

BALANCED DIET

- The components of food are : Carbohydrates, Fats, Proteins, Minerals, Vitamins , Water and Roughage.

CARBOHYDRATES

- Constitutes 3 elements: Carbon, Hydrogen and Oxygen
- Carbohydrates form a better fuel than proteins and fats because their molecules have relatively more oxygen.
- Main source of energy providers.
- Glucose, often called blood sugar.
- An adult man of average weight and doing moderate work needs about 500 gms of carbohydrates daily. Growing child, nursing mother and sports-persons need more carbohydrates.
- Is of 3 types: Cellulose, Sugar and Starch.
- Cellulose is present in the cell-wall of plants. It cannot be digested and simply acts as roughage.
- D-fructose is the sweetest of sugars. It is found in fruit juices, honey etc.
- Excess sugar is stored as glycogen in liver (by a process called glycogenesis). The sugar which is still left is converted into fat and stored in various parts of the body a adipose tissue (by a process called lipogenesis). In case the food provides inadequate glucose, reserve glycogen is converted into glucose for use in energy production. This conversion is known as Glycogenolysis.
- Sources of Carbohydrates are : 3 main cereals (wheat, rice and maize), sugarcane, milk (contains lactose-a type of sugar) , fruits honey, beet, etc.
- **Monosaccharides:** They are the simplest carbohydrates and are made up of one unit only (eg. glucose, fructose, galactose).
- **Disaccharides:** 2 units of monosaccharides (eg. sucrose, lactose and maltose)
- **Polysaccharides:** Those carbohydrates which contain a no. of monosaccharide units. (eg: starch in plants and glycogen in animals)
- During the process of digestion, all carbohydrates are broken down to monosaccharides.

FATS

- Provides twice the energy of carbohydrates
- Acts as the reserve food material because excess fat is stored in the liver and as adipose tissue. Stored fat is used as fuel when glucose is not available.
- An enzyme called Lipase digests fats. It breaks down into fatty acids and glycerol.

- Our diet should contain less saturated fats. Excess of saturated fats increases the blood-cholesterol level and may cause arteriosclerosis
- **Hydrogenation:** Process by which unsaturated fatty acids are converted into saturated fatty acids by the addition of hydrogen.
- Requirement : 50 gms daily.

Note:

- In whales and seals, the fat of the skin forms a thick layer called blubber.

PROTEINS

- Made up of Carbon, Hydrogen, Oxygen, Nitrogen and sometimes Sulphur.
- Important for growth and repair of the body (75% of our body is proteins only)
- Made up of amino acids.
- Proteins are first broken into amino acids and then digested.
- **As Enzymes:** As catalyst in digestion (Eg – Pepsin, Trypsin)
- **As a Hormone:** To regulate body functions
- **In transport of different substances:** (Eg- Haemoglobin- Transports O₂ in blood, Myoglobin – Stores O₂ in muscles)
- **As contractile proteins for contraction in muscles:** (Eg Actin and Myosin)
- **Structural proteins:** (Eg- Collagen Component of connective tissue, cartilage Keratin- Component of skin)
- **Protective proteins:** (Eg. Gamma globulins)
- **Visual proteins:** Rhodopsin and Iodopsin of rods and cones are proteins only. (Rods and Cones are the cells which are present in Retina of the eye).
- About 70-100 gms of proteins are daily needed.
- sources: Groundnuts, soyabean, pulses, lean meat, fish, eggs, milk, etc.

PROTEIN ENERGY MALNUTRITION

- In the age-group of 1-5 years.

Kwashiorkar

- Due to the deficiency of protein.
- When mother stops breast feeding.
- anaemia
- In infants under 1 year of age.

Marasmus

- Deficiency of proteins, carbohydrates and fats.
- between 6 months and 3 years.

MINERALS

BIOLOGY

- Apart from organic chemicals such as C, H, O, N human body needs inorganic chemical elements, called minerals, for a wide range of functions. These elements are present in the form of ions.
- Minerals help maintain the volume of water necessary to life processes in the body.
- Macroelements (more than 1 gm)
- Microelements (less than 1 gm)
- Deficiency of any of these leads to metabolic disorders.

VITAMINS

- Discovered by Funk
- Do not provide energy but help in different physiological processes.
- Vitamins are of 2 types:
- Water soluble, Fat Soluble

IMPORTANT VITAMINS REQUIRED IN HUMAN BEINGS

- B1 (Thiamine) – Beri-beri
- B2 or G (Riboflavin) – Cheilosis
- B3 or PP3 (Nicotinic acid or Niacin) – Pellagra
- B6 (Pyridoxine) – Dermatitis, anaemia
- B5 (Pantothenic acid) – Dermatitis
- Vit.H (Biotin) –
- Folic acid group – Megaloblasticaemia (low Hb content)
- B12 (Cyanocobalamin) – Pernicious anaemia
- Vit. C (Ascorbic acid) – Scurvy

FAT-SOLUBLE VITAMINS

- Vit.A(Retinol) – Xerophthalmia due to non function of lacrimal gland of conjunctiva. night-blindness
- Vit.D (Ergocalciferol and Cholecalciferol) – Rickets, Osteomalacia
- Vit E (Tocopherol) – Reversible sterility
- Vit K (Phylloquinone) - Haemorrhages

Water

- Important in digestion, transportation, excretion and to regulate body temperature (body contains 65% water)

ROUGHAGE

- Fibrous material present in the cell wall of plants.
- Mainly contains cellulose.
- It does not provide energy but only helps in retaining water in the body.

