgenic crops and organisms. The examples of transgenic crops are Bt cotton, transgenic tomato, and a transgenic soyabean called Roundup Ready. Similarly, transgenic organisms have also been developed. For e.g., transgenic cows which can produce useful proteins in their milk and transgenic bacteria producing human insulin, human growth factor interferons, interleukins etc.
7. **Cloning Animals** : Recombinant DNA has been used to develop clones of animals.
8. **Cloning Cells** : In the recent times, recombinant DNA is being used to clone stem cells of humans for a wide variety of applications. Stem cells from the fertilised eggs or very young embryos are pluripotent i.e., they can differentiate into any of the cells of the human body. Molecular biologists are now attempting to use stem cells to treat degenerative disorders like Alzheimer besides generating human organs for organ transplant.

11. THE BLOOD

The blood is a sticky fluid that transports oxygen from the lungs to the cells, carries food elements from the digestive tract to different parts of the body and carries away waste materials from the cells. Defense cells move in the blood to sites where they are needed to fight infection. Various hormones are also transported in the blood stream. In addition, the blood helps maintain a more or less constant temperature in the body (lie adult man's body contains about five litres of blood. The watery fluid in the blood is called plasma. The plasma contains different types of cells - the RBC's or erthrocytes, the WBC's or the leukocytes and the platelets or the thrombocytes. The plasma makes up around 50% to 60% of the blood. Besides serving as a vehicle for the transportation of RBC's, WBC's, platelets and other substances, plasma also acts in blood clotting and in the defense of the body against disease. After clotting' occurs, a straw-coloured fluid called serum is left. The water in the plasma holds many substances in suspension and solution. These substances include the proteins, products like sugar, fat, inorganic salts derived from food and other storage sites of the body, besides breakdown products of proteins such as urea, uric acid, creatine etc. The plasma also contains enzymes such as adrenal hormones, thyroxine and insulin.

The proteins in the plasma attract water. The proteins in the plasma serve to balance the pulling effect exerted by the proteins in the cells. That is, if the proteins were present only in the cells and not in the plasma, the cells would absorb water into themselves and would be swollen. Serum albumin is the plasma protein concerned with absorption of water. Gamma globulins are proteins that function as antibodies in the blood to immunise the body against disease. The globulin prothrombin plays an important role in the blood clotting mechanism. Another protein called fibrinogen also participates in blood clotting. The salts in the plasma provide many functions. For. e.g., sodium chloride helps in the dissolution of proteins. Some other salts in the plasma called buffers maintain the same degree of alkalinity in the blood.

The RBC's : These are the most numerous of the formed elements of the blood. The RBCs carry oxygen to the cells throughout the body and return carbon dioxide to the lungs. The RBC form in the red marrow of ends of long bones throughout the body and throughout the interior of flat bones like the vertebrae and ribs. The most important chemical of the blood is haemoglobin. It is made up of four parts of heme to ninetv-six parts of globin. In a man, the normal amount of haemoglobin is 14-15.6 gms per 100 CC of blood while in a woman, it is 11-14 gms in 100 CC blood. When haemoglobin combines with oxygen in the lungs after air has been inhaled, it forms a compound called oxyhaemoglobin. When RBC's reach different parts of the body, the parts of the body get oxygen from oxyhemoglobin. Hence, the RBC's draw oxygen from the lungs and transport it in the bloodstream to various tissues. In high altitudes, since there is lesser oxygen,' the bodv needs more RBC's to carry oxygen to different cells. Hence in higher altitudes, the people have more haemoglobin in their blood. The average life-span of RBC's is 110-120 days. Various methods are used to determine the total number of RBC's and the total haemoglobin content. For e.g.. RBC's are counted by diluting the blood in sodium chloride solution. The haemoglobin content can be determined by the spectrophotometer.

The WBC's : These constitute the chief defence mechanism of the human body. The number of WBC is one for 400 or 500 RBC. The **WBC** unlike the RBC, lack haemoglobin and have a cell nucleus. All WBC's have a life span of less than two weeks. The different varieties of WBC are:

(a) Neutrophils : These are the most numerous of the WBC. The neutrophils attack invading bacteria and also absorb those human cells which have been affected by the invading organisms.

(b) The Lymphocytes: These are the most numerous WBC after neutrophils. They are found in large numbers in the spleen and the lymph nodes.

(c) The Basophils: These have an affinity for a basic dye called Methylene blue. Basophils produce an anti- coagulant called heparin which prevents formation of blood clots.

(d) The Eosinophils : These are stained with the dye eosin. The number of eosinophils increase during diseases like asthma, hay fever and in certain parasitic infections like hookworm.

(e) The Monocytes: These are the largest WBC and form part of the body's defense against micro-organisms, especially in TB, malaria and typhoid.

The Platelets: Platelets are tiny circular or oval disks which are derived from certain giant cells in the bone marrow. The platelets serve many purposes. For e.g.,

when they disintegrate, they liberate thrombokinase or thromboplastin. This plays a vital role in the blood clotting process.

Blood Clotting: Clotting of blood is also called coagulation. In clotting, the blood is first converted into a jelly-like mass. As this process continues, thread-like structures, composed of the protein called fibrin, form a tangled mesh. All the elements of the blood i.e., the RBC, the WBC and the platelets are trapped in this mesh. It may be noted that fibrin is not present in tlie blood but is formed from the union of two substances called fibrinogen and thrombin. Whejl tissues are injured, they release thrombokinase, a clot-inducing substance. This reacts. with the prothrombin of the plasma in the presence of calcium ions to produce thrombin. Finally, the thrombin and fibrinogen react to produce fibrin.

Blood Diseases : The chief types of blood diseases are :

1. **Anaemia :** This is a condition due to deficiency of haemoglobin and hence less oxygen reaches the tissues. There are various types of anaemias. For e.g., nutritional anaemias are due to some malfunctioning of the blood-forming centres or enough of the materials necessary for blood formation may not be present in the diet, or the body may not be able to utilise those materials. Iron-deficiency anaemia is a type of nutritional anaemia in which the RBC's are smaller than normal and fewer in number. Hence, they will not able to carry enough oxygen leading to an oxygen deficiency in the tissues. Women are particularly prone to iron-deficiency anaemia. Achlorohvdric Anaemia is another type of nutritional anaemia. Another type of anaemia is hemolytic anaemia. In this disorder, the RBC are destroyed ton quickly. This condition may either be an acquired or an inherited characteristic. Another type of anaemia is perinicious anaemia. People with perinicious anaemia lack a certain enzyme in the gastric juice, rhis enzyme is necessary for the body to absorb cyanocobalamin or vitamin B_{12} and hence be able to produce RBC's.
2. **Polycythemia:** A serious disorder, polycythemia is a condition in which there is overproduction of RBC's, as a result, the blood becomes thick and moves slowly through the veins. It leads to frequent headaches and dizziness and the blood tends to form clots in the blood vessels.
3. **Leukamia :** This is condition with overproduction of WBC's. The WBC count may reach an amazing total of 5 lakh WBC per cc of blood. The white cells invade the bone marrow, squeeze out the RBC's and platelet producing material and cause an accompanying anaemia to develop. Leukemia is believed to be due to an abnormal condition of the bone mai row or lymphoid tissue, causing WBC-forming elements to multiply.
4. **Clotting Disorders** : If the body is deficient in the essential clotting elements or if the platelets are too few or defective, or if the fibrinogen content of the plasma is seriously reduced, or if there is. a prothrombin deficiency, "clotting disorders with excessive bleeding may result. The different types of clotting disorders are:
   - **(a) Thrombocytopenia :** This results because of too few platelets and hence, the blood tends to seep out of the circulatory system, leading to the development of black and blue bruise spots,
   - **(b) Haemophilia:** This is a hereditary disease, almost exclusively occurring in males and transmitted directly only by females. Due to this disease, even a small cut may lead to serious hemorrhages.

Blood Groups: Each person's blood possesses certain inherited characteristics which distinguish it from the blood of every other person. Human blood can therefore be divided into different groups. The research of Karl Landsteiner led to a clear understanding of blood groups. Landsteiner declared that the formation of clumps in the blood due to the mixing of different blood groups is due to substances called agglutinogens or antigens and agglutinins or the antibodies. A type of agglutinin will cause RBC to clump if the RBC contain a certain type of agglutinogens. Two important types of agglutinogens are labelled A and B. Corresponding to these are two types of agglutinins called anti-A or alpha and anti-B or beta. Clumping of blood takes place if blood containing A is mixed with blood containing anti-B. It may be noted than the RBC of a given person may contain both A and B or either A or B, or neither of them. On the basis OfA, B, anti-A and anti-B, the human blood has been divided into four groups. Those are A, B, O, and AB. An agglutinogen found in the RBC of most people is the Rh factor or the Rhesus Factor. Blood having the Rh factor is called Rh positive and blood lacking it is called Rh negative. If blood from an Rh- positive person is transfused into an Rh-negative person, the serum of the person who is Rh-negative produces an anti-Rh agglutinin. If this person receives some more blood from a Rh- positive person, the anti-Rh agglutinin causes the blood to clump. If an Rh-negative woman becomes pregnant with an Rh-positive baby, the baby inherits the Rh-factor from its father. During pregnancy, some of the RBC of the foetus may enter the blood stream of the mother and cause her blood to produce anti-bodies against the Rh-factor. These

antibodies can enter the foetus and destroy its RBC, a condition called erythroblastosis fetalis. This reaction usually does not occur in the first pregnancy unless the woman has previously built-up Rh-antibodies. Group-O blood may be given to peisons with any group, hence group-0 is called universal donor. Similarly persons with group AB can receive blood from all other groups, hence AB is called universal recipient.

Blood Type Frequency (As a per cent of Total Population)

Blood Type	**Frequency (in per cent)**
O	46
A	40
B	10
AB	4

Blood Type with Rh Factor Freaeency (As a per cent of Total Populs

Blood Type	**Frequency (in per cent)**
O Rh-positive (O^+)	38
O Rh-negative (0)	7
A Rh-positive (A^+)	34
A Rh-negative (A^-)	6
B Rh-positive (B^+)	9
B Rh-negative (B^-)	2
AB Rh-positiVe (AB^+}	3
AB Rh-negative (AB^-)	1

12. THE DIGESTIVE SYSTEM

The digestive tract or the alimentary canal consists of a long tube that runs through the body. It is made up of the pharynx (the back part of the mouth), the esophagus (a tube connecting the mouth with the stomach), the stomach, the large and the small intestines, the rectum and the anus.. The stomach, the large and the small intestines form the gastrointestinal tract.

The Process of Digestion : The food that is chewed is mixed with saliva. Saliva contains ptyalin which acts upon the starches in food. The ptyalin breaks down complex starch molecules into simpler ones. The muscles in the back of the mouth first relax to receive the bolus, (the ball of food). Then the constrictor muscles of the pharynx contract and the food is forced into the upper opening of the esopohagus. The esophagus is a thick-walled tube Whose inner surface is lined with mucous membrane. The food is earned through the esophagus into the stomach's opening,

Form and Structure of the Stomach: Some amount of digestion takes place in the stomach. The stomach is located in the upper left part of the abdominal cavity. The average capacity of an adult's empty stomach is one litre. The inner surface of stomach is lined with a mucous coat. This contains a surface lining called the epithelium and various glands which secrete mucous and other substances. This is followed inwards by three layers of smooth muscle. The outer coat of the stomach is made up of a smooth membrane called the peritoneum. The fundus or the upper part of the stomach is always filled with some gas that has been trapped. Part of this gas consists of air swallowed with food and the rest is a product of digestion.

Stomach Secretions : Upon receiving food, the stomach secretes various substances like mucous, hydrochloric acid and certain enzymes like pepsin and renin. Mucous, hydrochloric acid and pepsin are contained in the gastric juice, which is a ciear. waterv fluid. Protein rich foods such as meat, lead to. greater secretion of gastric juice, while carbohydrates and fats lead to least secretion of gastrjc juice. Through the action of gastric juice, the proteins are broken down into smaller units in the stomach. However, these are not completely digested till they are acted upon by various juices in the intestine. Some minerals such as calcium salts may be dissolved in the stomach. Fats and carbohydrates undergo only little changes in the stomach. The stomach performs a mechanical action i.e., it mixes food' and gastric juice by means of churning movements. As a result, the food is reduced to a semi-fluid mass called chyme.

The Processes in the Intestine : The semi-liquid chyme is carried from the pylorus to the first' part of the-small intestine i.e., the duodenum. Most food leaves the stomach three to four hours after eating. The digestion of the food is completed in the small interline. The wastes then enter the large intestine. The small intestine is divided into duodenum, the jejunum and the ileum. The duodenum is a little different from the rest of the small intestine. Its wall is thicker and more richly supplied with glands. It receives secretions not oniy from these giands but also from the liver and the pancreas. Digestion and absorption simultaneously occur in the upper part of the small intestine. Wave motion of the small intestine carries the liquid content into the large intestine. The liver provides bile to the small intestine. The bile is emptied into the duodenum. The pancreas .also empties pancreatic juice into the duodenum. If any one of these, are lacking, the digestive processes are seriously affected. The secretions i.e., bile and pancreatic juice are alkaline. Bile is. stored in the gall bladcfer, which is under the liver. Bile's most important function is to emulsify fats in the intestinal tract. Bile salts, break up globules of fats into very fine particles. They also help in the solution of fatty acids.

Chyme causes the secretion of the hormones secretin and pancreozymin from the intestinal wall. These hormones cause the secretion of pancreatic juice from the pancreas. Pancreatic juice contains sodium carbonate and other substances which aid in the solution of carbohydrates, fats and proteins. The enzyme amylase in the pancreatic juice changes starch into maltose. Trypsin and chymotrypsin are enzymes that act on proteins and break them down. Lipase is another pancreatic enzyme which acts an fats i.e., it breaks them down into fatty acids and glycerin. Intestinal juice, secreted by the upper part of the intestine, contains sodium chloride, sodium carbonate and other enzymes. After starches and complex sugars are broken down to simple sugars, fats to fatty acids and glycerin and proteins to amino acids, they are absorbed by the walls of the intestine.

The Large Intestine: The small intestine opens into the large intestine via the colic valve, the junction between both. The colic valve permits chyme to enter the large intestine but prevents it from re-entering the small intestine. The normal time of the small intestine to empty into the 'large intestine is 5-8 hours. When the chyme enters the large intestine, it is made up of indigestible residue, fats, cellular debris, bacteria and minerals. A great deal of water is absorbed as they pass through the large intestine to form the feces. The large intestine is made up of the caecum, the colon and the rectum. The caecum

occurs below the junction of the small and the large intestine. A small tube like projection called the vermiform appendix extends from the lower part of the caecum. The vermiform appendix serves, no special purpose in man and is hence a vestigal organ. The colon is the part of the large intestine extending from the caecum to the rectum. The rectum is the last section of the large intestine. It is divided into the rectum and the and anal cuaial. The anal canal leads to an aperture called the anus. After the contents of the ileum pass through the colic value, they collect in the caecum. Then they pass into the colon. The. fecal masses are finally pushed by colon movements into the rectum. The rectum expands to produce a definite stimulus indicating the need to pass the feces.

Digestive Tract Disorders :

1. **Constipation** : This is a condition of irregular or delayed bowel movements. This could be due to voluntarily delaying defecation for long periods or due to weakness of abdominal muscles. It could also be due to too little bulk or too little fluid in the food.
2. **Diaorrhea** : The bowels move too frequently in this condition and the stools are too soft. This nappens wnen contents of the large intestine pass through the large intestine rapidly and hence enough water is not absorbed by the contests from the bowel wall.
3. **Dysentery** : This of two sorts
   (a) Bacillary dysentery which is caused by shigella bacteria
   (b) Amebic dysentery : This is due to the amoeba entamoeba histolytica. This amoeba is found in the fecal matter of infected persons (infected with amoebic dysentery).
4. **Appendicitis :** When deposits accumulate in the vermiform appendix, its outlet may be obstructed. Bacteria wili invade the Wall of the appendix and inflamme it. Nausea is one of the principal symptoms of appendicitis. The appendix is removed by surgery.
5. **Ulcers :** The pepsin and the hydrochloric acid in the gastric juice destroy the lining of the duodenum or the stomach hence destroying the tissue. If the ulceration is intense, the walls of the duodenum and the stomach may develop pores, causing the contents of these organs to enter the abdominal cavity. The membrane lining the abdominal cavity i.e., the peritoneum may also be infected, a condition called peritonitis.
6. **Gallstones :** These are irregularly shaped bodies found in the gall bladder or the bile duct. They contain cholesterol, bile salts and calcium in varying proportions. Faulty metabolism may be one cause or infection of the gall bladder may be another. Sometimes the gallstones may. pass into the bile duct and obstruct the passage of bile into the intestine. Gallstones cannot be dissolved, surgery is the Only solution. Very frequently, the entire gall bladder is removed.

THE MUSCULAR SYSTEM

The human body has more than 600 different muscles. Latissimus Dorsi. is the broadest muscle of the back. The masses of muscle are bundles of firm threads or fibres. The human body has three types of muscle tissues. These are :

1. **Skeletal Muscles** : These are the most numerous of the three tvpes of muscles. These muscles are also called striated or striped muscles because they are made up of light and dark cross-striped bands. The skeletal muscles are voluntary muscles because they can be controlled by the mind. Each skeletal muscle cell has a large number of nuclei. These nuclei lie in the outer part of the cell. In this respect, skeletal muscle cells differ from most other muscle cells because in other muscle cells, a single nucleus is located in the center of the- cell. The striped portion of the skeletal muscle is made up of two types of proteins i.e., the actin and the myosin. The dark bands in the striped skeletal muscle is made up of rod iike molecules of myosin while the light bands consist of bent or curved molecules of actin. During a muscle contraction of the skeletal muscle, the straight rods slide past one another and the whole fibre is shortened.
2. **Smooth Muscles:** These do not show anv cross stripes. These are involuntary muscles since we do not have any control over their movements. .These are found in the walls of the stomach and intestines, in the blood vessels, in the bladder, around the pupils of the eyes and muscles attached to the roots of ttie hair. The smooth muscles contract more slowly than skeletal muscles.
3. **The Cardiac Muscle** : This is the heart muscle and if resembles the smooth muscle in that it is also an involuntary muscle. It also has a similarity to skeletal muscle since its fibres have a cross striped pattern-

Energy for Muscle Action : Muscular activity requires abundant energy. The most important sources of energy for muscles are the sugars and the starches. During digestion and assimilation, sugar and starch are changed to glycogen. Most glycogen is stored in the liver and is given out when needed. Fat is another source of energy for muscle. The body uses fat when the store of glycogen is greatly reduced. The carbon of food is another source of muscle energy. The human body does not burn glycogen directly but breaks it down into lactic acid. About one — fifth of the lactic acid (i.e., around 25%) is burned when it combines with oxygen, the remaining lactic acid is reconverted into glycogen. Since the breakdown of glycogen and lactic acid is a time

consuming process, the phosphorous compound Adenosintriphosphate or ATP breaks down to provide the energy necessary for muscle contraction. Another compound i.e., phosphocreatine also breaks down and provides the energy to build-up ATP again. Glycogen now decomposes into lactic acid and lactic acid provides the energy for the build-up of phosphocreatine. Any excess lactic acid is carried **by** the lymphatic system to the liver, where it is reconverted into glycogen.

Muscle Fatigue: If too much lactic acid accumulates within a muscle, it becomes tired and finally stops contracting. If myscles are to act effectively, lactic acid must be broken down into carbon dioxide and water or built up into glycogen. The waste products resulting from the activity of muscle cells also produce fatigue. Muscles must be well supplied with glycogen and oxygen and they must get rid of the waste products of combustion by way of the circulatory system.

Control of Muscle Activity : The fibres contained in the nerves that connect the brain or the spinal cord with the muscles are fundamental in the control of muscle activity. At the place of contact of the nerve fibre with the muscle, each nerve fibre divides into many branches and each goes to a muscle fibre. A message along a nerve fibre may cause as many as 100 muscle fibres to contract.

Muscle Motion: Flexor muscles bring adjacent body parts closer together and extensors move them apart. Abductors are muscles that move a part, such as a limb, away from the rest of the body and adductor muscles move A back. Pronator muscles can turn a part, such as the hand, face up. Suppinator muscles turn it face down. There are also muscles for rotation, as at the shoulder and the hip joints.

The main superficial muscles on the ventral (front) side are :

1. Orbicularis oculi (eye)
2. Pectoralis Major (the Greater Breast Muscle)
3. The Sartcrius - (Thigh)
4. Trapezius - (muscle over the collar bones)

Main superficial muscles on the dorsal side :

1. Grand Latissmus Dorsi.
2. Achille's Tendon - the muscle running from the calf of the leg to the heel bone.
3. Gemellr- the calf muscle.