Note:

- Excessive intake of food calories leads to obesity. It leads to high B.P. and heart problems and the person gets prone to diabetes, hypertension and other disorders.
- Excessive intake of saturated fats like butter, ghee, etc, leads to hypercholesterolemia.

HUMAN DISEASES

I. BACTERIAL DISEASES

TUBERCULOSIS

- mycobacterium tuberculosis, infection in lungs that causes high fever.
- BCG (bacillus – calmette-guerin) vaccine

DIPHTHERIA

- Mainly from 2-5 yrs, corynebacterium diphtheria.
- using DPT vaccine (Diphtheria, whooping cough and tetanus)

WHOOPING COUGH or Pertussis

- Bacillus Pertussis
- Use of DPT Vaccine

CHOLERA

- Vibrio comma

DIARRHOEA

- Pathogens responsible for these diseases are Escherichia coli, Shigella sp., Campylobacteria and Salmonella

LEPROSY or Hansen's disease

- rod –shaped bacterium Mycobacterium leprae.

TETANUS

- clostridiumtetani. Disease of the C.N.S. (also called lock-jaw)
- ATS (Anti-tetanus serum) is prescribed

PNEUMONIA

- Streptococcus pneumoniae

TYPHOID

- Caused by Salmonella typhi which is found in the intestine of humans.
- Vaccine TAB (Typhoid Para A & B)

PLAGUE

- Plague is primarily a disease of rat. It is caused by rod shaped bacterium Pasteurella/ Yersineapestis

ANTHRAX

- Bacillus anthracis
- It is most common in agricultural regions where it occurs in animals, but it can also occur in humans.

GONORRHOEA

- Neisseria gonorrhoeae. It is transmitted through sexual contact (It is an infection of the mucous membrane of the urinogenital tract)

- It may result in female sterility.

SYPHILIS

- Sexual disease caused by a bacteria, *Treponema Pallidum*, transmitted through sexual contacts.

II. VIRAL DISEASES

MUMPS

- caused by a virus : Paramyxovirus.

MEASLES

- rubeola virus.

CHICKEN POX

- Varicella-zoster virus

POLIOMYELITIS

- enterovirus

INFLUENZA (or FLU)

- influenza virus.
- Orthomyxoviridae.

COMMON COLD

- Rhinovirus ('rhino' means nose) which belongs to picornavirus group.

RABIES (Hydrophobia)

- Caused by RNA virus called Rabies virus.
- Vaccine against rabies was developed by Louis Pasteur

HEPATITIS

- viral infection of liver.
- Hepatitis A (epidemic jaundice): hepatitis A virus (HAV).
- Hepatitis B (Serum hepatitis) : hepatitis B virus (HBV)

DENGUE FEVER

RNA containing dengue virus. It is transmitted by the bite of female tiger mosquito *Aedes aegypti* during day time.

YELLOW FEVER

- Arbovirus. It is haemorrhagic disease transmitted by the infected *Aedes aegypti*.

III. PROTOZOAN DISEASES

MALARIA – Chloroquin vaccine

- Anopheles mosquito only female anopheles
- Quinine, a product of Cinchona tree, is administered for Malaria.

KALA AZAR (Leishmaniasis)

- *Leishmania donovani*. sandfly (Phlebotomus)
- dum dum fever

GIARDIASIS

- *Giardia intestinalis* (first parasitic protozoan known) .

Trypanosomiasis

- *Trypanosoma*. Main disease is Gambian fever or West African sleeping sickness the vector of which is Tsetse.

AMOEBIASIS (Amoebic dysentery or Enteritis)

- *Entamoeba histolytica*

HELMINTHIC DISEASES

Ascariasis

- *Ascaris lumbricoides* (Vector: Cockroach and Flies)

Filariasis

- *Wuchereria bancrofti*. Transmitted by female *Culex* mosquito
- Elephantiasis

Taeniasis

- *Taenia solium* (or pork tapeworm) Transmitted by pig.

V. FUNGAL DISEASES

Ringworm

- Caused by *Microsporum*.

ENDOCRINE SYSTEM

ENDOCRINE GLANDS

Hypothalamus

- part of fore-brain, secretes neurohormones, which effect the release of hormones from pituitary.
- Acts as the thermostat.

PITUITARY GLAND

- smallest endocrine gland.
- Somatotrophic hormone: Its hypersecretion leads to acromegaly in adults and gigantism in children. Its hyposecretion leads to dwarfness in children.
- Gonadotrophic hormone (GTH) : Stimulates the primary sex hormones
- Lactogenic hormone: Initiates milk production in the pregnant females.
- Thyrotrophic hormone: regulation of thyroid secretion.
- Adrenocorticotrophic hormone (ACTH)
- Diabetogenic or Metabolic Hormone:
- Oxytocin or Pitocin: smooth muscle contractions, helps in the secretion of milk.
- Vasopressin or ADH (Anti-Diuretic Hormone): Hypoactivity leads to Diabetes.

THYROID GLAND

BIOLOGY

- It is the largest endocrine gland located in the neck between the trachea and larynx. Controls BMR (Basal Metabolic Rate) it is 1600 Kcal/day

Secretes:

- Thyroxine: Hypoactivity in children leads to cretinism.
- A diet, poor in iodine which is insufficient for the synthesis of thyroxin, leads to simple goiter.
- Its hyperactivity leads to increased metabolic activities
- Thyrocalcitonin – controls the amount of calcium in the body.

Hashimoto Disease: thyroid gland is destroyed. It is known as suicide of the thyroid.

PARATHYROID GLAND

- Secretes Parathormone, which is also known by the name of Collip's Hormone.
- It influences calcium and phosphorus metabolism (Ca level = 12 mg/100 ml of blood)
- Removal of this gland leads to death due to tetany (cramps, tremors and convulsions in muscles)
- Hyperactivity withdraws calcium from bones

THYMUS GLAND

- near the heart.
- thymine
- formation of antibodies

PANCREAS

- It is an exocrine as well as an endocrine gland. Its endocrine part is known as Islets of Langerhans.
- Beta cells secrete Insulin which controls the amount of sugar in the blood. Its hyposecretion leads to Diabetes Mellitus.
- Alpha cells secrete Glucagon which increases blood sugar level.
- Gamma cells secrete Somatostatin which controls the functioning of alpha and beta cells.

ADRENAL GLANDS

- 2, on each kidney. Sugar metabolism, Salt retention, Sex hormone and Source of energy
- Outer cortex and inner medulla.
- Adrenaline or epinephrine 3F Gland

GONADS

- in addition to producing, sperms and ova, also produce hormones.

TESTES

- Its interstitial cells (Leydig's cells) secrete testosterone
- Deficiency leads to sterility (eunuchoidism)

OVARIES

- Follicular cells produces Oestrogen which controls the female secondary sexual characters.
- Corpus luteum secretes Progesterone which is essential for the completion of each menstrual cycle.
- Relaxin at the end of gestation period, and helps in easy birth by relaxing the uterus and ligaments of the pelvic girdle.

SKELETAL SYSTEM

- Skeletal system constitutes hard internal or external living or non-living parts that form the supporting framework of body.
- It is divided into 2 parts.
- **Exoskeleton:** Which is produced by ectoderm. It is present on the outside of the body (made of either dead tissues or biochemical secretion). Found in both invertebrates and vertebrates
- **Endoskeleton:** Which is produced by mesoderm. It occurs inside the body and is made of cartilages and bones.

HUMAN ENDOSKELETON

- Divided into two main parts: Axial Skeleton and Appendicular Skeleton.

A. AXIAL SKELETON (Total 80 bones) SKULL

- Skull consists of two main parts cranium and face.
- Cranium (brain box) is formed by 8 bones and provides a bony protection for the brain.
- Face: There are 14 bones which form the skeleton of face.
- There are also present 6 ear ossicles in the skull.
- Another bone is hyoid.

VERTEBRAL COLUMN

- It is made up of 33 vertebrae in which 26 bones are visible because five sacral vertebrae are fused to form one sacrum and four coccygeal vertebrae are fused to form one coccyx

RIBS

- Ribs are 12 pairs (12 x 2) of bony bars which form the sides of chest cage. They protect the delicate organs (heart, lungs, etc)

STERNUM or Breast Bone

- It is a narrow, elongated and flattened structure, present just under the skin in the middle front of the chest.

B. Appendicular Skeleton (Total 126 bones)

- This skeleton lies laterally and is attached to axial skeleton at an angle. It is made up of girdles (pectoral and pelvic) and limb bones (forelimb and hindlimb)

PECTORAL GIRDLE

- Shoulder girdle
- Has 4 bones (two in each pectoral girdle)

LIMB BONES:

- Forelimbs – Consists of 60 bones.
- Hindlimbs – Consists of 60 bones.
- Femur (2) – Thigh (longest bone in the body)
- Fibula (2) – Shank (thinnest bone)

PELVIC GIRDLE – Has 2 hip bones.

DISEASES OF SKELETAL SYSTEM:

- Gout:** Accumulation of uric acid crystals in joints leading to painful movement.
- Dislocation:** In this case, the bones at the joints are dislodged from their positions e.g., the ball of one bone may slip out of the socket.
- Hard tissue deposits over articular cartilage along with higher secretion of synovial fluid causing pain and stiffness lead to rheumatoid arthritis.
- Tearing of articular cartilage and development of bony lumps at places causing pain, stiffness and permanent bending lead to osteoarthritis.
- Bursitis** is inflammation of the bursae present within synovial joint as small membrane bound pockets which stores synovial fluid.
- Osteitis is inflammation of bone.
- Osteoporosis** is loss of bone density due to excessive absorption of calcium and phosphorus from the bone.
- Osteomyelitis is infection of bone.
- Osteopetrosis** is a hereditary disease marked by abnormally dense bone, and by the common occurrence of fractures of affected bone.

ARTICULATION OF BONES – THE JOINTS

- A bone joint or articulation may be defined as the junction of two bones. The study of such joints is known as arthrology.

Note:

- Femur (in hind limbs) is the longest bone and stapes (in middle ear) is the smallest bone of the body.
- Sternum is absent in fish.
- Fibulla – thinnest bone
- Osteology is study of skeleton.

- Chondrology is study of cartilages.
- Arthrology is study of joints.
- Masseters of jaw is the strongest muscle.
- Birds have spongy bones with air filled spaces, called pneumatic bones.