Tendons : These are bands of connective tissue attaching the ends of muscles to the bones. They are very strong. Ligaments are also made up of connective tissue but they join one bone to another. Tendons serve to transmit the force exerted by muscle fibres. In many muscles, the fibres are set at an angle and their force is carried by a tendon running the length of the muscle. Tendons also help muscles to withstand sidewise pressure and friction. Where muscles rub against each other or against bone, they develop protective tendon patches. The tendons are protected against friction by connective tissue called tendon sheaths. These sheaths contain a fluid that acts as a lubricant as the tendon slides back and forth.

Muscle Tone: Muscles play a chief part in preventing unwanted movement. The ligaments are only a secondary line of defense i.e., they act when the strain on joints is too great or to too quick for the muscles to control. Even when the muscles are relaxed, some of their fibres are contracting. This partial contraction is called muscle tone or tonus. The muscle tone serves to hold the bones in place. Muscle tone helps us to maintain an upright posture.

HUMAN TEETH

Human teeth are stationed at the entrance of the alimentary canal. The teeth are made hard by embedding of calcium, phosphorous, magnesium and other mineral salts in organic matter. The four tissues that make up teeth are :

1. **Enamel:** This covers the crown or the visible part of the teeth and is the hardest substance in the body.
2. **Dentine:** This makes up the main mass of the tooth andjs denser and harder than bone.
3. **Cementum:** This covers the dentine in the teeth root arid is a bone like substance.
4. **The Pulp** : This occupies the center of the tooth and contains nerves, arteries, veins, and lymphatic vessels. The periodontal membrane is a layer of soft tissue between the teeth root and jaw. It holds the tooth in place and.acts as a cushion.

Types of Teeth :

1. **Deciduous Teeth** : In a young child, there are 20 teeth in the first set. These are called the deciduous teeth because they are shed. They are also called the milk teeth. Tooth buds begin to form in the embryo as early as the sixth week of prenatal life.' They begin to harden about the 16^{th} week. Of the deciduous teeth, the first to be shed are the central incisors (which are shed around 7 Vi years) and the last teeth to be shed are the cuspid teeth (which are shed around eieven and half years of age).
2. **Permanent Teeth** : These number 32. The first permanent teeth to develop are the central incisors and the first molars. The eight front teeth are the central «nd lateral incisors, which are cutting instruments. Adjacent to these are the 4 cuspid teeth which have a sharp point for tearing food. These are also called canines. Next to the cuspids are 8 biocuspids or the premolars. (They occur as two on each side of the upper and lower jaw). The biocuspids tear and crush food. In the back of the mouth are the 12 molar teeth in groups of three on each side of the upper-and lower jaws: The third molars, the hindmost teeth of the mouth, are also known as wisdom teeth. The teeth in each jaw form

an arch called the dental arch. The first of the permanent teeth are the first molars.

Diseases of the Teeth :

1. **Dental Caries** : This is tooth decay. The disease destroys the tissues of the tooth and produces cavities that may lead to its death. The disease is caused by an acid that is formed when bacteria act on fermentable carbohydrates (principally sugar) in the -mouth. The acid **is** capable of dissolving the enamel of the tooth.
2. **Periodontal Diseases:** The diseases of the gums and of the bones that support the teeth are called periodontal diseases. They affect the structures surrounding the teeth and hence the teeth may become loosened and fall off. One of the principal periodontal diseases is Gingivitis, an inflammation of the gingivae or gums.
3. **Malocclusions:** Teeth that are irregularly spaced or do not meet properly when the mouth is closed are said to be in malocclusion. The condition may be due to certain hereditary factors like narrow dental arches, the eruption of the teeth before the jaw has grown sufficiently, premature shedding or prolonged retention of deciduous teeth.

THE BONES OF THE BODY

Bones are versatile tissues. Two thirds of the bone is made up of mineral matter, mostly calcuium phosphate, and the rest one-third is made up of collagen, an elastic substance. The outer surface of all bones is made up of compact bone. The compact bone has numerous canals called the Haversian Canals which provide passageway's for nerves and blood cells. Long bones entirely consist of a hollow shaft of compact bone. The cavitv in the centre is tilled with bone marrow. Id some long bones, there is an outer covering of compact bone and an inner covering of spongy bone or cancellous bone. The pore spaces within the cancellous bone are filled with bone marrow. In the ends of long bones and throughout the interior of flat bones and ribs, there are tissues which manufacture RBC. Some materials like benzol and lead are harmful to bone marrow. The human skeleton is made up of 206 bones which fall into two groups i.e.., the axial skeleton and the appendicular skeleton.

The Axial Skeleton and its Bones : The axial skeleton includes those- bones which transmit weight and protect body cavities. These are the skull, the vertebral column, the ribs and the sternum.

1. **The Skull :** There are 22 bones in die human skull. The cranium or the braincase is big in humans and expanded forward hence providing for deep sockets for the eyes. The human cranium is made up of 8 bones. These include the frontal bone which is ronghly over die forehead, the two parietal bones which a*e at the top and the sides of the head, the two temporal and the two sphenoid bones on the lower sides of the head, and the occipital bone which makes up the back of the skull. The foramen magnum is a huge opening at the lowest point in the back of the cranium which provides the passage for the spinal cord. The facial bones are thin and delicate. The facial bones surrounding the nasal cavities contain cavities called sinuses. The sinuses open out into the nose and are lined with the mucous membrane of the nose. The largest sinus extends along the nose, above the upper teeth and below the eyes. There are many sinuses in the bone between the eyes and behind the eyes. Hence infections can spread easily from the sinuses to the eyes. The mandible or the lower jaw is a horse-shoe shaped bone. A pair of vertical platy bones called rami extend the mandible upto the joint. The hyoid bone is a u-shaped facial bone at the junction of the mouth with the neck. The Adam's Apple or thyroid cartilage hangs from the hyoid bone. The Adam's Apple is the chief cartilage of the larynx.

The Vertebral Column : This is the backbone assembly. It is made up of a large number of cylindrical blocks. Each block is joined to the other by a cartilage. The blocks are called vertebrae and the cartilage is called intervertebral disk. The spinal cord is present behind these cylindrical blocks. It passes through, a series of arch-like bones called neural arches. Each neural arch forms part of one of the vertebrae. At the Sides, between adjacent arches, there are large openings called foramina. The spinal nerves make their way to the organs of the human body via the foramina.

The backbone is made up of 33 to 34 vertebrae: These vertebrae fall into 5 main groups i.e. the cervical vertebrae of the neck, the thoracic vertebrae of the chest, the lumbar vertebrae of the lower back, the sacral vertebrae below the lumbar vertebrae and finally the vertebrae making up the terminus of the backbone called coccyx. There are 7 cervical vertebrae, of which the first cervical vertebra which supports the head is called the Atlas and the cervical vertebrae below the Atlas is called the Axis. There are twelve thoracic vertebrae. These are larger than the cervical vertebrae. Each thoracic vertebra cairies a pair of ribs. There are 5 lumbar vertebrae. There are 5 sacrum vertebrae. All 5 are fused to form a single bone called the sacrum. It very large and triangular and attached to the hip bones. The sacroiliac joints occur at the place of attachment of the sacrum with the hip bones. These joints transmit the weight of the body to the legs. The coccyx makes up the lower end of the sacrum and represents the vestige of a tail.

The Sternum : This is the breastbone. The cartilages of the first seven ribs are attached to the sternum. (These

seven ribs are called the true ribs). The two clavicles or collar bones are joined to the sternum.

The Ribs : These are made up of twelve paired bows of bone. Each pair of ribs is attached to each of the twelve thoracic vertebrae. The first seven pairs of the ribs joined to the breastbone are called the true ribs. The next 5 pairs of ribs are called the false ribs. The last two pairs are called the Floating Ribs which extend only halfway across the body. The ribs play an important part in breathing and protect the heart and lungs.

The Appendicular Skeleton: The appendicular skeleton includes the shoulder girdle and the pelvic girdle. The shoulder girdle includes the collar bones, the shoulder blade and the arm bones. The pelvic girdle includes the bones of the pelvis and the limb bones.

1. **I'he Collarbone (or clavicle):** it is attache d to the breastbone at its inner end and at its outer end, to the shoulder blade. It forces the shoulder joint to keep its distance from the breastbone. When it breaks, the shoulder collapses inward.
2. **The shoulder Blade or Scapula** : It is a thin triangular bone suspended from the outer end of the clavicle. It slides over the upper and back parts of the chest. At the armpit, the outer part of the scapula forms the socket of the ball and socket joint between the shoulder blade and the upper arm. Just besides the shoulder joint another strong bone projects from the scapula called the coracoids. process. The clavicle is.joined to coracoids process by a ligament.

Arm Bones : These include :

(i) **The Humerus** : This is a single bone of the upper arm. Its upper end makes up the ball of the bail and socket joint. At its lower part towards the elbow, the humerus expands to form two joint , surfaces, one of which is called the trochlea. The inner bone of the lower ami i.e., the ulna is joined to the trochlea.

(ii) **The Radius and the Ulna** : The ulna is the inner bone of the forearm and is concerned with bending and straightening of the elbow. The radius is the outer bone of the forearm and carries the hand at the wrist.. When the thumbs point towards the body, the ulna and radius are crossed.

The Hand Bones : These include :

1. **The Carpais** : These are **8** little bones of the wrist. These occur as two rows. The movements of the carpais gives flexibility to the wrist.
2. **Metacarpals** : These are the palm bones. Their square bases lie towards the wrist and are in contact with each other . Their rounded heads form the knuckles. The metacarpal of the thumb moves freely and is opposable to the rest of the fingers.
3. **The Phalanges** : TheSe are the finger bones while the thumb has two phalanges, all other fingers have three.

The Hip Bones : The hip bone is very irregular in shape and is hence called the innominate bone. It has two symmetrical bones attached to the sacrum above and uniting below at the crotch. Three sets of bones make up the hip bone, the Ilia, the Ischia and the Pubes. l~he two ilia are the topmost bones. The ilia protect the lower abdominal organs. The lower end of each ilium ends in a cup like structure called the acetabulam. The acetabulum is joined to the thigh bone or femur - in a ball anu socket joint. This is the most secure ball and socket joint of the human body. The ischia is made up of the Ischium bones which run vertically down from the acetabulum. It is the bone on which were rest . when we sit straight. The Ischium merges with die Pubis. The Ischia, the Ilia and the Pubis and sacrum form the pelvis, which has no bottom. The cavity at the bottom of the pelvis houses the reproductive organs.

The Leg Bones : These include :

1. **The Patella :** This is kneecap and slides down the femur when the leg is bent.
2. **The Femure :** This is th^ thigh hor.c and is the longest bone of the body It fits i^to the acetabulum at its upper end. Its lower end at the knee develops a pair of prominences called the condyles.
3. **The Tibia :** The inner bone of the lower leg is the tibia. It alone receives and transmits weight. It supports the condyles of the femur.
4. **The Fibula :** This is the outer bone of the leg and is very thin and delicate. The tibia and fibula develop projections near theankle joint called flanges. These flanges hold the topmost bone of the foot i.e., talus. The fibula does not take any part in-the knee joint.

The Foot Bones : These are :

The'Talus : This is the uppermost bone of the foot and rests on the heel bone or calcaneus. The talus, the calcaneus and the 5 small bones in front of them are called the tarsals or the ankle bones. In front, theankle bones are joined to metatarsals an phalanges similar to those of the hand.

Disorders of Bones : The bones of the young are flexible and soft. Hence when they fracture, ᶜthey splinter instead of breaking completely. When the bones are very fragile, the ailment is called Fragilitas Ossium. Rickets is a bone disease of children. It is due to deficiency of calcium, phosphorous and vitamin D. Hence the bones do not solidify properly and the bones are deformed out of shape. When the bones are infected by certain bacteria, the marrow is inflamed by pus. This condition is called Osteomyelitis.

13. ECOLOGY

Ecology deals with the study of- the relationship of the organisms with their environment or study of structure and function of nature.

A single population (say for example Human Population) does not live in isolation in a natural environment. An association of several populations belonging to different species living in a common environment which interact with one another is called a Biotic community.

A Biotic community cannot live in isolation. It lives in an environment which supplies its material and energy requirements. The Biotic community together with the physical environment forms Ecosystem. It may be a large grass land or a pond or a forest.

Thus any structural and functional unit of the environment is called ecosystem. The whole network of relationships comprising biotic community and aboitic environment and its interactions has to be studied, if one intends to study ah ecosystem.

The structural component of ecosystem is classified into (1) Biotic or living (2) Abiotic or Torivrg.

The abiotic component consists of light, tempera- I ftm.waier.oxygen, carbon, nitrogen, and minerals. I Bnfec component consists of producers, consum- es and decomposers.

Both material and energy enter the living world through the producers (green plants) which syn- thesize food. The various levels of consumers consisting of herbivores (plants eating animals) and carnivores (animal eating animals) obtain their material and energy requirements by comsuming food and lastly the decomposers (Micro organisms) survive by decomposing com- plex organic molecules or dead and decaying organic matter into simpler ones, thus returning the materials. back to the environment. Energy from sun light escapes into surroundings as heat.

There is a. flow of food and energy from one trophic level to other. The food relations in its simplest form representing a producer, herbivore (primary consumer), Carnivore (secondary con- sumer) and a decomposer constitutes a "Food Chain". Each step in a food chain constitutes a trophic level.

In nature several food chains (i.e. food chains of forest ecosystem, pond ecosystem, etc) are inter-connected to form a network called the "Food Web".

The amount of energy transferred from one trophic level to other becomes less and less if we graphically represent. It assumes the shape of a pyramid. The same is the case with the Biomass, where the Biomass of different trophic levels becomes less forming the pyramid of, Biomass.

The place or locality in which an organism lives constitutes its habitat. ; Each .species of a community occupies a specific part of the habitat and has a definite-relation in, the environment, all of which together constitute its "Niche".

If we take marine ecosystem, the deep-water, of the Ocean basin is vertically divided into an upper layer of euphotic zone (where a clear light enters) upto 200 metres followed by less, lighted aphotic zone ahdr then the dark abyssal zone (below 2,000 mts).

There are 3 major environments ift this ocean basin. The littoral zone comprising the seafloor from shore to continental shelf. Benthic zone comprising of oCean basin, and the pelagic zone, free water of the ocean·

Marine life can be classified into 3 categories.

(a) Plankton : consists of passively drifting or floating organisms. They are confined to euphotic zone. It includes phytoplankton and zooplankton.

(b) Nekton : Actively moving organisms with weli developed locomotory organs. They feed on plankton or smaller Neckton. Eg: fishes.

(c) Benthic organisms : Found in sea-bed. Many of them are scavengers. Eg: Bacteria

Man made, ecosystems include villages, cities, parks, crop lands etc. Boundaries between any two ecosystems is not distinct. Thore is over- lapping and exchange of materials and energy always occurs between ecosystems.

BIOSPHERE

Life exists ohly on earth which provides the necessary environment for the sustenance of life.

The inhabited part of the earth and its atmosphere including the ;living.components is called Bio- sphere. It consists of 3 sub spheres called:

(a) Hydrosphere which includes all the water component

(b) Lithosphere Comprising the solid components of earth's crust

(c) Atmospheres-forms the gaseous envelope of the earth.

In respect of materials, the earth with atmosphere is a closed system but as far as energy, is concerned earth is an open system because most of the sunlight received by earth is radiated back to the outer space.

Materials in the form of elements and compounds also move back into the physical environment which are used/ again, by the living world. This kind of cycle of materials is called "cycle of matter". It involves substances like carbon, oxygen, hydro- gen and nitrogen which have atmosphere or water as reservoir are called gaseous cycle. While substances like phosphorus, suiphur etc. are termed as sedimentary cycles as lithosphere is their reservoir.

Only about one percent of solar energy is trapped by the plants through photosynthesis, The rate at which organic molecules are formed in a green plant is called its gross primary productivity.

Some of the organic compounds are used for its life activities and rest are stored as Biomass. That stored energy is called net primary produc- tivity. The energy incorporated by the producers is transported through the different trophic levels -in the form of food.

SEED PLANTS

The seed plants belong to the phylum Pteropsida. This phylum includes the seed-plants and also the ferns, which do not have seeds. The typical features of seed plants are :

1. Their reproductive structures are seeds, which are produced by seeds or cones.
2. The male sex cell i.e., the sperm finds its way to the female sex cell by the pollen tube. This is found only in seed plants. _
3. Seed plants possess complex vascular tissues which are conducting tissues that transport water, minerals, foods and other substances within the plants.
4. Almost all seed plants possess the green pigment, chlorophyll.

Structure and Physiology of seed plants :

1. All seed plants consist of stems, roots, leaves and cones or fiowers. However, the Asparagus plant and certain parasitic flowering plants lack leaves.
2. The roots, stems and leaves are called vegetative organs. Roots anchor the plant body firmlv in the soil and absorb water and minerals nutrients from the soil, conduct then? upward into the stems and transport food downward from stems. Stems produce and support leaves, flowers or cones. They conduct water and nutrients upwards and food downwards. They also store food. The leaves manufacture food.
3. Photosynthesis by leaves manufactures food. In this process, carbondioxide reacts with water, using the light energy absorbed by chlorophyll. By this process a simple sugar i.e., glucose is produced and oxygen is released. The carbondioxide is absorbed directly by leaves from air.
4. Since most chlorophyll of plants occurs in leaves, most photosynthesis take place in leaves. In some plants with green stems such as tomato and petunia, photosynthesis also occurs in green stem tissues.
5. In respiration by plants, foods combine chemically with oxygen and release stored energy as chemical energy. If photosynthesis converts light energy into stored chemical energy, respiration releases this stored chemical energy.
6. During thic day, the rate of photosynthesis exceeds the rate of respiration. During night, respiration continues but photosynthesis ceases. Hence green plants absorb oxygen in night and release carbondioxide.
7. In the process of growth of green plants, the new tissues form at the tips of roots and in the buds of stems. In many seed plants, a growth tissue called cambium is located in the stems and roots. The cambium lies between the two conducting tissues i.e., xylem which conducts water / soil nutrients upwards and, phloem which conducts foods (manufactured in leaves) downwards. . The growth activity of cambium produces new tissues in a transverse fashion in roots and stems and causes these organs to grow in diametpr.

Classification of Green Plants: Living seed plants are classified into A) Gymnosperms (division Pinopohyta) and B) Angiosperms (division Magnoliophyta). In Gymnosperms, the seeds are naked i.e., the seeds are produced on the surface of cone scales. In Angiosperms, the seeds develop in structures called fruits. In Gymnosperms, the reproductive process occurs in cones while in Angiosperms, it occurs in flowers. The embryos of gymnosperms have more than two seed leaves i.e., the cotyledons. In Angiosperms, the embryos have either one or two seed leaves. The ovules (i.e., structures that develop into seeds) of gymnosperms, bear their eggs in female sex organs called archegonia while Angiospenn ovules lack archegonia. The xylem of gymnospenns is simple in structure with vertically arranged cells called Tracheitis (which serve as support for the stem and conduct sap) and horizontally arranged cells called rays. The xylem of angiosperms is more complex yvith many types of cells and cell groups including tracheids, vessels (long, continuous conducting tubes), fibres and storage cells called Parenchyma.

Cone Bearing Plants or Gymnosperms: The Gymnosperms are woody plants (trees and shrubs). Their reproductive structures are cones. In many gymnosperms, there is a dominant main stems with conspicuously smaller branches. In some species, their main stems have no branches at all. The leaves of most gymnosperms are

needle-like or scale-like. In certain gymnosperms like the Cvcads and the Ginkgoes, the leaves are broad and thin. Most gymnospenns are evergreen. Some are deciduous iike the iarch, the cvpress and the ginkgoes. Many gymnosperms produce essential oils that are volatile and highly scented. When these oils combine with oxygen, they form viscous liquids or solids railed resins. The living species of the gymnosperms are divided into:

1. **Cvcads :** These have unbranched woody stems. Their leaves are subdivided into leaflets. Pue cycads ate chiefly tropical arid subtropical. The reproductive processes occur in cones. The large cone is female and the small cone is male.
2. **Ginkgoes :** They were abundant in the past. Today there is.only one living species i.e., Ginkgo Biloba - the Chinese Maindenhair tree.
3. **Conifers :** These belong to Pinatae. These include the pines, spruces, fir, cedar, juniper, cypress, sequoias (or the RedyvoOds of California) and larch. The largest number of species of the conifers belong to the Pines. Most conifers have needles. The majority **of** the conifers are evergreen. The conifers are abundant in temperate latitudes and high altitude regions of the tropics. They supply softyvood, resins and the bark of some species produce tannins.
4. **The Genetales :** This mainly includes three genera i.e., Ephedra, Welwitschia and Gnetum. Ephedra is found in dry rocky regions. Wehvitschia has only one species and is native to Southwest Africa.

The Angiosperms or the Flowering Plants : The angiosperms produce seeds within fruits. The fruits may become dry when they are mature forming structures such as pea pods, bean pods or the lily capsules or they may become soft and fleshy like the tomatoes, grapes, watermelons and peaches. There are tyvo classes of angiosperms - the monocotyledons or monocots and the dicotyledons or dicots. The main differences between them are :

1. The moncots have only one seed leaf or cotyledon in the embryo. The dicots have two.
2. The flower parts of the moncots are in threes or the multiples of threes. The flowers of dicots **are** most often in fives multiples of lives, less frequently in fours and rareiy in twos and threes.
3. The leaves of most monoeots are longer, are wide and the veins run length-wise in the leaves. The leaves of most dicots like the elms, the lettuce, the maple and the lilacs are as broad as they are long. Their veins form a branched network in the leaf.
4. The stems of monoeots generally lack cambium, hence the stems do not increase much in diameter, except the palm trees. Most species of dicots have cambium in their stems and roots and hence their stems are very broad.

The most primitive living angiosperms are probably the magnolias, the tulips and their relatives. The monocot orders include the cattails, the grasses, the sedges, the lilies, the tulips and the orchids. The dicot orders include the broad-leaf trees such as willows, elms, oak, maples, apple, walnuts, mahoganies, plum trees and others.

Plant Structure of Angiosperms : The four major parts of angiosperms are roots, stems, leaves and flowers. Grass roots are slender and fibrous while the roots of carrots, sugar beet and turnip become fleshy and enlarged because food and water are stored in them. Some stems are modified into tendrils c' into organs of food storage For e.g., the bulbs of onions and potato tubers are examples . of stems with food storage. Some stems are modified for vegetative reproduction like in strawberry. The leaves of most angiosperms are broad and thin. In some flowering plants, the leaves are modified into tendrils. Leaves of ccrtain species, like *he Venus Fly-trap, are specialised for trapping and digesting insects.

Flowers of angiosperms are structures where the reproductive processes take place leading to seed formation. Most flowers contain both stamen (male part) and pistil (the female part), But in oaks, willows and walnuts, some flowers have stamens while others have pistils. The mode of pollination i.e., the transfer of pollen grain from stamen to stigma (the tips of pistils) depends upon the type of flowers found in a plant. When pollen grain falls on stigma, it grows into a pollen tube. The pollen tube grows into the ovary of the pistil. The ovary has the ovules. Each ovule contains the embryo sac within the which a single female structure i.e., the egg is produced. The pollen tube enters a pore in the ovule and releases sperms into the embryo sac. The sperms fertilise the egg and the fertilised egg or zygote begins to develop..

Foods are transported into the ovule. The ovule grows and its surface cell layers develop into the seed coat. Foods and water move into the tissues surrounding the ovary which ultimately forms the mature fruit. The fruit has seed. It may be noted that in some angiosperms, fertilization does not occur.and the fruits are seedless.

INTERNAL STRUCTURE OF ANGIOSPERMS

The Tissues of Angiosperms : Plant tissues can be classified into two main groups. These are :

1. **Meristematic Tissues :** Though all cells of the embryo of a plant are capable of division, in a mature plant, only meristems are capable of cell division. A meristem is a localised region in which cell division occurs in a mature plant.

2. **Permanent Tissues :** These are made up of cells which have lost the capacity of cell division. The permanent tissues are of the following types :

   (i) Simple Tissues : These are homogeneous in nature because they are composed of structurally and functionally similar cells. The simple permanent tissues are parenchyma, collenchyma arid sclerenchyma tissues. The parenchyma is the most common tissue. It is unspeclalized and forms the basis of all plant organs and tissues like the cortex, the pith, the mesophyll of the leaf and floral parts. These tissues usually have plasnlodesmata i.e., the thread-like cytoplasmic strands ginning from one cell to another. When the parenchymatous cells are exposed to sunlight, they develop chloroplasts in them. Those tissues of the parenchyma which have chloroplasts are called chlorenchvma. The cells of the parenchyma are involved in various physiological activities like photosynthesis, assimilation, storage, secretion and excretion. The collenchyma is another simple tissue composed of elongated cells with primary, non-lignified cell yvalls. The most distinctive feature of collenchyma cells is the uneven thickening of the cdl-wall. The wall thickening is primary in nature and is composed of cellulose, hemicellulose and pectic materials with a high percentage of water. The cell walls have vacuolated protoplasts which typically occur in the hypodermis (i.e., the layer beloyv the epidermis) of the herbaceous dicots. The collenchyma cells constitute an effective mechanical tissue and provide elasticity and support to the growing organs. The third simple tissue is sclerenchyma which is specially meant for providing mechanical support. These cells have thick walls and are lignified. The cell walls lack living protoplasts.

   (ii) Complex Tissues : These are xylem and phloem. The xylem is a conducting tissue and is composed of four elements. The function of xylem is to conduct water and mineral salts upyvards from the root to the leaf and to give mechanical strength to the plant body. The phloem or bast is another conducting tissue. The main function of phloem is to conduct prepared food from the leaf to the storage organs and growing regions of the plant.

The Tissue System of Angiosperms : The tissues of the angiosperms yvere classified for the first time by Sachs in 1875. The three categories of tissues identified by him are :

1. **Epidermal Tissue System :** This is made up of:

   (i) Epidmermis : This is the outermost layer of the plant body. The cells of the epidermis are elongated and occur as a continuous layer yvithout any. “intercellular spaces. The outer wall of the epidermis is thick and is usually covered by a cuticle. The cuticle is made up of waxy material secreted by the epidermal cells. The cuticle of the xerophytic plants is the thickest.

   (ii) Stomata : These are the minute openings found on the epidermis of all the green aerial parts of plants. However, the stomata are abundant on the lower surface of leaves as they regulate the process of transpiration. In the aquatic plants, a large number of stomata occur on the upper surface of leaves.

   (iii) The Epidermal Appendages: These are the trichomes. These trichomes are the protuberances arising from the epidermal cells.

   (iv) Root Hair : The epidermis of roots bears root hair in the specialised region called the root hair zone.- The root hair are formed due to the elongation of the epidermal cells. The root hair Eire temporary structures which play an important role in anchoring the plant body in the soil besides absorbing water and mineral solutions from it.

   The functions of the epidermal system are :

   (i) The cuticle helps in checking excessive loss of water

   (ii) The stomata of the leaves help in transpiration and exchange of gases.

   (iii) The trichomes help in dispersal of seeds and fruits besides reducing water loss.

2. **The Ground Tissue System :** The ground tissue system forms the main bulk of the plant body. It includes all the tissues except the epdiermis and the vascular bundles. The primary function of the ground tissue system is storage and manufacture of food material. It has different kinds of tissues such as parenchyma, collenchyma and sclerenchvma. The parenchyma is the most abundant.

3. **The Vascular tissue system:** The vascular tissue system is formed by the phloem and the xylem. The elements of the xylem and phloem are always organised in groups and are called vascular bundles-

Internal Structure of a Dicot and a Monocot Plant : The internal structure of dicot and monocot plants can be studied under the following heads.

1. The epidermis of the root is the epiblema. It has the same structure in both monoeots and dicots. The cuticle and the stomata are absent. Below the epidermis is the cortex. This is a massive zone made up of several layers of parenchyma cells.
2. **The Stem of Dicots and Monoeots :** The outermost layer is epidermis. The epidermis of dicot stems has trichomes but in the monoeots, the trichomes are absent. The cortex lies below the epidermis. The cortex is made up of the hypOdermis, the general cortex and the endodermis. The hypodermis of the cortex of dicots is made up of collenchyma cells while in the monoeots, it is made up of sclerenchyma cells. The general cortex of the dicots has only a few layers of parenchyma, while the general cortex of the monoeots has a continuous mass of parenchyma. The vascular bundles of the cortex of dicots are arranged in the form of a ring while in the monoeots they lie scattered on the ground tissue.
3. **The Leaf of Dicots and Monocots** : Ihe epidermis is the outennost layer of the leaf (both on the upper and lower sides). A thick cuticle is present in the cell of the upper epidermis. The cells in the upper epidermis usually lack stomata but if present, are few in number. The vascular bundles of the leaf are made up of xylem and phloem. It may be noted that there are some differences between leaves of the monocots and the dicots. For e.g., in the leaf of the dicots, the cuticle is thicker in the upper epidermis and thinner in the lower epidermis. However, the cuticle in the leaf of the monocots is uniformly thick. In the dicot leaf, the stomata are more on the lower epidermis while in the monocot leaf there are equal number of stomata in both upper and the lower epidermis.

Secondary Growth in Stems and **Roots of Dicots and Monocots** : In most dicot stems and roots, a distinct secondary growth occurs which increases the diameter of the stems and the roots. In dicot stems, the intrafascicular cambium is present between the xylem and phloem. This is primary in nature. The parenchyma cells lying between the intrafascicular cambium of adjacent xylem and phloem bundles divide and change into meristematic tissue and form the interfassicular cambium. Both the intrafascicular and the interfascicular cambia join to form a complete ring of vascular cambium. Since the cambium is mute active in its growth on the inner side (where the secondary xylem occur), the xylem increases more than the phloem. The xvlem therefore forms the main bulk of the plant body.

The activity of the cambium ring is under the control of physiological and climatic factors. For e.g., in early summer (spring) and summer, dur to relatively higher temperatures and high relative humidity, the cambium grows rapidly, leading to the development of a large mass of xylem tissue. This is called spring wood or earlv wood and is lighter in colour. In autumn, due to relatively lower temperatures and lower relative humidity, there is reduced growth of the cambium and the cambium is also of darker colour. This is called autumn wood. The spring and the autumn wood make up the annual ring or growth ring of the tree. Due to the addition of secondary phloem and secondary xylem, the outermost layer of the cortex becomes highly stretched and may crack open. From these cracks, a feyv layers of the meristematic tissue may arise from the cortex. This is called cork cambium or phellogen.

14. EVOLUTION

Development of agriculture based on planting of seeds and the use of fire formed the basis for human civilization. All important crops, that we are using now were already used by ancient civiliza- tions. Without the knowledge of genetics), the early man introduced-piant-breeding in a natural way. No food crop was inrtroduced in recent times but application of scientific knowledge of genetics has, resulted.in enormous crop yields throughout the world.

PLANT BREEDING

The development of new varieties of plants possessing desirable characters from the existing varieties is called Plant Breeding or crop improvement.

Different methods of Breeding are based on the type of reproduction and pollination operating in a crop, fnere are 7 important methods of plant breeding. Those are:

1. Introduction
2. Selection
3. Hybridisation
4. Mutation Breeding
5. Polyploidy Breeding
6. Tissue Culture
7. Genetic Engineering

1. Introduction :

The process of introducing high yeilding vari- eties of plants from their growing locality into a new locality. That is simply transfer of plant from one place to another place. The newly introduced plant has to adapt or adjust itself to the new or changed environment. This ad- justment of the introduced plant is called Acclimatisation..

"IR-8" variety of rice was Introduced from Phil- ippines to India. Some other varieties are :

	Crop	Variety	Introduced from
1.	Wheat	Sonara 63, 64	USA
2.	Tomato	Siox	USA
3.	Pea	Rimpus	Germany
4.	Grape	Beauty seedless	USA
5.	Wheat	Ridley	Australia

Merits : It is the easiest and quickest method of crop inprovement.

Demerits : Plant pathogens may also seek entry along with the introduced plant material and cause damages to the introduced variety.

For ex: Pathogens like phytophthora infestens (late blight of potato) from Europe were introduced into India.

2. Selection :

It is the oldest breeding method. It is of two types. Natural selection where nature itself selects the course of evolution and. the other one is artificial selection. Here selecting agent is man. In, artificial selection simplest method is.

Mass selection : where farmer before harvest- ing the crop selects the best plants. From the field, seeds of these plants are collected ana pooled up and used to raise the crop in next year. The 2nd method is:

Pure line selection : In this isolating a desir- able homozygous individual from the mixed population arid multiplying the same without contamination to release a new variety.

The 3rd method in artifical selection is:

Clonal selection : In this the progeny (offspring) I of a single plant obtained by vegetative propaga- tion (without reproductive organs) is known as a clone. The stem cutting of sugar cane is a clone.

The selection of desirable clones from the mixed population of a vegetatively propagated crop is called clonal selection.

3. Hybridisation :

In this method two or more plants are crossed together. The main idea behind hybridisation is to bring new combinations of genes (ie) com- bining all good chracteristics into a single variety. The hybrid plants are usually superior to their parents in characters like height, yield, etc. This superiority of a hybrid over its parents is called hybrid vigour or heterosis.

4. Mutation Breeding :

Improvement of crops by changing the genotype of plants through induced mutation is called mutation breeding, (mutation : sudden heritable- change) Mutations that occur automatically in nature are called spantaneous mutations' and those are caused artificially are called Induced mutations. The agent which induce mutations is called mutagens.

Some mutagens are X-rays, Ultra Violet rays, alpha rays etc.

5. PolyPloidy Breeding :

Majority of the crop plants are usually diploid. The haploid number of chromosomes is called a genome.

Man has 46 Chromosomes or 23 pairs of Chro- mosomes i.e. he is having 2 genomes, like wise plants having more than 2 sets of Chormosomes are referred as polyploids. When compared to diploids,

polyploids show more vigour and less fertility. They produce fruits of bigger- size without seeds. Hence-these are usefull in crops when seed is not the economic product.

'The exploitation of polyploidy condition for crop improvement is called polyploidy breeding.

6. Tissue Culture :

The flowering plants normally propagate through seeds. The seeds germinate and produce new plants. New plants can also be produced by culturing the tissue in artificial medium.

The genetic complement of any cell in the diploid organism is intact similar to that of zygote. Each cell has an inherant capacity to develop into a total plant by regeneration when proper external conditions are provided. This inherent potency of the cell is called Cellular Totepotency;

For 'invitro' culture, either isolated plant cell or tissues or organs can be used in tissue culture or organ culture.

Important aspects of Tissue Culture are :

(i) To cultured tissues, nutrients must be' sup- plied.

(ii) The culture medium is made free of organ- isms. Otherwise these Micro Organisms may check the growth of the tissue, or even kill the tissue.

(iii) Proper aeration (Supply of Oxygen) should be provided for the growing tissue.

7. Genetic Engineering :

The objective of genetic Engineering or recombinent DNA Technology is to introduce or delete one or more genes into an organism that normally does not possess them. This requires isolation of a fragment of DNA corresponding to a desirable character in a vector (such as plasmid in a bacterium) and transfering it to the cell. Successful genetic Engineering requires identifi- cation of the desired genes/their trr.ric'cr to the cells of the target crop plant, their integration and expression.

IMPROVEMENT OF ANIMALS (ANIMAL-BREEDING)

Domestication of animals began during the hunting and gathering phase of human civiliza- tion beasts of burden, sources of milk, meat, leather, and Fur. As the civilization is pro- gressed, the domestication of animals gets importance. For this methods of improvement through selective breeding were used.

The present animal breeding techniques can be explained by taking the example of live stock.

The cattle and buffaloes constitute most important species of live stock in India. They are primary source of milk. The best Indian cattle breeds are found in the drier parts of the country. India has 227 million cattle and buffaloes.

Cattle Breeding :

About 10 to 60 % of cows are artificially insemi- nated by semen collected from high quality bulls. Artificial insemination ensures good quality prog- eny and is also economical as semen from a sing e bull can inseminate several thousand cows.

To increase the milk yield Indian cows are cross bred with European breads at the National Dairy research institute, Karnal and in Kerala.

Super ovulation and embryo transplantation :

A pedigreed bull and high production" cow are chosen'to prcduce super milk cows. Sfuper- ovulation is induced by hormone injection. After artificial insemination, embryos are collected'.and transplanted into carrier cow (surrogate Mother) after deep freezing (r196°C). it is posslblt? to preserve seven days old foetuses for several years to be used when needed.

Note :

APICULTURE	-	Rearing of Honey bees
SERICULTURE	-	Rearing of Silk Worn (silk yeilding inseot)
AQUACULTURE	-	Production of aquatic plants along with the animals like prowns, fishes, oysters etc.
PISCICULTUE	-	Production f fishes.

Note : Mules are hybrids of malt? donkey and female horse. They are hardy and used in high altitude regions as beasts of burdqn.

PESTICIDES

By improving seed and using various agricultural chemicals (pesticides), farmer can inci'ease crop yields. Synthetic fertizers are added to the soil to" replenish the various nutrients and maintain its fertility.

It is estimated that there is an annual loss; of 30% in agricultural productivity owing to pestis and diseases. This emphasises the heed for using pesticides. Pesticides are substances used fa kill or repel pests (insects, weeds, mites, rats etc). Pesticides attack nervous system of animals by interfering with the. conduction of nerve impulse. Although pesticides are benificial in protecting crops especially high-yeilding varieties, they are capable of damaging the ecosystem and in the long run render, agriculture non-sustainable.

BIO FERTILISERS

The total consumption of fertilisers in our country is about 9.2 million tonnes. Chemical fertilisers are expensive and their production releases pollut- ants.

further fertilisers applied to crops aire lost in surface run off and polute soil and water resource. In order to combat the ill effects of synthetic, agricultural chemicals green manures, biofertilisers, biological control methods and biopesticides have been introcuced.

Indian soils are usually, poor in organic matter as well as in nitrogen. Materials of biological origin which are used to maintain and improve soil fertility are grouped into 2 catagories:

1. Green Manures
2. Biofertilisers

Green manure is a mixture of cattle dung and crop residues. It supplies organic matter and additional nitrogen. They increase the crop yield by 30 to 50%.

Biofertilisers : These are organisms which can bring abut soil nutrient: enrichment. It includes nitrdgen-fixing micro organism to reduce dependence on chemical fertilisers.

The main spurces of biofertiliser are Bacteria, Cyanobacteria, and Fungi. Rhizobi'um produces nodules in the roots of leguminous plants and fixes atmospheric nitrogen.'

GENETIC CONSERVATION

Biological diversity (various diversified plants and animals) is threatened by encroachment on natu- ral ecosystems by the activities of the ever growing human population.

The plant-genetic resources constitute a category of genetic diversity. Genetic erosion is the loss of genes from a genepopl (Sum total and variety of all the genes- and their - alleles present in a population) caused by factors like deforestation,. Urban expansion, shifting cultivation, adoption of genetically uniform modern variety of crops.

There are 4 basic ways to conserve plant genetic resources those are.

1. Maintaining forest and nature preserves
2. holding in botanical garden.
3. feetiing in agricultural and horticultural trade
4. Preserving them in the form of seeds

Without green plants higher orders of life cease to exist since they provide directly or indirectly food to all animals. But tropical forests are being lost at the rate of 11 million hectares every year. This has implication with millions of forest dwelllers, tribals who live in harmony with nature. So, Situ conservation of wild plants helps to protect spe- cies threatened with loss of extinction.

An important approach to maintaining plant diversity involves collecting samples of cultivated arid wild species and storing them in botanical gardens and gene banks.

To acheive new and better yielding varieties, resistant to diseases, plant: breeders need germplasm collections For this they require entire 'array of genes available in one species and stores in gene Bank.

So, Qene Bartk is an institution where valuable plant material ll-xely to becom? irretrivably jpjst. in the wild or in cultivation are preserved. Gene Banks can serve both seeds and vegetative material. The most convenient way of maintaining plant germ plasm is by storing seeds.

Seed is a living material capable of surviving in a metabolicaily suspended state, In general, seeds last longest when dried arid stored in low tem- perature. Germ plasm preservation at ultra low temparature.of around -196°C is commonly called CRYOPRESERVATION. At such low tempera-, tures, biological activities stops and so genetic change would not occur.

Note :

Father of Green revolution - Norman E. Boriang

Father of Indian Greo. revolution - Dr. M.S. Swam.inathan.

BIOTECHNOLOGY

Biotechnology ifl a broad sense, is that technology which uses biological (living) organisms either totally or partially to produce desired products like drugs, chemicals etc Because of this broad definition, biotechnology can be categorised into two types : old biotechnology and modem bio- technology. Old biotechnology involves recombinant DNA technique, hybridoma, tissue culture, etc.

Recombinant DNA technique involves insertion of foreign DNA (genetic material) in the DNA of a host organism. For example, insulin producing DNA from rat is introduced into the DNA of E.Coli (bacterium). Production of insulin through E.Coli facilitates mass production of Insulin "at a low cost. This direct insertion of foreign DNA in a host organism was performed for the first time in 1972 by Prof. Paul Borg. For this feat, he was awarded Noble Prize.