MUSCULAR SYSTEM

- Human body has about 639 types of muscles.
- Muscles specialized to contraction are of 3 types: striated, unstriated and cardiac

Striated Muscles/Voluntary / Skeletal muscles

- Also called skeletal muscles.
- These muscles are mostly attached to bones by tendons and takes part in voluntary movements under conscious control of brain. Therefore they are called voluntary muscles.
- Each muscle fibre shows dark and light striations and is covered by a sheath, the sarcolemma.
- Its cytoplasm is called sarcoplasm in which are present large number of contractile myofibrils.

Unstriated Muscles

- These smooth muscles are involuntary muscles.
- Functionally they are of two types –single unit and multi unit.
- Single unit smooth muscles are present in urinary bladder and gastro intestinal tract.
- Multi unit smooth muscles are present in walls of large blood vessels.

CARDIAC MUSCLES

- They are involuntary, striated and non fatigued fibres which are found in the wall of heart where they form myocardium.

RESPIRATORY SYSTEM

All physical and chemical reactions in which atmospheric air oxides food in the body cells resulting in production of energy and liberation of CO₂ are included in respiration.

TYPES OF RESPIRATION

I. Anaerobic Respiration

- When nutrients are oxidized without using O₂ (also called fermentation)
- In yeast, glucose forms ethyl alcohol and CO₂. In bacteria and muscles, glucose is converted into lactic acid. Endoparasites like Ascaris, Fasciola, Taenia also respire anaerobically.
- It is a low energy yielding process.

II. Aerobic Respiration

- Cells utilize O₂ for oxidising nutrients. O₂ is used either from atmospheric air or from water.

RESPIRATORY ORGANS

I. NASAL CAVITY

- The air in the nasal cavity gets warmed (because nasal cavity has a very good blood supply) and moistened before it enters lungs.

II. PHARYNX

- From the nasal cavity the air enters the pharynx. It serves as a common passage for both air and food.
- The opening into the wind pipe or trachea is a narrow slit, the glottis. The glottis is protected against the entrance of food by a triangular flap of tissue, the epiglottis.

III. LARYNX (VOICE BOX)

- Called Adam's apple in man. It is the first part of trachea present in the neck.

IV. TRACHEA

- It is four and a half inch long tube with C-shaped ring of cartilages in its walls. These rings of cartilage make the wall non-collapsible.

V. LUNGS

- Surrounding each lung is a double walled sac, the pleural cavity. Hence the covering of lung are called pleural membrane.
- The right lung is divided into three lobes and left into two. The left lung is smaller than the right and has a concavity, the cardiac notch, where the heart lies.
- Inside the lung, each bronchi divides into numerous bronchioles, each of which terminates into an elongated sac, the alveolar duct, which bears on its surface air sac or alveoli. The latter provide a large surface for gaseous exchange.

PULMONARY VOLUMES & CAPACITIES

I. PULMONARY VOLUME

- Volume of air in the lungs.
- Tidal volume (TV): The volume of air inspired or expired involuntarily in each normal breath. It is about 500 ml of air in average young adult man.
- Inspiratory Reserve volume (IRV): It is about 3000 ml.
- Expiratory Reserve Volume (ERV): It is about 1200 ml

II. PULMONARY CAPACITIES

- Combination of two or more pulmonary volumes.
- Total lung capacity (TLC): TV + IRV + RV + ERV. It is about 5800 ml.

RESPIRATORY DISORDERS

- COPD: Chronic Obstructive Pulmonary Disease which includes Emphysema, chronic bronchitis and Asthma.
- Tuberculosis: A bacterial disease caused by Mycobacterium tuberculosis.

BLOOD

- Blood is a fluid connective tissue.
- It is 6.8 litres in man and 500ml less in woman.
- 6-8% of body weight (pH 7.4)

CONSTITUENTS

- Solid or cellular part called blood cells and fluid part called the blood plasma

BLOOD CELLS

1. Red Blood Corpuscles (RBC)

- Also called Erythrocytes, disc-shaped (for increased surface area), no nucleus contains a pigment called Haemoglobin, which gives blood its red color.
- Average man: Amount of Haemoglobin is 14-15.6gm/100cc of blood (11 – 14 in woman)
- RBC are produced in spleen and liver in foetus and in bone marrow after birth @ 1.2 million/sec
- Life of RBC is 120 days after which they are broken down in spleen or liver. Product of breakdown of haemoglobin is a pigment (yellow colour), called bilirubin which normally disposed off through bile whereas haem transferred to red bone marrow. Retention of bilirubin leads to jaundice.
- More: Polycythemia. Less : Anaemia

2. White Blood Corpuscles (WBC)

- Also called Leucocytes rounded, with a nucleus, far less numerous than RBCs (1:400 - 500) (5,000-10,000/cu mm), life 3-4 days, soldiers of body's defence system.
- Are of 2 types: Granulocytes (Basophils, Eosinophils, Neutrophils) and Agranulocytes (Monocytes: Lymphocytes)
- Basophils: Take up basic stains. Have an S-shaped nucleus. Secrete an anti-coagulant Heparin, which prevents clots within the blood vessels.
- Neutrophils: Stain equally well with both acidic and basic dyes. Most numerous of the WBCs (65-70%). Defence.
- Monocytes: Largest of all.

BIOLOGY

- Lymphocytes: 25% of the WBC. Takes part in antigen and antibody formation.