Hybridoma technique involves' fusion of cells capable of continuous multiplication (tumour cells) with cells producing a specific antibody.

This technique was developed in 1975 by Dr. Kholer, Jerne'and Mifetein at Medical Research Courtcil of England. These scientists have fused ;' antibody producing bolls from an immunised mouse with the tumour cells of the mouse. Out of this fusion emerged the hybrid cell called hybridoma with the properties of both original cells; antibody producing property and rapid multiplication property.

Tissue culture technique involves growing plant tissue in synthetic media in the laboratory to develop callus (a loose mass of cells) which is then separated into

single cells. These cells are then grown on suitable synthetic media to produce whole plants which are finally transferred to the field.

Thi.s technique facilitates growing large number of plants from a small piece of tissue at a very rapid rate.

Applications of Biotechnology : Biotechnology has. Applications, in man fields; Medicine, agri-. cultufie, energy, environment, etc.

Biotechnology in Medicinv : Genetically engi- neered! bacteria have emerged as suppliers of scarce; drugs like insulin, inte.'feron, hormones, vaccines etc. insulin] the important human hormone produced in the pancreas that regulates the sugar level in the blood, was being extracted from the pancreas of cows and pigs till recently for meoical pur- poses. : Some people are allergic to it. And its extraction is a labourious process and a costly affair. Bjut now the bacteria specially programmed for this purpose are producing insulin on commer- cial scale which is sold under the name 'Humu'lin'. This is qne of the first products to be commercially manufactured using recombinant DNA technique).

Interferon is a powerful anti-viral agent, made in the human body. But its supply is very limited when ctimpared to its demand. Its extraction from; the blood cells and other human tissues is costly. Biotechnology based interferons are now available.

Several human and animal hormone vaccines and enzymes are also under tests and are yet to be released into the market.

This technique has also been extended to genetherapy. Such a therapy is the only way out in certain diseases which have not sofar yielded to treatment..

Bid-technology in Agriculture : In agriculture plant cells have, been created capable of fixing atmospheric nitrogen-a unique character only in leguminous plants and some blue-green algae. Scientists are trying to impart this character into the cereals. lf scientists succeed in developing cereal crops with such a character, the cultivation of cereal crops will be very much cheaper; for the farmers can dispense with the synthetic nitrogen fertilizers which are very costly.

Research and development work is being carried out to breed plants to increase the photo-synthetic efficiency thus to raise yields and to make crops less Vulnerable to drought, cold, etc.

Biotechnology in Energy : Gobar gas genera- tion. involves micro organisms which convert gobar into gas in the presence of sunlight.

Research is being carried out for conversion of agricultural wastes into energy by using geneti- cally engineered organisms. The advantages of this method'are minimisation of the environmental pollution-and utilisation of the industrial residues and agricultural wastes to produce energy'.

Application of Biotechnology in Environment : Biotechnology promises to make biological method of controlling-pollution more effective. Bacteria are already used in environmental work for cleaning effluents at sewage works, and scientists have developed , bugs'that gobble up oil slicks; in the oceans which are named as "Super bugs".

BIOTECHNOLOGY IN INDIA

India'is the first country among developing coutries to tap the potential of biotechnology as it provides a valuable means in the development process. The first policy document to cover biotechnology development in the country: was formulated during Sixth Five Year Plan. The. Plan had called for attention in the new areas such as immunology, genetics, molecular biology and genetic engineer- ing for control of diseases like malaria, filariasis and Kalaazar. In the areas of Agriculture and Industry the Plan included tissue culture applica- tion for medicinal and economic-plants, fermentation technology, enzyme engineering for chemicals and waste utilization..

To meet these demands, an apex official agency namely National Biotechnology Board (NBTB) was set up in -1982 under chairmanship of member (Science) of Indian Planning Commission in April 1983. The NBTB issued a long term plan in bio-technology by taking into consideration of the national objectives such as self sufficiency in food; clothing and housing; provision of adequate energy and transportation; protection of environ- ment; employment; industrial growth and balance in international trade. The priorities of this long term, plan are in seven broad areas viz., health, industry, agriculture, energy, environment, com- munication and information, education and training. The Plan also formulated specific projects to fulfil the priorities with time ranging from 3 to 10 years. NBTB also formulated programmes in manpower development in biotechnology; funding of R & D projects; creation of infrastructure facilities and production of vaccines.

To implement the above programmes and schemes effectively, a full fledged Department of. Biotech- nology (DBT) was established in 1986 under Ministry of Science and Technology in place of NBTB. A Scientific Advisory Committee consisting of members representing different Sciencie and Technology agencies and other eminent authori- ties has been constituted to advise DBT.

The DBT initiated postgraduate and Doctoral programme in various universities to meet the technical man power requirement. To build up R & D base, the DBT hais established number of national facilities. The national facility dn Bluegreen algae collection has been

set up at Indian Agricultural Research Institute. National Bureau of Plant Ge- netic Resources has been set up in the area of Plant tissue culture; The National Microbial Culture Collection and Gene Bank has been set up at Institute of Microbial Technology, Chandigarh. Animal tissue culture facilities, have been created at University of Pune, National Institute of Nutrition, Hyderabad, Central Drug Research Institute, Lucknow and Indian Institute of Science, Bangalce. The various chemicals required for research in biotechnology are nOw available at CSIR Centre for Biochemicals (CFB) and Babha Atomic Re- search Centre (BARC).

DBT is also distributing "Biotechnology Informa-tion System" (BITS) which provides latest advances in different areas of biotechnology, research. DBT started funding specific R&D projects such as Bamboo propagation by tissue culture at the University of Delhi. As a part of Seventh Five Year Plan programmes, DBT was involved in Technol- ogy Misions on vaccines, edible oils and on cattle herd development.

MEDICINE :

Immunodiagnostics

DBT has concentrated on inexpensive diagnosis oftuberculosis, leprosy, pregnancy;.viral hepatitis, amoebiasis etc. Workable kits for detection of filaria, amoebiasis, pregnancy have been devel- oped. Kits for detection of tuberculosis, malaria and. leprosy are to be achieved.

Agriculture :

ICAR (Indian Council of Agricultural Research) has set up three biotechnology centres to work on live stock, and crop improvement at National pairy Research Institute, Karnal; Indian Veterinary Research Institute Izathnagar; and Indian Agricul- tural Research Institute, New Delhi. The centre at New Delhi was later renamed as "Lai-Bahadur Shastry Centre for Biotechnology".

One of the two centres of UNIDO'S (United Nations International Development Organisation) International Centre for Genetic Engineering and Biotechnology (ICGEB) is located at New Delhi. ICRISAT (International Crop Research Institute foe Semi Arid Tropics), Hyderabad is now using biotechnology for Crop improvement. The Re- search information systems for Non-Aligned and other developing countries based in New Delhi have undertaken a project on "Biotechnology Revolution and the Third World".

At bilateral layel, India has concluded R&D collaboration agreements in the area of biotech- nology with a number of countries viz., U.S.A., U.S.S;R,, U.K., Germany, France, Switzerland, Sweden, Japan, Vietnam and Mexico.

Indian industry is. now using biotechonology for their business. Hindusthan Lever Limited. (HLL) has modern bio-technology R&D base and launched high yielding varieties of number, of Crops like maize, Groundnut etc. Hoechst India Limited,, is developing a drug by genetic engi- neering for the treatment of Glucoma disease.

POLLUTION

Environment includes air, Water, soil and land- scape, oceans and lakes, buildings and other man made objects. Alteration in the natural qualities of the constituents of environment due to any addition or depletion of their natural contents rendering them harmful to the human beings, animals and plant life is known as pollution. Pollution can also be defined as a constituent in the wrong amount at the wrong place or at the wrong time.

Generally pollution is discussed in terms ol air pollution, water pollution and soil pollution.

Air pollution :

Release of any foreign material or gases into the atmosphere rendering it harmful to human beings, plants and animals is called air pollution.

Major air pollutants:

Compounds of sulphur such as sulphur, oxides, aerosols (chemical released in the form of mist or vapour), carbondioxide, partly burnt hydrocar- , bons, soot, metal dust, flourides, pesticides, cotton and cement dusts. Pesticides and radio active substances are the major air pollutants.

Causes of pollution :

Automobile exhausts (single largest air pollutant), exhaust or leakage from industries, burning of coal and other fossil fuels, which releases sulphur compounds, spraying of pesticides, cotton textiles and cement factories, and the thermal and nuclear power plants are the important sources of air pollution.

Adverse effects of air pollution :

Air pollution is a major health hazard to human beings, animals and plants. Air pollution causes respiratory diseases, bronchitis and. altergic reac- tions. Other adverse effects of air pollution are offensive odours, loss of atmospheric clarity, corrosion of buildings and machines, soiling of clothes, etc. Airborne flourides, and dioxide damage plant life and cause dental and mouth injuries to cattle grazing in pastures contaminated by flourides.

Flourocarbons : (Carbon compounds which con- tain flourine) deplete the ozone layer in the atmosphere thereby permitting more of the harm- ful ultraviolet radiation to reach the earth.

Increase in carbon dioxide levels traps the heat escaping through longwave radiation and thereby altering the earth's heat balance leading to global warming resulting in melting of polar ice and. submerging coastal cities.

Control of air pollution:

As far as air pollution is concerned, it is easy to control it at the source such as factory chimneys and automobile exhaust pipes by using some absorbers.

The industrial processes may be suitabaly altered to minimise the release of pollutants. Special filteration processes may be adopted to prevent the harmful gases from escaping into atmosphere. Use of tall chimneys can substantially reduce pollution at ground levels.

Pollutants from the automobile exhausts can be minimised by cleaning the exhausjs through the use of a catalystic converter. Alternate sources of energy for Oil and coal have to be developed. Under Motor Vehicles Act old vehicles which release a lot of exhaust should be impounded.

Air quality standards may be prescribed by the government, and the industrial concern must be persuaded or forced to maintain the prescribed air standards taking suitable steps. Government can also initiate legislative measures in this connection. **Water pollution:**

The presence of foreign organic, inorganic, bio-logical or radiological substances in the water' in large quantities degrading its quality and posing health hazards to human beings, .animals and plants is termed as-water pollution.

Causes of water pollution are industrial effluents, sewage water, bathing etc.

Agents:

Inert suspensions of fine particles of dust, clay, soil, ores, coal, chemicals such as acids phenol, alkalies, copper, lead, zinc .and mercury and bacterial substances are the agents of water pollution. Effluents released by various industries contain many of these chemical substances.

Release of hot water by industrial concerns into the tekes and rivers is harmful for the cold blooded armals.

Adverse effects of water pollution:

Water pollution causes diseases like cholera, diarrhoea and typhoid. Polluted water poses great danger to acquatic life, by depleting the oxygen . content. Presence of , chemical and poisonous substances at times causes mass death to acquatic life. Release of hot water which is called thermal pollution upsets life cycle and metabolic activities of various fishes.

Polluted water causes stunted growth in plants. . Contkraus irrigation of lands with degraded water damage the soil, rendering it unfit for cultivation of crops.

Control of water pollution:

Rivers, lakes and other large water bodies have a limited self cleaning capacity. But they are polluted beyond their self-cleaning capacity. Hence other artificial cleaning measures are necessary. The sewage and industrial effluents must be cleaned; before they are released into the rivers and lakes. The primary and secondary treat- ments are basic methods adopted for removing pollutants from the waste water. The primary treatment employs physical processes such as screening, shredding, sedimentation and floata- tion. Secondary treatment makes use of microbial activity to oxidize waste materials.. Both primary and secondary treatments remove only-suspended i solids and Organic matter. Chemical pollutants still remain in water.

A technique called reverse 'osmosis originally developed to' treat brackish water is being employed to treat the polluted waters as well.

Using the sewage for production of conbustible gases is , underway on an experimental basis. % % One such plant is in operation at Okhla industrial area near New -Delhi.

Recycling of wastes:

The municipal and agricultural wastes can be recycled by the process of decomposition to produce combustible gas. Biogas plaints; which use various types of biomass are being developed for recycling-the wastes'.

Gangs action plan:

The Central Government' along with the riparian states has initiated an action plan for reducing the pollution of Ganga, Accordingly suitable meas- ures are initiated for treating the industrial effluents and municipal sew,age.

As in the case of air pollution, government may prescribe standards for the quality of river arid lake waters and initiate legislative arid other measures for maintaining the standards.

Soil pollution:

Alteration in the quality of the soil by any substances affecting its productivity is called soil pollution. Soil productivity in this definition in- cludes both yield and quality of the produce.

Causes:

pollutants washed out from the atmosphere through rainfall, artificial fertilisers, pesticides and radio- active substances and the dumping of solid wastes such as plastic and metal cans are the major soil pollutants. Soil erosion,

water logging and continous irrigation with degraded, water also causes soil pollution.

Soil pollution in general, is localised in contrast with the widespread nature of air and water pollution.

Adverse effects of soil pollution:

Soil pollution makes the soil toxic, rendering it unfit for growing crops. Even then if the crops are grown on such Soils the chemical composition oj the produce is altered posing health hazards to the consumers.

Controlling soil pollution:

Control of air pollution, controlled use of pesti- cides and -fertilisers, substitution of chemical fertilisers with bio-fertilisers, soil conservation, controlled irrigation, afforestation'and proper drain-age facilities to prevent water logging are the needed steps in the direction of preventing soil pollution.

Measures initiated in India to control pollution:

Water (Prevention and control of pollution) Act 1-974. and Air (Prevention and control of pollution) Act 1981 were passed by the Parliament to initiate legkl action for controlling pollution. But the scope of these Acts was limited and are merely regu- latory-in nature. To overcome these shortcomings the new Environment (Protection) Act,. 1986 was passed with a comprehensive approach to tackle the problem of pollution.

Unlike the earlier acts, the scope of the new Act is unlimited extending to all kinds of pollution. It empowers the Central Government to make rules prescribing maximum allowable limits of any environment pollutant.

The new Act has a separate section on the industries producing hazardous substances such as chemicals and gases which are harmful to the living organisms. It empowers the Government to make rules of- accidents in such industries. According to the Act, a person or orgnisation responsible for the discharge of hazardous sub- stances has to inform immediately the authorities concerned, and render all possible assistance to the public. It also empowers the government authorities to order closure of grossly polluting unit, or regulate its activity.

The new act confers a right on the citizens to file a complaint in a court of law against any polluting unit. Eariier Acts allowed Only pollution control boards to file complaints.

Punishments:

The new act provides for a punishment of upto 7 years of imprisonment and a fine of Rs.T lakh.

Drawbacks of the new Act:

The whole authority, under the Act is vested with the Central Government completely ignoring State governments. Unless the authority[5]-is delegated to states, it would be difficult to enforce it.

The Act does not provide for the submission of environmental impact assessment reports by the enterpreneours before starting the industry as in the United-States. What all that is required in India .is a. no objection certificate from the Pollution Control Board.

Motor Vehicles Act has been, amended empow- ering Government, to seize old. vehicles that release a lot of exhaust.

Protection of Environment has been included in-., the chapter of Directive principles of State policy by the 42nd Constitution Amendment Act.

Pollution free technologies like solar energy and Wind Energy are being-developed. Biofertilisers are being'produced to clean Ganges, Ganga Action Plan has been launched.

MAJOR POLICY INITIATIVES AND ACHIEVEMENTS OF THE MINISTRY OF ENVIRONMENT AND FORESTS OF GOVERNMENT OF INDIA

Conservation of Resources:

The national conservation Strategy and the Policy Statement on the Abatement of Pollution were announced, providing ihe basis for the integration and internalisation of the environmental consid- erations in the policies and programmes of different sectors of Government. They urge the establish- ment of sustainable lifestyles and appropriate management and conservation of resources.

Pollution Control and Prevention:

- 17 grossly polluting categories of industries have been identified for priority monitoring of compliance with the prescribed standards assigning deadlines, for different categories of industries. There has been an estimated 25% reduction in polluting industrial. emmissions during the last few years from nearly 1,600 large and medium scale heavily polluting units.
- Common Effluent Treatment Plants are being set up for small scale industries located in clusters, since these would not have otherwise possesed the technical know-how and the financial capability to meet the minimum polluting control standards.
- The prevention and control of. water pollution was amended to introduce an incremental cess on the industries which consumed water. in excess of their, genuine requirements, and those whose effluent quality was not upto the prescribed standards.
- Three .thrust greas have been identified for pollution; control .....
  (a) Fly ash

(b) Vehicle pollution

(c) Chemical pollution.

The effort'is to initiate a programme which will eventually reach near zero levels of pollution by 2000 A.D. in these designated spheres.

- Minimum standards for vehicle emmissions have been fixed for compliance in two stages. The firjst stage is to be achieved by 1995, and the second, requiring unleaded petrol is to be achieved by the year 1997. This would bring, vehicles manufactured in India on par with) those in Europe, as far- as emissions are concerned.
- Penta Chlora Phenol (PCP), which was being used in the leather industry arid is harmful to skin, has been banned.
- The Public Liability Insurance Act was passed by Parliament year before last stipulating in- surance by industries manufacturing hazardous chemicals in order to enable payment of compensation to the general public against any pollution hazards.
- Legal provisions have been made for Environ- mental Audit by industrial units, to motivate industry to adopt environmentally oriented tech- nology and practices.

  To promote environmentally, friendly technolo- gies, an 'EcoMark' scheme has also been initiated to certify products which fulfil minimum pollution control standards, and achieve high environment-friendliness in production, pack- aging and waste disposal. So far, standards have been fixed for soaps, detergents, paints and paper. A dozen, more categories of products were brought under the scheme.
- Prior environmental clearance based on im- pact assessment is proposed to be made mandatory for certain categories of industries. The procedure for environmental clearance is being rationalised and standardised and exten- sive delegations to State Governments are contemplated.
- A Bill to set up Environmental Tribunals has been introduced in Parliament.

Forestry:

- Due to stringent enforcement of the Forest Conservation' Act of 1980 'and compensatory afforestation as also schemes of afforestation taken up under various programmes, forest cover in India has increased by 56,000 ha, since the last forest survey.
- The National Afforestation and Eco-Develop- ment Board (NAB) has been set up to provide an impetus to afforestation of wastelands .and degraded forest areas. The total effort resuited in the greening of 2 million ha. (5 million acres) in 1992.
- Three Eco. Task Forces constituted for the purpose of undertaking ecological restoration work, with participation of Ex-serviceman, in selected environmentally degraded areas, carried out afforestation, pasture development, soil and water conservation and other res- toration works in the States of Uttar Pradesh, Rajasthan and Jammu and Kashmir.

Rivers, Mountains and Wetlands:

- A National River Action plan for cleaning the grossly polluted streaches of 17 major rivers of the country has been drawn up. This follows the progress achieved in improving the water quality of the river Ganga during the last 7 years.
- A notification was issued designating the Aravalli bill Range, one of the oldest mountain ranges in the world, an eco sensitive area, which provides for the regulation of industrial and other activities in this region.
- 31 Wetlands and Mangroves have been iden- tified in' the country for conservation and management on a priority basis.
- A Coastal Zone Regulation has been formu- lated which establishes guide-lines for all kinds of developments along India's 2000 km long coast-line.
- A programme for the conservation of selected lakes and eco sensitive water bodies has been prepared. This will concentrate, in the first stage, on urban lakes, which have the greatest interface with people.

Wildlife :

- The Wildlife protection Act was amended to ban all types of hunting of wild animals for commercial purposes or for pleasure.
- Project Tiger, which has' beeninternationally acclaimed as a successful conservation.effort, completed 20 years in 1993. A detailed programme has been prepared to launch project Tiger Phase-ll for the next two decades including the setting up of a Global Tiger Forum, involving all the tiger range countries of the world.
- Project Elephant has been launched with a view of. restoring the' degraded habitat; of elephants, creating migratory corridors, estab- lishing an authentic database, mitigation of elephant, etc.
- The Central Zoo Authority. has been consti- tuted. It has laid down minimum standards for zoos throughout the country and coor- dinated the activities of almost two hundred existing zoos. It also supervises the exchange of animals on a

scientific basis and encour- ages research in relevant areas under the aegis of the wildlife Institute of India.

International Co-operation Activities:

- India played a key role on behalf of the developing world in UNCED Conference .at Rio de Janeiro.. As follow-up of this conference a Status Report on Biodiversity Conservation is under preparation. It will scientifically identify the technology needs and manage- ment gaps in the protected areas network. A Core Group has been set up to review the existing national legislation on the subject and suggest specific action, such as formulation of projects and a national strategy for bio-diver- sity conservation.
- India hosted the first Ministerial level Confer- ence of the Forestry Forum for developing Countries, 1-3 September 1993, to discuss ways,and means to implement the Forest principles agreed upon at Rio-36 developing countries participated; 9 developed countries and 7 UN organisations participated as Ob- servers. The Conference issued the Delhi Declaration on Forests.
- India became a signatory to the Mdnetreal protocol, and as follow up measure a Country programme has been drawn up with the involvement of private industry to implement the national strategy to phase out ozonedepleting substances within the frame- work envisaged by the protocol, and also to identify those areas in which technology trans- fer and funding of costs are required to be made available under the terms of the Protocol. The country programme envisages an expenditure of about 2 million U.S. dollars.
- An Environmental Action Programme to be funded by the UNEP and a National Forestry Action Plan to be funded by FAO are under preparation.

Environmental Awareness:

- The National Environmental Awareness Cam- paign was launched with "Global Environmental Concern" as the theme in 1991. "Biodiversity" was the theme for 1992. Two new Environmental Information Centres have been set up, bringing the countrywide network to 12. ENVIS centres collect, retrieve, and disseminate information.
- A new scheme called- Paryavaran Vahini (En- vironmental Brigades) has been launched with the obective of involving common people, village youth, students and NGOs in the environmental management, protection and conservation over the length and breadth of the country.
- A similar scheme called Variki Vahini (Affor- estation Brigade) is being finalised to encourage people's participation in the afforestation effort.
- A National Environmental Awareness Compe- tition was launched in May, 1992 which got an overwhelming response of over 2 lakh entries in the form of posters/emblems/videos/ essays/poems in over a dozen Indian lan- guages.

15. APPLICATIONS OF BIOLOGY

Development of agriculture based on planting of seeds and the use of fire formed the basis for human civilization. All important crops, that we are using now were already used by ancient civiliza- tions. Without the knowledge of genetics), the early man introduced-piant-breeding in a natural way. No food crop was inrtroduced in recent times but application of scientific knowledge of genetics has, resulted.in enormous crop yields throughout the world.

PLANT BREEDING

The development of new varieties of plants possessing desirable characters from the existing varieties is called Plant Breeding or crop improvement.

Different methods of Breeding are based on the type of reproduction and pollination operating in a crop, fnere are 7 important methods of plant breeding. Those are:

1. Introduction
2. Selection
3. Hybridisation
4. Mutation Breeding
5. Polyploidy Breeding
6. Tissue Culture
7. Genetic Engineering

1. Introduction :

The process of introducing high yeilding vari- eties of plants from their growing locality into a new locality. That is simply transfer of plant from one place to another place. The newly introduced plant has to adapt or adjust itself to the new or changed environment. This ad- justment of the introduced plant is called Acclimatisation..

"IR-8" variety of rice was Introduced from Phil- ippines to India. Some other varieties are :

	Crop	Variety	Introduced from
1.	Wheat	Sonara 63, 64	USA
2.	Tomato	Siox	USA
3.	Pea	Rimpus	Germany
4.	Grape	Beauty seedless	USA
5.	Wheat	Ridley	Australia

Merits : It is the easiest and quickest method of crop inprovement.

Demerits : Plant pathogens may also seek entry along with the introduced plant material and cause damages to the introduced variety.

For ex: Pathogens like phytophthora infestens (late blight of potato) from Europe were introduced into India.

2. Selection :

It is the oldest breeding method. It is of two types. Natural selection where nature itself selects the course of evolution and. the other one is artificial selection. Here selecting agent is man. In, artificial selection simplest method is.

Mass selection : where farmer before harvest- ing the crop selects the best plants. From the field, seeds of these plants are collected ana pooled up and used to raise the crop in next year. The 2nd method is:

Pure line selection : In this isolating a desir- able homozygous individual from the mixed population arid multiplying the same without contamination to release a new variety.

The 3rd method in artifical selection is:

Clonal selection : In this the progeny (offspring) I of a single plant obtained by vegetative propaga- tion (without reproductive organs) is known as a clone. The stem cutting of sugar cane is a clone.

The selection of desirable clones from the mixed population of a vegetatively propagated crop is called clonal selection.

3. Hybridisation :

In this method two or more plants are crossed together. The main idea behind hybridisation is to bring new combinations of genes (ie) com- bining all good chracteristics into a single variety. The hybrid plants are usually superior to their parents in characters like height, yield, etc. This superiority of a hybrid over its parents is called hybrid vigour or heterosis.

4. Mutation Breeding :

Improvement of crops by changing the genotype of plants through induced mutation is called mutation breeding, (mutation : sudden heritable- change) Mutations that occur automatically in nature are called spantaneous mutations' and those are caused artificially are called Induced mutations. The agent which induce mutations is called mutagens.

Some mutagens are X-rays, Ultra Violet rays, alpha rays etc.

5. PolyPloidy Breeding :

Majority of the crop plants are usually diploid. The haploid number of chromosomes is called a genome.

Man has 46 Chromosomes or 23 pairs of Chro- mosomes i.e. he is having 2 genomes, like wise

plants having more than 2 sets of Chormosomes are referred as polyploids. When compared to diploids, polyploids show more vigour and less fertility. They produce fruits of bigger- size without seeds. Hence-these are usefull in crops when seed is not the economic product.

'The exploitation of polyploidy condition for crop improvement is called polyploidy breeding.

6. Tissue Culture :

The flowering plants normally propagate through seeds. The seeds germinate and produce new plants. New plants can also be produced by culturing the tissue in artificial medium.

The genetic complement of any cell in the diploid organism is intact similar to that of zygote. Each cell has an inherant capacity to develop into a total plant by regeneration when proper external conditions are provided. This inherent potency of the cell is called Cellular Totepotency;

For 'invitro' culture, either isolated plant cell or tissues or organs can be used in tissue culture or organ culture.

Important aspects of Tissue Culture are :

(i) To cultured tissues, nutrients must be' sup- plied.

(ii) The culture medium is made free of organ- isms. Otherwise these Micro Organisms may check the growth of the tissue, or even kill the tissue.

(iii) Proper aeration (Supply of Oxygen) should be provided for the growing tissue.

7. Genetic Engineering :

The objective of genetic Engineering or recombinent DNA Technology is to introduce or delete one or more genes into an organism that normally does not possess them. This requires isolation of a fragment of DNA corresponding to a desirable character in a vector (such as plasmid in a bacterium) and transfering it to the cell. Successful genetic Engineering requires identifi- cation of the desired genes/their trr.ric'cr to the cells of the target crop plant, their integration and expression.

IMPROVEMENT OF ANIMALS (ANIMAL-BREEDING)

Domestication of animals began during the hunting and gathering phase of human civiliza- tion beasts of burden, sources of milk, meat, leather, and Fur. As the civilization is pro- gressed, the domestication of animals gets importance. For this methods of improvement through selective breeding were used.

The present animal breeding techniques can be explained by taking the example of live stock.

The cattle and buffaloes constitute most important species of live stock in India. They are primary source of milk. The best Indian cattle breeds are found in the drier parts of the country. India has 227 million cattle and buffaloes.

Cattle Breeding :

About 10 to 60 % of cows are artificially insemi- nated by semen collected from high quality bulls. Artificial insemination ensures good quality prog- eny and is also economical as semen from a sing e bull can inseminate several thousand cows.

To increase the milk yield Indian cows are cross bred with European breads at the National Dairy research institute, Karnal and in Kerala.

Super ovulation and embryo transplantation :

A pedigreed bull and high production" cow are chosen'to prcduce super milk cows. Sfuper- ovulation is induced by hormone injection. After artificial insemination, embryos are collected'.and transplanted into carrier cow (surrogate Mother) after deep freezing (r196°C). it is posslblt? to preserve seven days old foetuses for several years to be used when needed.

ESTICIDES

By improving seed and using various agricultural chemicals (pesticides), farmer can inci'ease crop yields. Synthetic fertizers are added to the soil to" replenish the various nutrients and maintain its fertility.

It is estimated that there is an annual loss; of 30% in agricultural productivity owing to pestis and diseases. This emphasises the heed for using pesticides. Pesticides are substances used fa kill or repel pests (insects, weeds, mites, rats etc). Pesticides attack nervous system of animals by interfering with the. conduction of nerve impulse. Although pesticides are benificial in protecting crops especially high-yeilding varieties, they are capable of damaging the ecosystem and in the long run render, agriculture non-sustainable.

BIO FERTILISERS

The total consumption of fertilisers in our country is about 9.2 million tonnes. Chemical fertilisers are expensive and their production releases pollut- ants. further fertilisers applied to crops aire lost in surface run off and polute soil and water resource. In order to combat the ill effects of synthetic, agricultural chemicals green manures, biofertilisers, biological control methods and biopesticides have been introcuced.

Indian soils are usually, poor in organic matter as well as in nitrogen. Materials of biological origin which are used to maintain and improve soil fertility are grouped into 2 catagories:

1. Green Manures
2. Biofertilisers

Green manure is a mixture of cattle dung and crop residues. It supplies organic matter and additional nitrogen. They increase the crop yield by 30 to 50%.

Biofertilisers : These are organisms which can bring abut soil nutrient: enrichment. It includes nitrdgen-fixing micro organism to reduce dependence on chemical fertilisers.

The main spurces of biofertiliser are Bacteria, Cyanobacteria, and Fungi. Rhizobi'um produces nodules in the roots of leguminous plants and fixes atmospheric nitrogen.'

GENETIC CONSERVATION

Biological diversity (various diversified plants and animals) is threatened by encroachment on natu- ral ecosystems by the activities of the ever growing human population.

The plant-genetic resources constitute a category of genetic diversity. Genetic erosion is the loss of genes from a genepopl (Sum total and variety of all the genes- and their - alleles present in a population) caused by factors like deforestation,. Urban expansion, shifting cultivation, adoption of genetically uniform modern variety of crops.

There are 4 basic ways to conserve plant genetic resources those are.

1. Maintaining forest and nature preserves
2. holding in botanical garden.
3. feetiing in agricultural and horticultural trade
4. Preserving them in the form of seeds

Without green plants higher orders of life cease to exist since they provide directly or indirectly food to all animals. But tropical forests are being lost at the rate of 11 million hectares every year. This has implication with millions of forest dwelllers, tribals who live in harmony with nature. So, Situ conservation of wild plants helps to protect spe- cies threatened with loss of extinction.

An important approach to maintaining plant diversity involves collecting samples of cultivated arid wild species and storing them in botanical gardens and gene banks.

To acheive new and better yielding varieties, resistant to diseases, plant: breeders need germplasm collections For this they require entire 'array of genes available in one species and stores in gene Bank.

So, Qene Bartk is an institution where valuable plant material ll-xely to becom? irretrivably jpjst. in the wild or in cultivation are preserved. Gene Banks can serve both seeds and vegetative material. The most convenient way of maintaining plant germ plasm is by storing seeds.

Seed is a living material capable of surviving in a metabolicaily suspended state, In general, seeds last longest when dried arid stored in low tem- perature. Germ plasm preservation at ultra low temparature.of around -196°C is commonly called CRYOPRESERVATION. At such low tempera-, tures, biological activities stops and so genetic change would not occur.

Note :

Father of Green revolution - Norman E. Boriang

Father of Indian Gre«u revolution - Dr. M.S. Swam.inathan.

BIOTECHNOLOGY

Biotechnology ifl a broad sense, is that technology which uses biological (living) organisms either totally or partially to produce desired products like drugs, chemicals etc Because of this broad definition, biotechnology can be categorised into two types : old biotechnology and modem bio- technology. Old biotechnology involves recombinant DNA technique, hybridoma, tissue culture, etc.

Recombinant DNA technique involves insertion of foreign DNA (genetic material) in the DNA of a host organism. For example, insulin producing DNA from rat is introduced into the DNA of E.Coli (bacterium). Production of insulin through E.Coli facilitates mass production of Insulin "at a low cost. This direct insertion of foreign DNA in a host organism was performed for the first time in 1972 by Prof. Paul Borg. For this feat, he was awarded Noble Prize.

Hybridoma technique involves' fusion of cells capable of continuous multiplication (tumour cells) with cells producing a specific antibody.

This technique was developed in 1975 by Dr. Kholer, Jerne'and Mifetein at Medical Research Courtcil of England. These scientists have fused ;' antibody producing bolls from an immunised mouse with the tumour cells of the mouse. Out of this fusion emerged the hybrid cell called hybridoma with the properties of both original cells; antibody producing property and rapid multiplication property.

Tissue culture technique involves growing plant tissue in synthetic media in the laboratory to develop callus (a loose mass of cells) which is then separated into single cells. These cells are then grown on suitable synthetic media to produce whole plants which are finally transferred to the field.

Thi.s technique facilitates growing large number of plants from a small piece of tissue at a very rapid rate.

Applications of Biotechnology : Biotechnology has. Applications, in man fields; Medicine, agri-. cultufie, energy, environment, etc.

Biotechnology in Medicinv : Genetically engi- neered! bacteria have emerged as suppliers of scarce; drugs like insulin, inte.'feron, hormones, vaccines etc.

insulin] the important human hormone produced in the pancreas that regulates the sugar level in the blood, was being extracted from the pancreas of cows and pigs till recently for meoical pur- poses. : Some people are allergic to it. And its extraction is a labourious process and a costly affair. Bjut now the bacteria specially programmed for this purpose are producing insulin on commer- cial scale which is sold under the name 'Humu'lin'. This is qne of the first products to be commercially manufactured using recombinant DNA technique).

Interferon is a powerful anti-viral agent, made in the human body. But its supply is very limited when ctimpared to its demand. Its extraction from; the blood cells and other human tissues is costly. Biotechnology based interferons are now available.

Several human and animal hormone vaccines and enzymes are also under tests and are yet to be released into the market.

This technique has also been extended to genetherapy. Such a therapy is the only way out in certain diseases which have not sofar yielded to treatment..

Bid-technology in Agriculture : In agriculture plant cells have, been created capable of fixing atmospheric nitrogen-a unique character only in leguminous plants and some blue-green algae. Scientists are trying to impart this character into the cereals. lf scientists succeed in developing cereal crops with such a character, the cultivation of cereal crops will be very much cheaper; for the farmers can dispense with the synthetic nitrogen fertilizers which are very costly.

Research and development work is being carried out to breed plants to increase the photo-synthetic efficiency thus to raise yields and to make crops less Vulnerable to drought, cold, etc.

Biotechnology in Energy : Gobar gas genera- tion. involves micro organisms which convert gobar into gas in the presence of sunlight.

Research is being carried out for conversion of agricultural wastes into energy by using geneti- cally engineered organisms. The advantages of this method'are minimisation of the environmental pollution-and utilisation of the industrial residues and agricultural wastes to produce energy'.

Application of Biotechnology in Environment : Biotechnology promises to make biological method of controlling-pollution more effective. Bacteria are already used in environmental work for cleaning effluents at sewage works, and scientists have developed , bugs'that gobble up oil slicks; in the oceans which are named as "Super bugs".

BIOTECHNOLOGY IN INDIA

India'is the first country among developing coutries to tap the potential of biotechnology as it provides a valuable means in the development process. The first policy document to cover biotechnology development in the country: was formulated during Sixth Five Year Plan. The. Plan had called for attention in the new areas such as immunology, genetics, molecular biology and genetic engineer- ing for control of diseases like malaria, filariasis and Kalaazar. In the areas of Agriculture and Industry the Plan included tissue culture applica- tion for medicinal and economic-plants, fermentation technology, enzyme engineering for chemicals and waste utilization..

To meet these demands, an apex official agency namely National Biotechnology Board (NBTB) was set up in -1982 under chairmanship of member (Science) of Indian Planning Commission in April 1983. The NBTB issued a long term plan in bio-technology by taking into consideration of the national objectives such as self sufficiency in food; clothing and housing; provision of adequate energy and transportation; protection of environ- ment; employment; industrial growth and balance in international trade. The priorities of this long term, plan are in seven broad areas viz., health, industry, agriculture, energy, environment, com- munication and information, education and training. The Plan also formulated specific projects to fulfil the priorities with time ranging from 3 to 10 years. NBTB also formulated programmes in manpower development in biotechnology; funding of R & D projects; creation of infrastructure facilities and production of vaccines.

To implement the above programmes and schemes effectively, a full fledged Department of. Biotech- nology (DBT) was established in 1986 under Ministry of Science and Technology in place of NBTB. A Scientific Advisory Committee consisting of members representing different Sciencie and Technology agencies and other eminent authori- ties has been constituted to advise DBT.

The DBT initiated postgraduate and Doctoral programme in various universities to meet the technical man power requirement. To build up R & D base, the DBT hais established number of national facilities. The national facility dn Bluegreen algae collection has been set up at Indian Agricultural Research Institute. National Bureau of Plant Ge- netic Resources has been set up in the area of Plant tissue culture; The National Microbial Culture Collection and Gene Bank has been set up at Institute of Microbial Technology, Chandigarh. Animal tissue culture facilities, have been created at University of Pune, National Institute of Nutrition, Hyderabad, Central Drug Research Institute, Lucknow and Indian Institute of Science, Bangalce. The various chemicals required for research in biotechnology are nOw available

at CSIR Centre for Biochemicals (CFB) and Babha Atomic Re- search Centre (BARC).

DBT is also distributing "Biotechnology Informa-tion System" (BITS) which provides latest advances in different areas of biotechnology, research. DBT started funding specific R&D projects such as Bamboo propagation by tissue culture at the University of Delhi. As a part of Seventh Five Year Plan programmes, DBT was involved in Technol- ogy Misions on vaccines, edible oils and on cattle herd development.

MEDICINE :

Immunodiagnostics

DBT has concentrated on inexpensive diagnosis oftuberculosis, leprosy, pregnancy;.viral hepatitis, amoebiasis etc. Workable kits for detection of filaria, amoebiasis, pregnancy have been devel- oped. Kits for detection of tuberculosis, malaria and. leprosy are to be achieved.

Agriculture :

ICAR (Indian Council of Agricultural Research) has set up three biotechnology centres to work on live stock, and crop improvement at National pairy Research Institute, Karnal; Indian Veterinary Research Institute Izathnagar; and Indian Agricul- tural Research Institute, New Delhi. The centre at New Delhi was later renamed as "Lai-Bahadur Shastry Centre for Biotechnology".

One of the two centres of UNIDO'S (United Nations International Development Organisation) International Centre for Genetic Engineering and Biotechnology (ICGEB) is located at New Delhi. ICRISAT (International Crop Research Institute foe Semi Arid Tropics), Hyderabad is now using biotechnology for Crop improvement. The Re- search information systems for Non-Aligned and other developing countries based in New Delhi have undertaken a project on "Biotechnology Revolution and the Third World".

At bilateral layel, India has concluded R&D collaboration agreements in the area of biotech- nology with a number of countries viz., U.S.A., U.S.S;R,, U.K., Germany, France, Switzerland, Sweden, Japan, Vietnam and Mexico.

Indian industry is. now using biotechonology for their business. Hindusthan Lever Limited. (HLL) has modern bio-technology R&D base and launched high yielding varieties of number, of Crops like maize, Groundnut etc. Hoechst India Limited,, is developing a drug by genetic engi- neering for the treatment of Glucoma disease.

POLLUTION

Environment includes air, Water, soil and land- scape, oceans and lakes, buildings and other man made objects. Alteration in the natural qualities of the constituents of environment due to any addition or depletion of their natural contents rendering them harmful to the human beings, animals and plant life is known as pollution. Pollution can also be defined as a constituent in the wrong amount at the wrong place or at the wrong time.

Generally pollution is discussed in terms ol air pollution, water pollution and soil pollution.

Air pollution :

Release of any foreign material or gases into the atmosphere rendering it harmful to human beings, plants and animals is called air pollution.

Major air pollutants:

Compounds of sulphur such as sulphur, oxides, aerosols (chemical released in the form of mist or vapour), carbondioxide, partly burnt hydrocar- , bons, soot, metal dust, flourides, pesticides, cotton and cement dusts. Pesticides and radio active substances are the major air pollutants.

Causes of pollution :

Automobile exhausts (single largest air pollutant), exhaust or leakage from industries, burning of coal and other fossil fuels, which releases sulphur compounds, spraying of pesticides, cotton textiles and cement factories, and the thermal and nuclear power plants are the important sources of air pollution.

Adverse effects of air pollution :

Air pollution is a major health hazard to human beings, animals and plants. Air pollution causes respiratory diseases, bronchitis and. altergic reac- tions. Other adverse effects of air pollution are offensive odours, loss of atmospheric clarity, corrosion of buildings and machines, soiling of clothes, etc. Airborne flourides, and dioxide damage plant life and cause dental and mouth injuries to cattle grazing in pastures contaminated by flourides.

Flourocarbons : (Carbon compounds which con- tain flourine) deplete the ozone layer in the atmosphere thereby permitting more of the harm- ful ultraviolet radiation to reach the earth.

Increase in carbon dioxide levels traps the heat escaping through longwave radiation and thereby altering the earth's heat balance leading to global warming resulting in melting of polar ice and. submerging coastal cities.