3. Platelets

- Also called Thrombocytes, formed in bone marrow, about 2,50,000/cu mm of blood life 3-7days, sets off blood clotting

PLASMA (65%)

- Watery part of blood, clear, yellow fluid. Contains about 90% water, proteins and organs salts.
- Plasma contains 7% proteins which include Albumin, Globulin and Fibrinogen.
- Plasma transports nutrients from the small intestine to the body tissues, and return the waster material to the kidneys, where it is filtered out.
- Regulates pH of blood.

LYMPH

- Lymph = Blood – RBC i.e. Plasma + WBC.
- Lymph forms second circulatory sytem. It acts as middle man between blood and tissue.
- All interchanges of nutrients and waster products between blood and tissue takes place through lymph only.
- It has more of lymphocytes as compared to that of blood (Blood has more of neutrophils.)
- Spleen produces lymph. At the same time it also acts as the graveyard of lymph.
- Spleen is also known by the name of 'Blood Bank' because RBCs, WBCs and Lymph are produced in spleen. It is situated above left kidney behind the stomach.

COMPARISON BETWEEN BLOOD AND LYMPH

BLOOD	LYMPH
It is red colour due to presence of haemoglobin in erythrocytes	It is colourless due to absence of haemoglobin
Circulation starts from the heart	Circulation starts from the tissue space
Act as vehicle	Act as middle man

BLOOD GROUPS

- Father of blood grouping Karl Landsteiner (Australian pathologist). He discovered A, B and O blood groups in 1900.
- Decastello and Sturle in 1902 discovered AB blood group.
- ABO system of blood groups is based on antigens and antibodies.
- Antigens: They are proteins and are found on the surface of RBC's Antigens are A and B.

- Antibodies: They are produced in lymph glands and are present in blood plasma .
- AB: Universal recipient.
- O: Universal donor.
- RH factor: It is based on RH antigen. Discovered in 1940 by Landsteiner and A.S. Veiner. It discovered in Rhesus monkey. Rh+ can receive blood from Rh- but no vice-versa.
- Blood transfusion technique was first developed by James Blundell in 1825
- Blood circulation by William Harvey
- Blood grouping – by Karl Landsteiner
- Inlargerons – Antiviral proteins increases immunity of our body by producing antibodies.

NERVOUS SYSTEM

- Its unit is Neuron
- Largest cell of our body is neuron only.
- Types: A. Central nervous system: Brain + spinal cord
B. Peripheral Nervous system : Nerves
C. Autonomic Nervous system : Sympathetic + Parasympathetic nervous system.

A. CENTRAL NERVOUS SYSTEM

- Brain is covered by 3 layers Meninges
 1. Durameter (toughest)
 2. Arachnoid mater
 3. Plamater
- Cerebrospinal fluid is filled between the meninges.

(a) Cerebrum

- Grey matter controls activities such as speech, taste, smell, hearing (conscious activities)

(b) Cerebellum

- Concerned with equilibrium of the body and brings about co-ordination and control of muscular activities of the body.

(c) Medulla Oblongata

- Lowest part of the brain and is connected to the spinal cord.
- Controls the involuntary actions (respiration, heart beat, flow of blood in blood vessels, secretion of glands, etc)

REFLEX ACTION

- First discovered by Marshal Hall.
- Co-ordinated by spinal cord

CONDITIONAL REFLEX

- First shown by Payloy on dog
- It is controlled by the cerebrum

PERIPHERAL NERVOUS SYSTEM

- Composed of Cranial nerves and spinal nerves.
- Cranial are 12 pairs while spinal are 31 pairs.
 - Trigeminal : Mixed
 - Facial : Mixed
 - Vagus : Mixed(largest)

AUTONOMOUS NERVOUS SYSTEM

- Not under voluntary control.
- Controlled by Central Nervous system.

SENSORY ORGANS

1. SCLEROTIC LAYER

- The transparent bulging, circular part of sclerotic layer which lies in the front is called cornea.
- Cornea is covered by the thin conjunctiva.

2. CHOROID LAYER

- Choroid layer starts from iris which is next to cornea. It controls the amount of light entering into the eye.
- The circular aperture of iris is called pupil.
- Next is lens (proteinous). It is biconvex in nature.
- Space between lens and cornea is filled with a transparent watery fluid called Aqueous Humour.
- The space behind the lens is filled with Vitreous Humour.

3. RETINA

- Image of the object is formed on retina.
- Rod cells: Sensitive to dim light
- Cone cells: Color sensitive for 3 primary colors (Red, Blue and Green)
- Yellow spot (Macula Lutea): On retina, finest image is formed here.
- Blind spot: No image formation takes place here as the optic nerves innervate the eyeball here. Also the rods and cones are absent here.
- Color of eye is the color of the iris.
- Cornea is donated in eye donation
- Eyes glow in animals due to tapetum

DEFECTS OF EYE

- Myopia: Cannot see distant objects, image formed before retina, concave lens is used.
- Hypermetropia: Cannot see near objects, image formed behind retina, convex lens is used.
- Astigmatism: Curvature of cornea becomes irregular and image is not clear. Cylindrical lens is used.
- Cataract: Due to defective protein metabolism the lens becomes opaque.

- Gloucoma: Due to defect in aqueous humour.
- Xerophthalmia: It is due to deficiency of Vitamin A.
- Presbiopia: In this, power of accommodation of lens decreases due to age factor and defected metabolism. Can be removed by bifocal lens.

EAR

MIDDLE EAR

- It encloses 3 ear ossicles.
- Middle ear is connected to the pharynx by Eustachian tube.