Control of air pollution:

As far as air pollution is concerned, it is easy to control it at the source such as factory chimneys and automobile exhaust pipes by using some absorbers.

The industrial processes may be suitabaly altered to minimise the release of pollutants. Special filteration

processes may be adopted to prevent the harmful gases from escaping into atmosphere. Use of tall chimneys can substantially reduce pollution at ground levels.

Pollutants from the automobile exhausts can be minimised by cleaning the exhausjs through the use of a catalystic converter. Alternate sources of energy for Oil and coal have to be developed. Under Motor Vehicles Act old vehicles which release a lot of exhaust should be impounded.

Air quality standards may be prescribed by the government, and the industrial concern must be persuaded or forced to maintain the prescribed air standards taking suitable steps. Government can also initiate legislative measures in this connection.

Water pollution:

The presence of foreign organic, inorganic, bio-logical or radiological substances in the water' in large quantities degrading its quality and posing health hazards to human beings, .animals and plants is termed as-water pollution.

Causes of water pollution are industrial effluents, sewage water, bathing etc.

Agents:

Inert suspensions of fine particles of dust, clay, soil, ores, coal, chemicals such as acids phenol, alkalies, copper, lead, zinc .and mercury and bacterial substances are the agents of water pollution. Effluents released by various industries contain many of these chemical substances.

Release of hot water by industrial concerns into the tekes and rivers is harmful for the cold blooded armals.

Adverse effects of water pollution:

Water pollution causes diseases like cholera, diarrhoea and typhoid. Polluted water poses great danger to acquatic life, by depleting the oxygen . content. Presence of , chemical and poisonous substances at times causes mass death to acquatic life. Release of hot water which is called thermal pollution upsets life cycle and metabolic activities of various fishes.

Polluted water causes stunted growth in plants. . Contkraus irrigation of lands with degraded water damage the soil, rendering it unfit for cultivation of crops.

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Control of water pollution:

Rivers, lakes and other large water bodies have a limited self cleaning capacity. But they are polluted beyond their self-cleaning capacity. Hence other artificial cleaning measures are necessary. The sewage and industrial effluents must be cleaned; before they are released into the rivers and lakes. The primary and secondary treat- ments are basic methods adopted for removing pollutants from the waste water. The primary treatment employs physical processes such as screening, shredding, sedimentation and floata- tion. Secondary treatment makes use of microbial activity to oxidize waste materials.. Both primary and secondary treatments remove only-suspended i solids and Organic matter. Chemical pollutants still remain in water.

A technique called reverse 'osmosis originally developed to' treat brackish water is being employed to treat the polluted waters as well.

Using the sewage for production of conbustible gases is , underway on an experimental basis. % % One such plant is in operation at Okhla industrial area near New -Delhi.

Recycling of wastes:

The municipal and agricultural wastes can be recycled by the process of decomposition to produce combustible gas. Biogas plaints; which use various types of biomass are being developed for recycling-the wastes'.

Gangs action plan:

The Central Government' along with the riparian states has initiated an action plan for reducing the pollution of Ganga, Accordingly suitable meas- ures are initiated for treating the industrial effluents and municipal sew,age.

As in the case of air pollution, government may prescribe standards for the quality of river arid lake waters and initiate legislative arid other measures for maintaining the standards.

Soil pollution:

Alteration in the quality of the soil by any substances affecting its productivity is called soil pollution. Soil productivity in this definition in- cludes both yield and quality of the produce.

Causes:

pollutants washed out from the atmosphere through rainfall, artificial fertilisers, pesticides and radio- active substances and the dumping of solid wastes such as plastic and metal cans are the major soil pollutants. Soil erosion, water logging and continous irrigation with degraded, water also causes soil pollution.

Soil pollution in general, is localised in contrast with the widespread nature of air and water pollution.

Adverse effects of soil pollution:

Soil pollution makes the soil toxic, rendering it unfit for growing crops. Even then if the crops are grown on such Soils the chemical composition oj the produce is altered posing health hazards to the consumers.

Controlling soil pollution:

Control of air pollution, controlled use of pesti- cides and -fertilisers, substitution of chemical fertilisers with

bio-fertilisers, soil conservation, controlled irrigation, afforestation'and proper drain-age facilities to prevent water logging are the needed steps in the direction of preventing soil pollution.

Measures initiated in India to control pollution:

Water (Prevention and control of pollution) Act 1-974. and Air (Prevention and control of pollution) Act 1981 were passed by the Parliament to initiate legkl action for controlling pollution. But the scope of these Acts was limited and are merely regu- latory-in nature. To overcome these shortcomings the new Environment (Protection) Act,. 1986 was passed with a comprehensive approach to tackle the problem of pollution.

Unlike the earlier acts, the scope of the new Act is unlimited extending to all kinds of pollution. It empowers the Central Government to make rules prescribing maximum allowable limits of any environment pollutant.

The new Act has a separate section on the industries producing hazardous substances such as chemicals and gases which are harmful to the living organisms. It empowers the Government to make rules of- accidents in such industries. According to the Act, a person or orgnisation responsible for the discharge of hazardous sub- stances has to inform immediately the authorities concerned, and render all possible assistance to the public. It also empowers the government authorities to order closure of grossly polluting unit, or regulate its activity.

The new act confers a right on the citizens to file a complaint in a court of law against any polluting unit. Eariier Acts allowed Only pollution control boards to file complaints.

Punishments:

The new act provides for a punishment of upto 7 years of imprisonment and a fine of Rs.T lakh.

Drawbacks of the new Act:

The whole authority, under the Act is vested with the Central Government completely ignoring State governments. Unless the authority[5]-is delegated to states, it would be difficult to enforce it.

The Act does not provide for the submission of environmental impact assessment reports by the enterpreneours before starting the industry as in the United-States. What all that is required in India .is a. no objection certificate from the Pollution Control Board.

Motor Vehicles Act has been, amended empow- ering Government, to seize old. vehicles that release a lot of exhaust.

Protection of Environment has been included in-., the chapter of Directive principles of State policy by the 42nd Constitution Amendment Act.

Pollution free technologies like solar energy and Wind Energy are being-developed. Biofertilisers are being'produced to clean Ganges, Ganga Action Plan has been launched.

MAJOR POLICY INITIATIVES AND ACHIEVEMENTS OF THE MINISTRY OF ENVIRONMENT AND FORESTS OF GOVERNMENT OF INDIA

Conservation of Resources:

The national conservation Strategy and the Policy Statement on the Abatement of Pollution were announced, providing ihe basis for the integration and internalisation of the environmental consid- erations in the policies and programmes of different sectors of Government. They urge the establish- ment of sustainable lifestyles and appropriate management and conservation of resources.

Pollution Control and Prevention:

- 17 grossly polluting categories of industries have been identified for priority monitoring of compliance with the prescribed standards assigning deadlines, for different categories of industries. There has been an estimated 25% reduction in polluting industrial. emmissions during the last few years from nearly 1,600 large and medium scale heavily polluting units.
- Common Effluent Treatment Plants are being set up for small scale industries located in clusters, since these would not have otherwise possesed the technical know-how and the financial capability to meet the minimum polluting control standards.
- The prevention and control of. water pollution was amended to introduce an incremental cess on the industries which consumed water. in excess of their, genuine requirements, and those whose effluent quality was not upto the prescribed standards.
- Three .thrust greas have been identified for pollution; control .....
  (a) Fly ash
  (b) Vehicle pollution
  (c) Chemical pollution.
  The effort'is to initiate a programme which will eventually reach near zero levels of pollution by 2000 A.D. in these designated spheres.
- Minimum standards for vehicle emmissions have been fixed for compliance in two stages. The firjst stage is to be achieved by 1995, and the second, requiring unleaded petrol is to be achieved by the year 1997. This would bring, vehicles manufactured in India on par with) those in Europe, as far- as emissions are concerned.

- Penta Chlora Phenol (PCP), which was being used in the leather industry arid is harmful to skin, has been banned.
- The Public Liability Insurance Act was passed by Parliament year before last stipulating in- surance by industries manufacturing hazardous chemicals in order to enable payment of compensation to the general public against any pollution hazards.
- Legal provisions have been made for Environ- mental Audit by industrial units, to motivate industry to adopt environmentally oriented tech- nology and practices.

  To promote environmentally, friendly technolo- gies, an 'EcoMark' scheme has also been initiated to certify products which fulfil minimum pollution control standards, and achieve high environment-friendliness in production, pack- aging and waste disposal. So far, standards have been fixed for soaps, detergents, paints and paper. A dozen, more categories of products were brought under the scheme.
- Prior environmental clearance based on im- pact assessment is proposed to be made mandatory for certain categories of industries. The procedure for environmental clearance is being rationalised and standardised and exten- sive delegations to State Governments are contemplated.
- A Bill to set up Environmental Tribunals has been introduced in Parliament.

Forestry:

- Due to stringent enforcement of the Forest Conservation' Act of 1980 'and compensatory afforestation as also schemes of afforestation taken up under various programmes, forest cover in India has increased by 56,000 ha, since the last forest survey.
- The National Afforestation and Eco-Develop- ment Board (NAB) has been set up to provide an impetus to afforestation of wastelands .and degraded forest areas. The total effort resuited in the greening of 2 million ha. (5 million acres) in 1992.
- Three Eco. Task Forces constituted for the purpose of undertaking ecological restoration work, with participation of Ex-serviceman, in selected environmentally degraded areas, carried out afforestation, pasture development, soil and water conservation and other res- toration works in the States of Uttar Pradesh, Rajasthan and Jammu and Kashmir.

Rivers, Mountains and Wetlands:

- A National River Action plan for cleaning the grossly polluted streaches of 17 major rivers of the country has been drawn up. This follows the progress achieved in improving the water quality of the river Ganga during the last 7 years.
- A notification was issued designating the Aravalli bill Range, one of the oldest mountain ranges in the world, an eco sensitive area, which provides for the regulation of industrial and other activities in this region.
- 31 Wetlands and Mangroves have been iden- tified in' the country for conservation and management on a priority basis.
- A Coastal Zone Regulation has been formu- lated which establishes guide-lines for all kinds of developments along India's 2000 km long coast-line.
- A programme for the conservation of selected lakes and eco sensitive water bodies has been prepared. This will concentrate, in the first stage, on urban lakes, which have the greatest interface with people.

Wildlife :

- The Wildlife protection Act was amended to ban all types of hunting of wild animals for commercial purposes or for pleasure.
- Project Tiger, which has' beeninternationally acclaimed as a successful conservation.effort, completed 20 years in 1993. A detailed programme has been prepared to launch project Tiger Phase-ll for the next two decades including the setting up of a Global Tiger Forum, involving all the tiger range countries of the world.
- Project Elephant has been launched with a view of. restoring the' degraded habitat; of elephants, creating migratory corridors, estab- lishing an authentic database, mitigation of elephant, etc.
- The Central Zoo Authority. has been consti- tuted. It has laid down minimum standards for zoos throughout the country and coor- dinated the activities of almost two hundred existing zoos. It also supervises the exchange of animals on a scientific basis and encour- ages research in relevant areas under the aegis of the wildlife Institute of India.

International Co-operation Activities:

- India played a key role on behalf of the developing world in UNCED Conference .at Rio de Janeiro.. As follow-up of this conference a Status Report on Biodiversity Conservation is under preparation. It will scientifically identify the technology needs and manage- ment gaps in the protected areas network. A Core Group has been set up to review the existing national legislation on the subject and suggest specific action, such as formulation of projects and a national strategy for bio-diver- sity conservation.

- India hosted the first Ministerial level Confer- ence of the Forestry Forum for developing Countries, 1-3 September 1993, to discuss ways,and means to implement the Forest principles agreed upon at Rio- 36 developing countries participated; 9 developed countries and 7 UN organisations participated as Ob- servers. The Conference issued the Delhi Declaration on Forests.
- India became a signatory to the Mdnetreal protocol, and as follow up measure a Country programme has been drawn up with the involvement of private industry to implement the national strategy to phase out ozonedepleting substances within the frame- work envisaged by the protocol, and also to identify those areas in which technology trans- fer and funding of costs are required to be made available under the terms of the Protocol. The country programme envisages an expenditure of about 2 million U.S. dollars.
- An Environmental Action Programme to be funded by the UNEP and a National Forestry Action Plan to be funded by FAO are under preparation.

Environmental Awareness:

- The National Environmental Awareness Cam- paign was launched with "Global Environmental Concern" as the theme in 1991. "Biodiversity" was the theme for 1992. Two new Environmental Information Centres have been set up, bringing the countrywide network to 12. ENVIS centres collect, retrieve, and disseminate information.
- A new scheme called- Paryavaran Vahini (En- vironmental Brigades) has been launched with the obective of involving common people, village youth, students and NGOs in the environmental management, protection and conservation over the length and breadth of the country.
- A similar scheme called Variki Vahini (Affor- estation Brigade) is being finalised to encourage people's participation in the afforestation effort.
- A National Environmental Awareness Compe- tition was launched in May, 1992 which got an overwhelming response of over 2 lakh entries in the form of posters/emblems/videos/ essays/poems in over a dozen Indian lan- guages.

16. ECONOMIC BOTANY

The branch of scince that basically deals with the various uses of plants, and plant products for the well-being of mankind. Economic plants are numerous and have a variety of uses and they are classified under the following heads.

(a) Cereals & millets food
(b) Pulses
(c) Vegetables
(d) Oil seeds
(e) Fruits
(f) Sugar
(g) Spices & condiments
(h) Medicinal plants
(i) Bevarages
(j) Timber
(k) Fibres
(l) Rubber
(m) Paper

(a) Cereals : Cereals constitute the staple food of almost whole human race. They are rice, wheat, maize, barley;

1. Rice : can be grown 2 or 3 times a year, occupiying about 37 % of the total area, under cereals. Edible part is grain. They are poor in fats. In polished rice, the pericarp is destroyed with the loss of some precious nutrients (proteins, vitamins & minerals) finally, starch remains as food.
Varieties like Bala, Cauvery, IR-8, IR-20, Hansa, Ratna are popular.

2. Wheat: second staple food of people in India. Major constituent is starch nearly 70% and pro- teins 12% and oils 15%; It is used as flakes, atta, rhaida, etc. Wheat straw is fodder-for cattle. PUSA, sonalika, kalyana, sona are important varieties.

3. Maize : Important food for poor people. Mainly used for feeding livestock: Here also grains are edible. Maize contains 70% starch, 10% proteins, and 3% to 5% of oils. Maize starch is largely used in making afcoholic beverages..

4. Barley : It is useful in malt, and allied products. Malt is used in making Alcoholic bevarges Oats and Rye are other cereals which can be used as food.

(b) Millets : Important ones are sorghum (Jowar) Pearl Millet (Bajra) Finger Millet (Ragi)

1. Sorghum or great Millet or Jowar : It is the best of- all Millets. It affords nutritious food nearly as good as wheat. The average chemical composition is 72% starch, 9% proteins, and 2% oil.

2. Pearl Millet or Bajra : It grows in regions with low (rainfalls. The chemical composition is 71 %. starch, 10% proteins, and 3% oils.

3. Finger Millet or Ragi: It is an important food crop of Karnataka. It is a short duration crop. The grains are difficult to digest. The straw is nutritious fodder to cattle.

(c) Pulses : Pulses stand next to cereals as food grain. They are cultivated extensively as winter crops in rotation with cereals. It has light protein content averaging 22-25 % and starch content about 58% & oil content 2%. They contain vitamins A,B.C. The important pulses are Bengal grams, Black gram, Red gram, Pea,. Lentil, Soyabean.

(d) Oil seeds : There are several, species of plants yielding oils. In oil seed production, India holds a prominent position in. the world market. Oils are liquid at room temperature and fats' are solid (or) semi solid at room temparature. Some of, important .oil'seeds are: .

1. Ground nut oil ; The yield of oil is '43-46% Ground nut cultivation is a major agricultural operation. Nuts are nutritious and contain 31% of proteins, calcium, phosphorus and Vitamin B. The oil cake is a good feed of cattle.

2. Sesamum oil : It is obtained from seeds of sesamum. They are widely used as cooling hair oil. Also used for lighting .the villages and soap making industries. The oil cake is a good cattle feed.

3. Musturd oil : The oil content in musturd is 35%. It is a non-drying edible oil, chiefly used for cooking purpose in northern India.

4. Coconut oil: It is obtained from dry kernal. The yeild of oil is 50-65%. It is a valuable oil used for cooking, lighting and also in the preparation of soap, shampoo, hair oil etc. Oil cake is a fattening food for cattle.

5. Castor oil: It is a non-drying oil with a yield of 30 to 40% oil, is used as a medicine especially as a purgative." It is widely used as a lubricant in mechinaries. Also used in dressing leather and in tanning industries.

6. Sunflower oil : Oil yeild is 30 to 45%. It is used as cooking medium, also used in paints, soaps, cosmatics.

(e) Fruits : India is producing excellent fruits. Apart from their food value, they always contains some vitamins. There is an export of fruits like Bananas and Mangoes. Some of the" common fruits are:

1. **Mango :** is regarded as king of fruits and its edible part is mesocarp. India is producing nearly 90% of world mango production. Mangoes are rich in vitamin A, also little B and C vitamins.
2. **Pineapple :** Pineapple slices and juices are carried on a large scale. The. juice contains 8- 15% of sugar. Vitamin A, C and certain Minerals.
3. **Banana** ; is parthenocarpic' fruit. ifThe fruit contains 20% sugar and 4.7% proteins, Vitamins A,B,C,D & E. It is also rich in potassium calcium, Iron and phosphorus.
4. **Orange :** The juice contains citric acid & rich in vitamin C.
5. **Papaw :** contains vitamins A & C. The latex obtained contains Papain, a digestive enzyme.

(f) Sugar : Cane Sugar or sucrose (C_{12} $H_{22}O_{11}$) is the main commercial sugar, used universally for sweetening various food preparations. The sugar industry in India is second largest Industry next only to textiles.

Nearly 55% of sugar canes are used for rhaking gur (jaggery) and Khaiidsari as cottage Industries. Approximately 25% of cane sugar.is used in mills to manufacture white sugar. Sugar cane contains 10 % to 15 % of sugar. Sugar is also extracted from tuberous roots, of sugar-beet in cold countries.

(g) Spices & condiments : Spices are certain aromatic and pungent plant products used for seasoning and flavouring- food. They are also used in medicines. Some of common ones are:

1. **Cardamoms :** These are dried fruits. They have yellowish skin and enclose, 15-20 black seeds, the seeds contain an aromatic volatile oil. India is the largest producer of cardmom followed by Srilanka.
2. **Pepper :** It is the dried berry of peppervi.ie. Kerala is the principal centre of the cultivation.
3. **Chilli or Red pepper :** !t is the red pod like fruit, Chillies are pungent , stimulant, stomachic. In small doses they help in secretion of saliva and gastric juice.
4. **Camphor :** obtained from the wood of cinnamomum. Camphor is extracted by stem distillation from old wood cut into chips.
5. **Cloves :** are the dried flower buds of syzygium aromaticums. Cloves are very aromatic and have extensive uses in curries and medicines. Clove oil is extracted from unripe fruits and leaves. It is used in certain medicines, toothache etc.,
6. **Ginger :** is the Rhizome (root modifioation) of gingiber officinale. It is largely used as a condiment. It gives anomatic hot taste to curries.
7. **Garlic** : is a strong smelling whitish bulb. The smelt being due to the presence of a sulphur containing volatile oil present in' all parts of, the plant. It is an - effective remedy for high blood pressure, rheumatic and.muscular pain. It heals intestinal & stomach ulcers & is infact regarded as NATURE'S BEST ANTISEPTIC FOR THE ALIMENTARY CANAL.

(h) Medicinal Plants : Indias forests contain nearly 4,000 species of medicinal plants. The eastern and western Himalayas and Nilagiris'are known to be Natural abodes of many such plants. The Central Drug Research institute in Lucknow is carrying on research work on indigenous medici- nal plants.

Plant	Part of Plant body	Importance
Ipecae	Powdered Roots	Small doses to treat amoebic dysentary, It stimulates liver helping secretion of gastric juice.
Rauwolfia	Roots -1	Used in treatment of insomnia, Mental imbalance & insanity. It has property of reducing high blood pressure.
Nux-vomica	Seeds	It increases secretion of gastric juice. Sharpens appetite & promotes digestion, also helps in treatment of nervous disorders. It is effective in the treatment Of PARALYSIS.
Cinchona	Bark of the tree	It is a "quinine" yielding plant which is useful in the treatment of Malaria fever.
Aconite	Tuberous Roots	ReleivOs pain due. to rheumation & inflamed joints.
Deadly Night Shade (or) ATROPA	Dried leaves	Releives pain neuralgia and inflammation of muscles. Also useful, in bronchitis, asthema & whooping cough.
Poppy	Unripe capsules	Yields Narcotic drug, which is the latex obtained by increasing unripe capsules. The late is dried and made into balls which form the commercial OPIUM.OPIUM relejves intestienal pain, diarrhoea. It removes sen- sation of hunger, coughing and fatigue etc.

(i) BEVARAGES : These are mild, agreeble and stimulating liquors meant for drinking. Tea, coffee,- cocoa are examples of non-alcoholic bevarages.

1. Tea : It is the dried & prepared leaves. Tea plants grow in the plains and in the hills upto an altitude of 2,100 metres and flourish in localities di high rainfall. Annual pruning after plucking is a veiy important practice: Tea contains .4-5% of tannins, responsible for colour and strength of infusion and 3.3 - 4.7% of caffeine which is stimulant for the heart.

2. Coffee : It is regarded as.a'Whole some and refreshing drink. Seeds are the sources of coffee. Thery are roasted and powdered. Coffee contains 0.75 to 1.5% of caffeine' several vitamins and little volatile oil.

3. Cocoa : It is prepared from the seeds of Theobroma cocoa. Seeds are the sources,'they are dried, roasted and powdered. Cocoa seeds contain theobromine, caffeine (1%) proteins 15% and fatty oifs (30 to 50%) and starch 15%.

(j) Timber Trees : Timber is used for various building purposes. To be self suffcient in timber, a country should normally have about 1/3-of the total land area under forest. 75 species' of timber trees are present in India.. The quality Of timber depends up on its. hardness, strength, weight. Some important timber yeilding trees are:Teak - (Tectona grandis)Indian Red wood - (Dalbergia Sissoo) .Sal - (shorea robusta)

(k) FIBRES : Fibres are thread like tissues obtained f;om different parts of the plant body. They are mostly made of sclerenchymatous cells strongly lignified except cotton fibres. The quality of fibres depends on their length, strength, fine- ness, lustre. Some of the important fibres are as follows.

1. Cotton : (Gossypium) is the most important commercial textile fibre spun into yarn and woven into Various kinds of garments. Black soils are most suitable for cotton cultivation. Gotten is the hairy out growths of the seed.

2. Jute : is very valuable and is the best fibre widely cultivated mainly in the low-lying areas of West Bengal. Bast fibres are the selerenchymatous tissues of the secondary phloem. It is commer- cially irrip'ortant in preparing gunny bags (for. package),- cheap rugs, carpets, etc,

3. Hemp : Obtainded from ganja plant. It's fibers are very strong and durable. Commercial hemp is the "sun hemp or Indian, hemp" (crotalaria juncea). It is used in various kinds of cordage ropes, twine, fishing nets etc. Sun Hemp is much stronger than jute and stands water well.. It is also used for making strong paper.

4. Coir : is the tissue fibre obtained from dry .fruits of coconut. The fibres are short, coarse, rough, but very durable and resistent to water. It is used for making door mats, carpets etc,

(l) RUBBER : is obtained from the latex of Hevea brasiliensis, which is the main source, of commer- cial rubber, The latex is collected by tapping the bark. It, is then allowed to coagulate with the addition of water and a little acetic acid and then it is separated from liquid portion, washed and dried in the smoke house. It is then passed through rollers and pressed into blocks. The majority of rubber plantations are in Kerala (90%).

(m) PAPER : Cellulose is the basic constituent of paper and the various raw materials Used for paper pulp are wood of coniferous trees, bamboo, various grasses. In India, the total production of paper can not meet her demand.

17. ECONOMIC ZOOLOGY

The branch of science that basically deals with the various uses of animals and animal products for the well being of mankind. It is studied under different headings. They aire:

1. **APICULTURE :** culturing of honey bees. Honey bees arc highly organised social insects. The chief products of bee keeping .industry are (i) Honey (ii) 'bees' wax. Honey has high nutritive value and possessing 80% of sugar. It is esti- mated that 200 gms of honey provides as much nourishment as i 1.5 litres of milk. 2 gms of honey porvides 67 k.cal of energy. Honey is mildly laxative, anticeptic, and sedative. It is helpful in building up Of the haemoglobin of the bipod: Bee wax is used in the manufacture of cosmetics, paints, ointments, insulators,, plastic works, car- bon paper etc.
2. **LACCULTURE :** Culturing of lac insects is lacculture. There are 3. products from lac insects which are economically important. Lac is a com- plex substance having large amout of resins together with water and other alcaline substances. It is not soluble in water but soluble in alcohol and it has adhesive quality. About 50% of the total lac produced in India is obtained from Chota Nagapur area.
3. **Sericulture :** The production of silk from the silk worm rearing practices on commercial scale is called sericulture. The whole sericulture indus- try is based on the best utilisation of the mulbery leaves as it is the only food of the larva of the insect. (2nd stage.). In the 3rd stage of the life history ,i.e pupal stage, it secretes Saiivery fluid through the silk gland. The secreted fluid comes out through a ,spinneret and takes the form of long fine thread of silk which hardens on exposure to the air & wrapped around the body of the caterpiller (larva) in the form of a covering called cocoon. The rawsilk is used in the manufacture of woven materials and the knitted fabrics for the preparation of garments etc.
4. **Pearl Culture :** Pearl is a white, highly shining, found in the shell of an oyster. Pearl formation is an interesting phenomenon for protection against foreign invaders, parasites or sand grain accident^ entering- the body of the oysters which happens to adhere to a part of its mantle. The 3rd layer of shell, Nacreous layer (Mother of the pearl) which secretes concentric layers of calcium carbonate around the foreign body, ultimately forms the pearl. Although pearl industry may be established only on natural basis of pearl formed by oysters in the natural conditions but an artificial device to insert the 'Nucleus'' as a foreign particle in the shell of oyster has proved useful for the production of pearls in greater number.
5. **Edible fresh water fishes :** Fishes have been used as protein rich diet for human beings. Flesh of fish is a highly perishable commodity consti- tuted by 60-30% water and 13 to 20% of protein and lesser amount of fat, vitamins, phosphorus etc. Hence inorder to give supplement to ill balanced cereal diet, this fish culture has emerged.
   The main aim of fish culture is to obtain maximum yeild of palatable and highly nutritive fish flesh. Major corps have proved to be best culturable fish in India. ' .
   In addition to providing food,, most of the fishing industry yield a number of by -products of com- mercial importance. The chief among these are:
   Fish oil : extracted from fatty tissues of the fishes. It is used for industrial purposes as lubricants, cosmetics, paints etc.
   Fish fiver oil has great medicinal value. It is the main source of vitamin A. The fish meal is prepared from the wastes of fish oil or from the whole fish. It is used, as major, food of domestic animals like pigs, poultry, cattle etc: It is richly proteinacious diet.
   The wastes obtained during the preparation of fish is widely used as manure for coffee, tea & tobacco plantation.
   The skin of some fishes like shark is used as ah abressive and also strong durable leather prepared after special tanning.
   In certain fishes like catfishes, carps, airbladder, is of economic importance because a high grade collagen 'ISIN GLASS' is produced, which is used in the preparation of purses, book and ribbon etc.
6. **Snake venom :** It is used in curing a number of diseases. Viper venom is used to cure haem- orrhage and cobra's veriom (costly in the world of medicines) is used in the preparation of pain relieving tablets and also cures nervous disorders.
   The snake venom is a mixture of protein sub- stance, cellular debris, salts including toxic substance like haemotoxin & neurotoxin' which, affects the functional units of body results in death.
   The poisonous glands of snakes are modified salivary glands.
7. **Poultry :** Poultry became an important small scale indusrty due to modern need for nutritive food in the form of eggs and adult animal flesh.
8. Some important medicines obtained from animals:

a) Insulin is manufactured from the pancreas of cow and pigs.
b) Heparin is used as. anticoagulant prepared from the liver of animals.
c) Hirudin extract from leeches used as anti [1] coagulant and also used in the treatment of swellings and inflamation.
d) In the preparation of B-corriplex liver of ani- mals is used
e) The capsules are made up of "gelatin" which is obtained by boiling the horns, hoofs, skin and bones of animals.
f) For the preparation of anti-rabies vaccine the brain of sheep is used.
g) Musk obtained from musk deer is used for the preparation of medicines in Ayurvedic sys- tems.
h) Animal bones are widely used for manufacture of phosphate fertilizer.
i) Horses are used for. the commercial produc- tion of anti-venom because they have p^atest potential as anti-venom. produces.

BRANCHES OF ZOOLOGY

1.	Anthropology	-	Study of APEs & MAN
2.	Arthrology	-	Study of Joints'
3.	Carcinology	-	Study of Crustaceans
4.	Chonchology	-	Study of Molluscan shells
5.	Dermatology	-	Study of Skin
6.	Entomology	-	Study of Insects
7.	Heiminthology	-	Study of Helminth worms
8.	Haematology	-	Stydy of Blood
9.	Herpetolgy	-	Study of Reptiles
10.	Ichthyology	-	Study of Fishes
11.	Mammology	-	Study of Mammals
12.	Mastology	-	Study of Breast
13.	Myology	-	Study of Muscles
14.	Malacology	-	Study of Molluscus
15.	Nephrology	-	Study of Kidney
16.	Neurology	-	Study of Nervous system
17.	Ophiolpgy	-	Study of Snakes
18.	Ornithology	-	Study of Birds
19.	Osteology	-	Study of Skeleton
20.	Odontology	-	Study of Teeth
21.	Saurology	-	Study of Lizards
22.	Bionomies	-	Study of its Organisms and its Environment.
23.	Chronobiology	-	Study of duration of Life
24.	Cytogenetics	-	Study of heridity from the point of importance of view of Cytology & Genetics
25.	Phenology	-	Study of Behaviour of Insects
26.	Epidemiology	-	Branch of Medicine dealing with epidemic diseases.
27.	Ethnology	-	Origin, distrubution & distin- guishing character-stics of race of Mankind
28.	Ethology	-	Study of Animal Behaviour
29.	Gerontology	-	Study of old a'ge, its phe- nomenon & disease
30.	Microbiology	-	Study of minute Living or- ganisms
31.	Orthopedics	-	Prevention, diagnosis, and treatment of disease and abnormalities of musculo skeletal system
32.	Phthisiology	-	Scientific study of tuberculosis
33.	Radiobiology	-	Effects of radiation on Living organisms.
34.	Teratology	-	Study of abnormalities during the development of Embryo
35.	Andrology	-	Study of Curing defects in male reproductive organs
36.	Aquaculture	-	Breeding of Aquatic ani- mals of human food valves like fishes, prawns, etc.The increased Production of such marine organisms is calle "BLUE REVOLUTION"
37.	Dairy	-	Breeding of Milk cattle. Increase of milk in. catties is called white revolution
38.	Piggery	-	Breeding of Pigs

18. BRANCHES OF BOTANY

1. Morphology - deals with form & structure of various organs of plants

External Morphology : Study of external characters of organs like root, stems, leaf, flower, etc.

Internal Morphology : Study of internal structure like cell, tissues, etc.

2. Taxonomy - deals With identification, naming & classification of plants
3. Embryology - Study concerned with for- mation of garnets fertilization & development of Embryo
4. Physiology - Study of various functions performed by different plant parts
5. Ecology - Study of plants & animals in relation to their environ- ment
6. Genetics - Study of variations & Heridity
7. Evolution - deals with the progressive development of organisms through time
8. Palaeontology - Study of fossils. Fossils are the impressions, casts or petrifactions of organisms that existed in. the past
9. Phytogeography - Study of distribution of plants over the earth
10. Palynology - Study of pollengrains (Male garnet)
11. Phycology - Study of Algae
12. Mycology or Mycetology - Study of Fungi
13. Bactiriology - Study of Bacteria
14. Virology - Study of Virus
15. Micro Biology - Study of Microscopic or- ganisms like protozoa, algae, fungi, bacteria, viruses etc.
16. Lichenology - Study of Lichens (Lichens are composite organisms, formed by combined.growth of Algae & fungi)
17. Bryology - Study of Bryophytes
18. Reridology - Study of Pteridophytes

APPUED BOTANY

19. Plant Breading - deals with various aspects of improvement of crop plants & other useful plants
20. Economic Botany - Study of plants & plant products useful to man
21. Plant Pathology - Study of causes, prevention & control of plant diseases caused by fungi, bacteria, viruses etc.
22. Horticultiure - Study of improvement in garden or ornamental plants
23. Forestry or Sylviculture - deals with protection & development of forests'
24. Agronomy - Study of field crops
25. Pharma Pomology - Study of Medicinal plants
27. Olericulture - Study of Vegetable crops
28. Arboriculture - Study of (growth)' wood yielding trees
29. Floriculture - Study of cultivat pf the flower yielding plnats
30. Agriculture - Study of various methods of cultivation, harvest, stor- age & protection of various crops.
31. Dendralogy - Study of Trees
32. Limnology - Study of fresh water ecosystems
33. Exo Biology - Study of life oh other planets & outer space
34. Anthology - Study of flowers
35. Agrostology - Study of Grasses
36. Cytology - Study of different aspects of cell
37. Histology - Study of Tissues

19. NATIONAL INSTITUTES IN BIOLOGY IN INDIA

1. **Botanical suryey of India**
   Aim : Study of the flora in India
   Office at : Culcutta (Head Quarters)
2. **Central Institute of Medicinal and Aro- matic plants (C1MAP) or Central Indian Medicinal Plants Organisation (CIMPO)**
   Aim : Maintaining hortbarium of Medicinally useful plants.
   Head Quarters : Lucknow
3. **Indian Agricultural of Research Institute (IARI)**
   Aim : lmproving lndian Agricultural sector
   Head Quarters : New Delhi
4. **Indian Council of Agricultural Research (ICAR)** under cntrol of Ministry of Agriculture.
   Activities : Supervises 30 Agricultural Re- search Institutes, 21 Agricultural Universities
   Head Quarters : New Delhi
5. **Council of Scientific & Industrial Research (CSIR)** Under Ministry of Education.
   Main objective : Coordinating the research work carried out of different research stations
   H.Q : New Delhi
6. **National Institute of Oceonography (NIO)** Control by CSIR
   H.Q : New Delhi
   Aim : Promote Research on Oceanography
7. **National Institute of Nutrition (NIN)**
   H.Q : Hyderabad
   Aim : Promote research on Nutritional as- pects of different Indian foods
8. **Indian Council of Medical Research**
   W.Q : New Delhi
   Aim : Control Medical Research Institution
9. **International Crops Research Institution for Semi Arid Tropics (ICRISAT)**
   H.Q : Hyderabad
   Aim : Improvement of 5 crops namely Bajra, jowar, red gram, bengal.gram, & groundnut.
10. **Forest Research Institute (FRI) At :** Dehradun
    Aim : Carry out research on various aspects of forest trees.
11. **National Seeds' Corporation (NSC)**
    At : Delhi
    Aim : Collecting good seed from farmers of Agricultural farms & Universities
12. **National Botanical Research Institute (NBRI)**
    At : Lucknow. Carries out research in different branches of Botany.

20. GLOSSARY

1. **ABIOGENESIS :** Spontaneous Generation.
2. **ABSCISIC ACID :** Growth inhabiting plant hormone.
3. **ABYSSAL :** Organisms inhabiting deep Water.
4. **ACCLIMATION :** Slow change in the physiology of organisms as a result 6f its exposure to a changed environment.
5. **ACETYL CHOLINE :** Substance secreted at the ends of n6rve fibres.
6. **ACOELOMATE :** Having no coelone. Eg:- Platy helminthes, Nematodes.
7. **ACROMOSME :** Part of head of animal sperm. Usually forming a cap over the nucleus.
8. **ACTIVE TRANSPORT :** Transfer of substance from region where its concentration is low tp where it is bigh accomplished by means of expenditure of energy from metabolism.
9. **ADIPOSE TISSUE :** Fatty Tissue
10. **ADRENAL GLAND :** Hanmone secreting gland near each kidney
11. **AEROBIC RESPIRATION :** Respiration requiring free oxygen.
12. **AESTIVATION :** In Botany, the arrangement of the parts in a flowerbud. In Zoology, dormancy during summer season
13. **AGAR :** Mucilage obtained from certain sea weeds from a gel with water. It is usded to solidify culture media on which Micro Organisms are grown.
14. **AIR BLADDER :** Swin Bladder or Lungs of fish.
15. **AIR SACS :** Air field extentions of lung of Bird.
16. **ALBINISM :** Failure of developmnet of Skin Pigments.
17. **ALBUMEN :** Egg white of Birds. A solution of Gluey Protein with some salts in water between ovum and shell membrane.
18. **ALBUMIN :** Main protein constituent of blood serum in verte brates.
19. **ALLELES :** two or more genes, when occupy the sofne relative position (locus) on homelogus chromosomes.
20. **ALVEOLUS :** Minute air filled sac in Vertebrate Tungs surrounded by blood vessels, where exchanged gases takes place.
21. **AMINO ACID :** Fundamental constituents of living matter[1] because some thousands of amino acids are combined to make each protein-molecule.
22. **AMNlOiN :** Fluid filled sac of embryo. Am- niotic fluid within the sac provides a fluid environment for the embryo. It cushions the embryo against distortion by maternal organ.
23. **ANAEROBIC RESPIRATION :** Respiration without presence of Oxygen.
24. **ANTHER :** Terminal portion of a stamen.
25. **ANTI BIOTIC :** Substance produced by living organisms which diffuse into its surroundings and is toxic to individuals to other species. First antibiotic, discovered is pencillin pro- duced, by species of poncillium, which is toxic towairds bacteria such as streptococcus causing of Pneumonia.
26. **ANTIBODY :** A protein produced in a vertebrate animal when Antigen (foreign to body fluid) gain access to it. Antibody chemically combines with Antigen. Importance of Anti- body formation is as defence mechanism againist invasion by parasitic foreign organ-isms' particularly by bacteria, & viruses.
27. **AORTA :** (In Man) the great Artery which leaves the left ventricle of heart distribut- ing blood supplies for the whole body.
28. **APPENDIX (verminform) :** Small diverticulum , of caegum.
29. **ARTERY :** Blood vessel carrying pure blood from the heart towards the tissues, (excep- tion; pulmonry artery which carries impure blood from , heart to lungs)
30. **ARTIFICIAL INSEMINATION :** Artificial injec- tion of semen into female. Much used in animal breeding.,
31. **ASEXUAL REPRODUCTION :** Reproduction without Garnetes.
32. **AURICLE or ATRIUM :** One of the chambers of heart, receives blopd from veins and passes it to ventricle.
33. **AUT ECOLOGY :** Study of individual species as opposed to communities.
34. **AUTOLYSIS :** Self dissolution that tissues undergo after death of their cells due to action of their own enzymes. Eg : Lysosomes.
35. **AUTOSOME :** Chromosome which is not sex chromozome.
36. **AUXINS :** Groups of plant harmOnes pro- duced by reasons of acline cell division.
37. **BACILLUS :** Rod shaped Bacteria.

38. **BENTHOS :** Anirflals-and plants living on the bottom of the sea
39. **BIENNJAL :** Plant that requires 2 years to complete its life cycle.
40. **BILE :** Secretion of liver cells of vertebrates, passed through-bile duct to duodeum, important in digestion of fats.
41. **BINOMIAL NOMENCLATURE :** The present method of naming species of animals & plants scientifically.'. They name it in 2 parts. One part is genus name & other species name.
42. **BIOCHEMISTRY :** Study of chemical sub- stances & chemical process of living things.
43. **BIOLUMlNESCENCE :** Production of light by living organism.
44. **BIOMASS :** The Weight of all organisms in a given population or tropic level.
45. **BlOME :** Major regional ecological commu- nity of plants and animals.
40. **BIOMETRY :** Application of Mathematics to the study of living things.
47. **BIOSPHERE :** That part of the earth and its atmosphere which is inhabitted by living things.
48. **BIOTIN :** Vitamin of the B-Complex.
49. **BIVALENT :** Two hOmologyous chromo- somes, which'pair during Meiosis.
50. **BLIND SPOT :** Place where optic nerve enters retina of vertebrate eye devoid of rods and cones arid hence blind.
51. **BLOOD GROUP :** Group of people bear- ing the same Antigens on their RBC. There are 4 main groups A, B, AB, O. Agglutination occurs when blood from any two different groups is mixed owing to a reaction between substances on RBC.
52. **BLUBBER :** Thick layer of fatty tissue below dermis of skin insulating against heat loss in aquatic mammal.
53. **BUD :** Complex undeveloped shoot, consist- ing of short stems bearing overlapping, immature leaves. %
54. **CALORIE :** Amount of heat required to raise 1 Kg of water from 15° to 16°. Used as a measure of energy turn over in animals.
55. **CALYX or (whorl of sepals) :** Outer most part of a flower. Sepals enclose flower parts & protect in bud condition.
56. **CARCINOGEN :** Producer of cancer Eg:- certain hydrocarbons which produce local cancer when injected into.
57. **CARPLE :** "Female Reproductive organ of a floWer consists of ovary containing ovules.
58. **CARYOPSIS :** Fruit of grasses.
59. **CELLULOSE :** Fundamental constituent of cell wall in higher plants.
60. **CENTRIOLE :** Minute rod shaped body useful in spindle formation during cell division.
61. **CENTROMERE :** A region of chromosome for spindle attachment.
62. **CERVICAL VERTEBRAE :** Neck vertebra
63. **CERUMEN :** Ear Wax.
64. **CHITIN :** Nitrogen containing polysaccharide, present in cuticle of insects and crustaceans.
65. **CHLOROSIS :** Disease of green plants charactersied by yellow condition of parts that are normally green, caused by condition preventing chlorophyll formation.
66. **CHOLESTEROL :** A sterol found in all animals. Important constituent of animal plasma membranes.
67. **CHORDATA :** Phyllum of animals with noto- chord.
68. **CHROMATID :** One of the two strands which result from duplication of a chromosome.
69. **CHROMOSOME :** Thread shaped body con- sisting of DNA which are hereditary in function.
70. **CISTRON :** A gene, defined functionally that is a length of DNA producing the RNA that inturn produces a polypeptide chain.
71. **CLASSIFICATION :** Organisms are classi- fied scientifically in a hierarchical series ofgroups. The smallest group regularly used is the specjes, (individual member) species are-grouped together into genus.