INTERNAL EAR

- Various parts are there which perform 2 acts: Maintenance of balance and hearing.
- Succulus and cochlea parts are associated with hearing. It is filled with a fluid, perilymph.
- In the internal ear are 3 semi-circular canals and utriculus which are filled with a fluid, endolymph. They perform the balancing act.

DIGESTIVE SYSTEM

- The process of converting food into energy giving substances is carried out by this system.

1. Buccal Cavity

- In the mouth salivary glands secrete saliva which contains the enzyme ptyalin.
- Also contains Lysozyme which kills bacteria
- Teeth: They are produced in two sets temporary and permanent. The teeth are of four types: Incisors, Canines, Premolars and Molars

Structure of a Tooth:

- It is covered by a shining material called Enamel.
- Enamel is the hardest substance in the human body.

Dental Formula:

- 2123/2123. This means that there are 2 incisors, 1 canine, 2 premolars and 3 molars in half of the upper jaw and exactly the same arrangement in half of the lower jaw. i.e. 32
- The premolars and the molars are called the grinding teeth. The last molars are called the wisdom teeth.
- Linked with pharynx.

Pharynx

- Trachea opens into pharynx through an aperture called Glottis. It also receives the opening of the Eustachian tubes from the middle ear through an aperture called Gullet.

Oesophagus

- 25 cm long tube.
- Leads to stomach

Stomach

- In stomach, the food is called chime.
- Has 3 parts: Fundus, Cardiac and Pyloric
- It is a warehouse, where food can be stored to await the main process of digestion.
- Gastric juices produced in the stomach help in digestion of food. Also contains HCl which kills bacteria and provides acidic medium.

Small intestine(Duodenum + Jejunum + Ileum)

- Here the food from the stomach is mixed with bile (from liver) and pancreatic juice (from pancreas) and moves forward by peristaltic movement.
- Duodenum receives the bile-pancreatic duct formed by the union of bile duct and pancreatic duct.
- Bot jejunum and ileum have numerous figurelike projections called the villi.
- Bile doesn't take direct part in digestion of fat, it just makes the food alkaline.

Large Intestine (Caecum+colon + Rectum)

- It receives undigested material from the small intestine and absorbs water.
- Cellulose digestion takes place in it.
- Vermiform appendix is a part of caecum, which produces antibodies.

TONGUE

- Saliva, secreted by the salivary glands, is mixed with the chewed food by the tongue.
- Tongue also contains taste buds due to which we sense bitter, sour, salty or sweet taste.

DIGESTIVE GLANDS

Parotid Glands

These are largest salivary glands.

Liver

- It is bilobed, right lobe being the larger and left lobe the smaller.
- Secretes Bile, which is yellowish in color.
- Bile helps in digestion in three ways.
- Liver is a gland which has got diverse functions.
- Digestion: With the help of bile (already discussed)
- Regulation of Blood Sugar: The liver separates the excess of sugar from the blood and stores it in its cells as glycogen (animal

starch). This process is called Glycogenesis and is aided by pancreatic hormone insulin.

- During the days of food shortage, the stored glycogen is changed into glucose and added to the blood stream for distribution to the body.
- Formation of Glycogen from Non-carbohydrate sources: Excess of amino acids/ fats are also changed into glycogen. This process is called Glyconeogenesis.
- Their amino radical separating as ammonia and carbon chain changing into a keto acid. This process is known as Deamination.
- Excretion: Liver collects haemoglobinwhile keto acid takes part in metabolism.
- Blood clotting: liver produces heparin, prothrombin and fibrinogen.
- Formation of Red Blood Corpuscles: Liver produces RBCs in the embryo.
- Phagocytosis: Foreign matter, dead cells and bacteria are disposed off in the liver.
- Synthesis of Vitamin A
- Storage: Besides glycogen liver stores (a) lipids such as fats fatty acids and cholesterol

Pancreas

- Endocrine – α , β , γ cells
- Exocrine – pancreatic juice
- It is both an exocrine and an endocrine gland. The endocrine part (called islets of langerhans) secretes hormones . The exocrine part secretes pancreatic juice.

HUMAN HEART AND ITS FUNCTIONING

- Size 12 x 9 cm and 300 gm weight
- Enclosed in a tough, 2 layer connective tissue sac, the pericardium.
- Has 4 chambers: 2 upper smaller auricles and 2 lower larger ventricles.
- The right auricle opens into right ventricle through tricuspid valve.
- This blood vessel is guarded by semi-lunar valve to prevent backflow of blood into ventricles.
- Blood again returns to heart from the lungs in left auricle. Now the blood is oxygenated.
- The left auricle opens into the left ventricle through a bicuspid valve.
- From the left ventricle the blood flows throughout the body through a large blood vessel callec aorta.
- To pump-out blood, the heart chambers undergo alternate contraction called systole and relaxation called diastole.

COMPARISON OF ARTERY, CAPILLARY AND VEIN

Artery	Vein	Capillary
Transports	Transports	Link arteries to

blood away from the heart	blood towards the heart	veins.
Except where they leave heart	Semilunar valves	No semilunar valves
Blood oxygenated except in pulmonary artery	Blood deoxygenated except in pulmonary vein	Mixed oxygenated and deoxygenated blood.

- Lubbis produced by the closing of tricuspid and bicuspid valves while dupp is produced by the closing of semi-lunar valves.
- This patch is the sino-auricular node which is called the pacemaker. Normal heart beat is 72/min.
- Heart failure: When S.A. node does not initiate any impulse.
- Sphygmomanometer measure the B.P. BP is 120/80 mm of Hg.

Pulmonary artery: The only artery which carries deoxygenated blood. It carries blood from right ventricle to lungs.

Pulmonary vein: The only vein which carries oxygenated blood. It carries blood from lungs to left auricle.

EXCRETORY SYSTEM

- Nitrogenous substances carbondioxide, pigments, excess water, etc.
- The nitrogenous waste can be excreted in the following forms:
- Ammonia, Urea, Uric acid- conservation of water is needed.

EXCRETORY SYSTEM OF MAMMALS

1. Kidneys

- Left kidney is higher than the right kidney.
- A kidney is composed of 1.2 million microscopic structural and functional units called nephrons or uriniferoustubules.

Urethra

Act of passing urine is called Micturition.

EXCRETORY PRODUCTS

AmmonotelicAnimals

- These animal excrete nitrogen in the form of ammonia, e.g., aquatic invertebrates Amoeba, Hydra, Prawn, Pila, and freshwater fishes Bony Fish, Frog’s tadpole.

Ureotelic Animals

- They excrete nitrogen in the form of urea, e.g., mammal (man), frogs, toads, other amphibians and cartilaginous fishes like sharks.

Uricotelic Animals

- They excrete the nitrogenous wastes in the form of uric acid e.g., reptiles, snakes, lizards, crocodiles and birds.

NEPHRON

Functional unit of kidney. It is a long tube differentiated into 4 regions.

1. Bowman’s Capsule

The Bowman’s capsule and the glomerulus together form a globular body called Malpighian body.

- The yellow colour of urine is caused by the pigment urochrome, which is a breakdown product of haemoglobin from worn out RBCs
- The urine on standing gives a pungent smell. It is due to conversion of urea into ammonia by bacteria
- pH of urine is between 5-8. Average pH is 6.0 (slightly acidic)
- kidney stones: Calcium Oxalate.

REPRODUCTIVE SYSTEM

1. Binary Fission

It occurs in unicellular organisms e.g., Amoeba, Euglena, Paramecium, etc.

2. Multiple Fission

The nuclei move towards the periphery and each one is surrounded by small amount of cytoplasm which gives rise to new daughter cells.

It occurs in protozoa e.g., Plasmodium.

3. Sporulation

In many protozoa and bacteria the asexual reproduction occurs by the division of nucleus into several daughter nuclei and then each daughter nucleus gets enclosed by small amount of cytoplasm to form a spore

4. Budding

Budding is an unequal division of the parent where the identity of the parent body is still maintained.

It is common in Hydra.

5. Fragmentation

The body may break into two or more fragments and each fragment develops into a complete individual e.g., Filamentous algae, spirogyra

SEXUAL REPRODUCTION

- In a certain animals, the male and female sex organs are present in the same individual. Such species are called monoecious or bisexual e.g. earthworm, leech.

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- Parthenogenesis is a specialized reproduction in which eggs develop without fertilization e.g., bees, ants, wasps, etc.

MAMMALIAN REPRODUCTIVE SYSTEM

- The reproductive system of sexually reproducing animals consists of:
- Primary sex organs called gonads which produce gametes and hormones.
- Secondary sex organs/glands which participate in reproduction but do not form gametes
- Accessory sex organs/characters which distinguish the two sexes in appearance.

MALE REPRODUCTIVE SYSTEM

- Testes are paired structures which lie outside the abdominal cavity in a thin pouch of skin called scrotum.
- Temperature of scrotum is 2°C below the body temperature.
- Interstitial cells or cells of Leydig which secrete male sex hormone (testosterone)

SECONDARY SEX ORGANS

Seminal Vesicles: They secrete viscous fluid which constitute the main part of the ejaculate. Seminal fluid contains fructose (as a source of energy which provide nourishment for the activity of sperm), citric acid and prostaglandins (these two stimulate the movement of sperms in female tract)

Prostate gland: It contributes an alkaline component to the seminal fluid for sperm motility. It also provides a characteristic odour to the seminal fluid.

FEMALE REPRODUCTIVE SYSTEM

Uterus: Its walls are composed of smooth muscle fibres called myometrium.

Vagina: The opening of the vagina in young females is partially closed by a thin membrane called hymen.

Mammary glands: Its secretion is under the control of prolactin hormone (of pituitary), while milk ejection is under the control of oxytocin hormone.

GAMETOGENESIS

- Process of formation of gametes in gonads. It includes spermatogenesis (formation of sperms by the testes) and oogenesis (formation of eggs by the ovaries)
- It is controlled by gonadotrophic hormones (FSH, LH, ICSH etc) secreted by pituitary gland. Meiosis forms the most significant part of the process of gametogenesis.

MENSTRUAL CYCLE

- The reproductive period of the human female continues from about the age of about 12 years to 45-50 years.
- This period is marked by a characteristic event repeated almost every month (28 days with minor variation) in the form of a menstrual flow.
- Menopause is stopping of ovulation and menses.
- Menstrual cycle is controlled by FSH, LH, estrogen and progesterone.
- Menstrual phase: Due to the shedding of the uterine lining rupturing the blood vessels which is mainly due to decrease of estrogen and progesterone secretion.
- Estrous cycle: At the time of ovulation sexual urge increases due to rising level of estrogen. This is called period of heat.