    Eg : Homo Sapiens : (Man) similarly genera . "are grouped ihto families, families into order, order into classes, classes into phyla, phyla,into kingdom.
72. **CLAVICLE :** Shoulder girdle of vertebrates (collar bone of man)
73. **CLITORIS :** Homologue of penis in female Mammal.
74. **CLOACA :** Terminal part of gut of most vertebrates into which kidney and reproduc- tive ducts open.
75. **CLONE :** The descendants produced vegitatively from a single plant.
76. **COBALAMINE :** Cobalt containing yitamin . . . . . ^{12}) organ- ism, Deficiency of. this upsets cell division.
77. **COCCUS :** Bacteria of Globular form. >
78. **COCHLEA :** Part of internal ear concerned in the reception of sound.
79. **COCOON :** Protecive covering of eggs. Eg:- eggs of some annelids are-fertilised & de- veloped in a cocoon.

80. CODON : Sequence of 3 adjacent nucleated in messenger RNA or m RNA that deter- mines particular amino acid.

81. COELOME : Main body cavity of many triploblastic animals in which gut is sus- pended.

82. CONJUNCTIVA : The layer of mucus secret- ing epidermis covering the white o? the eye and lining the eyelids in vertebrates.

83. CONTRACTILE VACUOLE : Of protista par- ticularly in many fresh water species, a; membrane.surrounded vacuole which peri- odically expands and contracts (excretory and osmoregualatory in function)

84. CORONARY VESSELS : Arteries and veins of vertebrates carrying blood suply of heart muscle.

85. CTENIDIA : Gills of Mollusca.

86. CYCLOSIS : Circulation of protoplasm in cells.

87. DECIDUOUS : Plants shedding leaves at a certain season.

88. DENITRIFYING BACTERIA : Soil Bacteria which in absence of oxygen breakdown nitrates and nitrites with evolution of free nitrogen.

89. DIALYSIS : Method of separating small molecules. Eg: Salts from large, molecules.

90. DIAPAUSE : Period-of suspended develop- ment or growth accompained by decreased metabolism (in insects).

91. DIGESTION : Break down of complex food t stuffs by enzymes to simpler compounds which can. be incorporated into metabolism.

92. DIGITIGRADE : Walking on toes not or whole foot. Eg: Cat, dog

93. DIANOSAUR : Fossil reptile

94. DIPLOID : Having the chromosomes in pairs, the members of each pair being homologus so that twice the haploid number is present.

95. DIURESIS : Increased output of urine in kidney

96. ECDYSIS OR MOULTING : (In Arthophoda) Periodic shedding of cuticle in course of. growth.

97. ECOLOGY : Study of the relations' of ani-mals and plants to their surroundings.

98. ECOSYSTEM : A community of organisms interacting with one another and the environ- ment in which they live.

99. EDAPHIC FACTORS : Environmental con- ditions that are determined by the physical, chemical and biological characteristics of soil.

100. EMBRYOLOGY : Study of development of embryos.

101. ENAMEL : Hard covering of the exposed part of teeth.

102. ENDO SPERM : Nutritive tissue surrounding and nourishing the embryo in seed plants.

103. ENERGY FLOW : The movement of energy through the tropic levefs of a food chain.

104. ENTOMOLOGY : Study of Insects.

105. ENZYME : A protein which is catalyst (that , is a substance which in minute amounts promotes chemical change without itself used up in the reaction) in virtue of its power of. increasing the reactivity of a specific sub- stance.

106. EPHEMERAL : Plant With short life cycle (seed germinations to seed production)

107. EPIDEMIC : Large scale temporary increase in prevalence of a disease due to a parasite.

108. EPIGEAL : seed germination, seed leaves , appearing above ground.

109. EPIGENESIS : Origin of entirely new structure during embryonic development.

110. EPIGLOTTIS : Flap of Mucous membrane . arid cartilae in mammals at base of tongue on ventral wall of pharynx against which glottis, is pushed and thus closed when swallowing.

111. EUGENICS : Study of possibility of improving humanity by altering its genetic composition by encouraging breeding of those pfesun&d to have desirable genes.

112. EUPHOTIC ZONE : Zone near surface of sea into Which sufficient light penetrates for active photosynthesis.

113. EVOLUTION : Cumulative change in the characteristic, of populations or organisms, occuring in the course of successive generations related by descent.

114. FAUNA : The Ariimal population present in a certain place.

115. FEMUR : Thigh bone in tetrapod vertebrates.

118. FERMENTATION : Decomposition of sugar forming ethyl alcohoPand carbondioxide by yeast.

117. FERTILISATION : The Union of two special cells, .the garnets, resulting formation of zygote.

118. FLAGELLUM : Fine long thread having lash- ing or undulating movement, projecting from a cell.

119. FLAMECELL : cup shaped cell concerned with excretion. Eg: platyhejminthes.:

120. FLORA : Plant population of a.-.particular area.

121. FOETUS : Mammalian embryo after recog- nizable appearance of main features.

122. FOSSIL : Remains of organisms, presented ; in rocks.

123. GALL BLADDER : Small bladder in verte- brates near or in the liver storing bile.

124. **GAMETE :** Reproductive cell whose, nucleusr and ofteri cytoplasm fjjses with that of another gamete.
125. **GENE :** Unit pi heridiiary material or a pari of chromosome which functions'as. a unit.
126. **GENEFLOW :** Movement of genes as; a result of matingj and gene exchange with in population.
127. **GENE POOL :** Collective name for all the genes of a particular population.
128. **GENETIC DRIFT :** Change in the genetic make up of a population.- occur by gharice, riot a result of a natural selection.
129. **GENETIC ENGINEERING :** Artificial alterna- tion of genetic makeup of cells.
130. **GENETICS :** Study of heriditary and variation.
131. **GENOME :** The set of chromosomes found in each nucleus of a. given species.
132. **GESTATION PERIOD :** Length of time from conception to birth ih viviparous animal.
133. **GIBBERELINS :** Class of plant harmones required in promoting stem elongation of certain' plants.
134. **GILL :** Respiratory organs of acquatic animats.
135. **GLOTTIS :** Opening of Trachea into phranynx.
136. **GLUCAGON :** Harmone of vertebrates pro- duced by the islets of langerhans of pancreas. It causes breakdown of glycose in the liver with the release of glucose into the blood.
137. **GUTTATION :** Excretion of drops of water by plants through hydathodes occuring under condition of high humidity.
138. **HABITAT :** Place in which specified organisms live.
139. **HOEMOCYANIN :** Blue respiratory pigment : present in blood of some molluscus and arthropods. It is a protein containing copper.
140. **HAEMOGLOBIN :** Red respiratory pigment occuring in RBC of the vertebrates (A protein with Iron).
141. **HAEMOPHILIA :** Human disease in which blood clotting is defective known only in males.
142. **HAEMOPOIESIS :** Formation of RBC occuring in lymphoid tissue and bone mar- row of adult vertebrates.
143. **HEPARIN :** Substance which prevent blood
144. **HERBARIUM :** collection of; preserved plant specimen.
145. **HETEROSIS OR HYBRID VIGUOR :** Increased vigour, of growth, fertility, etc.
146. **HIBERNATION :** Dormancy during winter occurs' in many vertebrates - metabolism is greatly slowed.
147. **HISTOLOGY :** Study of tissues.
148. **HOLOZOIC :** Feeding in an animal like manner that is by eating other organisms.
149. **HOMEOSTATIS :** Maintenance of constancy of internal environment.
150. **HOMODONT :** having a set of teeth of the same kind.
151. **HOMIOTHERMIC :** Maintaining constant body temperature independent of the surroundings.
152. **HOMOLOGOUS CHROMOSOMES :** Chromosomes which contain identical sets of loci.
153. **HOMOZYGOUS :** having identical genes in the two corresponding loci of a pair, of chromosomes.
154. **HUMUS :** Complex organic matter result- ing from decomposition of plant and animal tissue in the soil. It is of great importance for piant growth.
155. **HYDROPONICS :** System of large scale plant cultivation in which growing plants in solution of nutritive medium in laboratories.
158. **HYPERPARASITE :** Organism which lives parasitically on another parasite.
157. **HYPERGEAL GERMINATION :** Cotyledons remaining underground when the seed ger- minates.
158. **IMMUNITY :** Ability of an animal or plant to resist infection by parasitic organisms.
159. **INBREEDING :** Reproduction by the making of closely related individuals.
160. **INSULIN :** Harmone of vertebrates.
161. **INTERFERON :** Protein produced in an animal cell when it is infected by virus.
162. **INTERPHASE :** State of cell when not undergoing mitcsis
163. **ISLETS OF LANGERLANS :** Groups of cells present in pancreas which secrete insulin and glucagon.
164. **KEEL :** Thin plate like pro^tipri M ban? from ventral surface of breast bone of birds to either side of which powetf ul wfng mijscles attached.
165. **LAC :** Resinous exudation, covering female of an insect.
166. **LACHRYMAL GLAND :** Teaf gland of eye lies beneath upper eyelid of man and other mammals continually secrets, small amounts of sterile and slightly antiseptic tears which keep cornea moist.
167. **LACTOSE :** Sugar occuring in mammalian milk.
168. **LANUGO :** Crop of very fine hair, covering human foetus which disappears before birth.
169. **LARYNX :** Dilated region of upper part of
170. **LATEX :** Fluid produced by number of tiowering plant excluding from cut surfaces as a milky' juice.. .

171. . . . . . Small raised pore of woody stems when epidermis (outerlayer) replaced by cork.

172. LIGAMENT : Strong barid of collagen connecting the two bones at a joint. It prevents dislocation.

173. LIMONOLOGY : Study of fresh water biology.

174. LIPASE : Enzyme which splits esters of fatty acids.

175. MALTOSE : Sugar formed as a result of starch breakdown.

176. MAMMARY GLAND : Milk producing gland present in female mammals.

177. MANDIBLE : Lower jaw of vertebrates

178. MARSUPIUM : Pouch of many marsupiales.

179. MAXILLA : Upper jaw of vertebrates.

180. MELANIN : Dark-brown pigment present in many animals. Colour of human hair is mainly due to melanirr

181. mRNA (messenger RNA) : It conveys fromthe, DMA the j.hformation that is to be translated into the structure of a particular peptide-molecule.

182. MONOECIUM : Plants having both male and female reproductive organs on the same individual.

183. MUSHROOM : Popular name for edible fruit bodies of fungi.

184. MUTANT : Gene which has undergone mutation.

185. MYCOSIS : Disease of Animals caused by Fungal .Infection. Eg: ring worm.

186. MYOGLOBIN : A variety of Haemoglobin - occuring irt muscle fibres.

187. MYOCiN : Protein that in conjugation with actin provides the contractive mechanism in muscle.

188. NEKTON : Swimming animals of pelagic zone.

189. NEPHFUDIUM : Organ present in many invertebrates responsible for excretion.

190. NEPHRON : Excretory unit of vertebrate kidney. .

191. NERITIC : Inhabiting the, sea over continental shelf.

192. NICHE : A particular role (set of relation- ships) of organisms in an ecosystem.

193. NITROGEN FIXATION : Conversion of atmospheric nitrogen into organic nitrogen compounds.

194. NODE : part of plant system where one or more leav,es arise.

195. NUCLEIC ACID: Long chain molecule formed from a large number of nucleotides, univer- sally found in living things.

196. OCCIPITAL CONDYLE : Bony knob at back of skull articulating with first vertebra. It is absent in fishes whose skull is not mobile. Double in mammals and single in birds.

197. OMNIVOROUS : Eating a diet of both plants and animals.

198. ORBIT : Cavity or depression in skull of vertebrates housing eyeball.

199. OVIPAROUS : Egg laying animals.

200. OVULE : Structure found in seed plants that develops into a seed after, fertilisation of an egg cell with in it.

201. OVUM : Unfertilised egg cell.

202. PALATE : roof of vertebrate mouth.

203. PALYNOLOGY : Pollen Analysis

204. PARTHENOCARPY : Formation of fruit with- out fertilisation.

205. PARTHENOGENESIS : Development of ovum without fertilisation.

206. PASTEURIZATION : Method of partial sterlisation i.e. destroying bacteria by healing well below boiling point.

207. PATELLA : Knee Cap.

208. PEAT : Accumulated dead plant material that has remained incompletely decomposed due to lack of oxygen.

209. PECTORAL GIRDLE : Shoulder girdle.

210. PEDICEL : Stalk of a flower.

211. PELAGIC : Inhabiting the base of water of sea or lake. . ,

212. PEPTONE : product of protein splitting.

213. PEPTIDE : Compound formed of 2 or more aminoacids.

214. PERISPERM : Nutritive, tissue surrounding embryo in some seeds.

215. PETIOLE : Leaf stalk.

216. PHLOEM : Vascular tissue that conducts synthesised food.

217. PHOTOSYNTHESIS : Synthesis of organic compounds from water and carbondioxide using sunlight.

218. PHYLLOTAXY : Arrangement of leaves on stems.

219. PHYLOGENY : Evolutionary history.

220. PINOCYTOSIS : Cell drinking or ingestion of surrounding fluid by cell.

221. PLACENTA : In Botony it is a part of ovary wall on . which ovules are born. In Zoology, organ consisting of embryoinic and maternal tissues in close union by which embryo of viviparous animal is nourished. An unbilical cord connects plancenta with embryo.

222. PLNTIGRADE : Walking on ventral surface on whole foot.

223. PLASMOLYSIS : Shrinkage of cell proto- plasm away frorp its .cellulose wall when placed in .hypertonic solution (high concen- trated solution) due to osmotic withdrawal of wafer.

224. POIKILO THERMIC : Cold blooded animals (ie) having body temperature with regard to environment.

225. POLLINATION : Transfer of pollen from anther to stigma of a flower.

226. PROSTATE GLAND : Gland of Male reprodutive system of Mammals which con- tribute? substances to semen.

227. PUPA : Stage between larva & adult in insect's life history.

228. PUPIL : Opening of iris at front of eye.

229. RADICLE : Root of embryo of seed plants.

230. RENIN : Harmone produced in kidney reacts With blood protein to produce Angiotensin which acts on Mineralocorticoid production of Adrenal gland.

231. RENNIN : Enzyme secreted in stomach . which clots milk.

232. R^H Factor (RHESUS FACTOR) : substance (An Antigen) occuring in blood corpusles of a . high proportion of Human beings. (R^H positive). The rest of the population is with- out the factor (R^I negitive). Depends on .a complex of linked genes.

233. RIBOFLAVIN : (Vitamin B_2), It forms part of co-enzymes concerned in cellular oxidation.

234. SALIVA : Fluid secreted in mouth containing mucous and ptyalin enzynme.

235. SEBACIOUS GLAND : Skin gland of mam- mals opening into a hair follicle. It secrets an oily substance which helps to water proof the fur.

236. SEED : Product of fertilised ovule consisting of an embryo enclosed by protective seed coat.

237. SEX CHROMOSOME : Chromosomes of which there is a homologous pair in the nucleus of one sex (Females X,X) and a dissimilar pair in those of others (Males X,Y).

238. SPECIES : Smallest unit of classification.

239. SPLEEN : Mass of Lymphoid tissue in mesentary of stomach or intestine. An im- portant reservoir of lymphocytes, defending the blood stream againist invading organ- isms. .

240. SPORE : Single celled or several celled reproductive body, that gives rise to a new individual.

241. STATOCYST : Organ of balance consisting of a vericle which stimulates sensory ceils as the animal moves.

242. STERNUM : Breast bone, to which the ventral ends of most of the ribs are attached.

243. STEROIDS : Chemically, similar but biologi- cally diverse substances, Eg:- bile acids.

244. SYMBIOSIS : Associates of dissimilar organ- isms to their mutual advantage.

245. SYNECOLOGY : Ecology of communities.

246. SYNGAMY : Union of garnets in fertilisation.

247. SYRINX : Sound producing organ in Birds.

248. TANNINS : Group of astringent substances of wide occurrence in plants.

249. TAXONOMY : Science of. classification of organisms according to their resemblances and differences.

250. TESTA : Seed coat.

251. THALAMUS : Receptacle of flower.

252. THALLUS : Simple vegetative plant body showing no differentiation into root, stem and leaf.

253. THORAX : Region of the body of terrestrial vertebrates containing heart and lungs.

254. TIBIO-FIBULA : Two long bones of the shank of the hind limb of the tetrapod. (4 leg) vertebrates.

255. TISSUE : Consists of cells performing the same function associated in large numbers in characteristic arrangement.

256. TRANSFER RNA (t RNA) : A relatively small molecule of RNA,. whose function is to place the aminoacids that will be linked into a poly peptide molecule in a specific sequence specified by a molecule of messenger RNA. (m RNA)

257. TRANSPIRATION : Loss of water vapour by land plants occurs mainly from leaves.

258. TUBEFEET : hollow extensile appendages con- nected to the water vascular system of Echinoderms.

259. UNGULATE : Hoofed mammals, adopted for running on firms open ground, herbivorous, living in herds.

260. UREA : Main excreted product of amino acid break down in ureoteclic vertebrates.

261. UREASE : Enzyme which splits urea into, ammonia and carbondioxide.

262. URETER : Duct conveying urine away from kidney.

263. URETHRA : Duct leading from urinary blad- der of Mammals to exteriori

264. URIC ACID : Main excreted product of Uricoteclie animals.formed after break down of ammonia, nucleic acids.

265. URINARY BLADDER : Sac storing urine.

266. UTERUS : Womb in which the embryo develops.

267. VACUOLE : fluid filled space within the cytoplasm, bound by a membrane.

268. VAGINA : Duct of female mammal; connect- ing uteri with exterior via a short vestibule. It receives penis of male during copulation.

269. VASCULAR BUNDLE : Longitudinal strand of conducting tissue consisting essentially of xylum and phloem.

270. VECTOR : An organism which transmits parasites. Eg:- Mosquitoes are vectors of Malarial parasite.

271. VENATION : Arrangement of veins in a leaf (vein is a vescular bundle of a leaf)

272. VESTIGIAL ORGAN : Organ of diminished size, structure, function and simplified in the course of evolution.

273. VITAMIN : Organic substance which an organism must obtain from its environment though it is necessary only in minute amounts.

274. VIVIPAROUS : animals giving birth to offspring.

275. WILTING : Condition of plants in which .ceils lose turgidity because of dropping of leayes in young stem takes place.

276. XEROPHYTE : Plant of dry or desert plants.

277. XYLUM OR WOOD : Vascular tiss'uia that conducts .water and mineral salts.

278. YEASTS : Widely distributed unicellular'fungi of great economic importance. The brewing and baking industries depend upon capacity of yeasts to secrete enzymes, that convert sugar into alcohol and carborftiioxide.

279. YOLK : Storage Of food material in the form of protein and fat granules, in eggs of majority of animals.

280. ZYGOTE : The fertillised ovum.

HUMAN DISASES :

1.	Pnsumonia	2.	Throat infection
3.	Whooping cought	4.	Tetanus
5.	Typhoid	6.	Cholera
7.	Tuberculosis	8.	Leprosy
9.	Diphtheria	10.	Plague
11.	Wound infection	12.	Syphills