Note:

- Hernia is the protrusion of body part through an abnormal opening.
- If the number of sperms falls below 20 million the person become infertile.
- Surrogate motherhood is by-product of the artificial insemination.

TEST TUBE BABIES

- The technique of in-vitro fertilization (IVF) and in-vitro development followed by the embryo transfer in the uterus of the normal female to start the development and finally leading to normal birth is called test tube baby.
- Zygote is stimulated to develop in vitro upto 32 celled stage.
- First attempt to produce a test tube baby was made by an Italian scientist Dr. Petrucci in 1959.
- The world's first test tube baby (a baby girl) named as Louise Joy Brown was born on July 25, 1978 in Great Britain. India's first test tube baby was born in Calcutta on October 3rd 1978. Her name is Durga.

CLONIC

Therapeutic cloning: The goal of therapeutic cloning is to produce a healthy copy of a sick person's tissue or organ for transplant.

STRUCTURAL ORGANISATION OF THE CELL

- Study which deals with the cell is called cytology.
- Cell was first discovered by Robert Hook in 1665 in sections of cork. He only coined the term 'cell'
- The cell Theory was given by Schleiden and Schwann.

TYPES OF CELLS

- In a typical cells, the protoplasm consists of nucleus and cytoplasm
- Depending on the type of nucleus present, the cells are of two types.
- Prokaryotic cell and Eukaryotic cell.

Prokaryotic cell	Eukaryotic cell
It is a simple and primitive in nature	It is developed and comparatively complex in nature
The nucleus is not well organized.	The nucleus is well organized.
The cell has no membrane bound organelles except ribosomal granules	The cell contains almost all the membrane bound organelles
Chromosomes are not formed in this cell during cell division	Chromosomes are formed in the nucleus during cell division
Single DNA thread remains freely in the nuclear material	DNA is present in the nuclear reticulum or chromosomes

- On the basis of number of cells, the organisms are classified as Unicellular and Multicellular organisms.

Plant cell	Animal cell
A plant cell has a rigid wall on the outside. It is usually larger in size	Cell wall is absent. An animal cell is comparatively smaller in size.
It cannot change its shape	An animal cell can often change its shape.
Plastids are found in plant cells	Plastids are usually absent.
Plant cells exposed to sunlight possess chlorophyll containing plastids called choloplasts	Cholorophyllis absent.
Nucleus lies on onse side in the peripheral cytoplasm	Nucleus usually lies in the centre.
Lysosomes are rare.	Typical lysosomes occur in animal cell
Reserve food is generally starch and fat	Reserve food is usually glycogen and fat

- Huxley called protoplasm ‘Physical basis of life’.
- Human nerve cell is the longest animal cell.
- Largest acellular plant acetabularia is 10 cm and animal is amoeba, which is 1 mm .
- In human beings, cells of kidney are the smallest.
- Smallest cell is 0.1 – 0.3µm in size. It is PPLO (Mycoplasma gallisepticum)

CELL ORGANELLES

1. CELL MEMBRANE

- Cells are enclosed by a thin film like membrane called plasma membrane, cytoplasmic membrane or plasmalemma.
- Lies immediately outside the cytoplasm.
- Structure was defined by Singer and Nicholson in ‘Fluid Mosaic Model’.
- Selectively permeable in nature.
- Endocytosis: Taking of substance inside the cell by the plasma membrane.
- Exocytosis: Reverse of endocytosis, i.e., material is removed from the cells including reverse pinocytosis.

2. CYTOPLASM

It is part of protoplasm lying between plasma membrane and nucleus, Jelly-like fluid. Participates in the intracellular distribution of nutrients, metabolites and enzymes.

3. CELL WALL

- It is absent in animals.
- In true bacteria and cyanobacteria, cell wall is of peptidoglycan, in some fungi it is of chitin and in most of the algae and higher green plants it is of cellulose.

4. NUCLEUS

- Discovered by Robert Brown.
- RBCs of mammals don't have nucleus.
- Contains nucleoplasm (nuclear sap) which contains chromatin.
- Nucleolus is also present which helps in the production of ribosomes.
- Nuceluscontrols the metabolic activities of the cell by controlling the synthesis of enzymes.

5. CHROMOSOMES

- Waldeyer coined the term chromosome.
- Sutton and Boveri proved that chromosome is the physical basis of hereditary.
- Each chromosome is made up of DNA and this DNA by replication gives rise to messenger RNA which carry the genetic information in the form of code.
- Diploid number (2n) of chromosomes are there in somatic cells (all body cells except sperms and ova) and haploid (n) of chromosomes are there in gametes (sperms and ova).
- In humans, the diploid number is 46. Of these, 23 are from egg cell and 23 from sperm cell.

6. Mitochondria

- Powerhouse of the cell or energy converting organelles, as oxidation of ‘fuel’ occurs

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stepwise in these, resulting in the release of chemical energy. This energy is stored as ATP.

- Each mitochondria is enclosed by a double-membraned envelope, outer and inner.
- Fluid called matrix is there between these 2 layers inner membrane has many folds called cristae.

ENDOPLASMIC RETICULUM

- Provides mechanical support to the cytoplasm
- Both smooth Endoplasmic reticulum and rough endoplasmic reticulum form passages for transport of secretory proteins, lipids and sterols.

8. GOLGI COMPLEX

- Main function is secretion.

9. LYSOSOMES

- Also called Suicidal bags.
- Contain powerful enzymes (acid hydrolases), rupture of lysosome membrane releases these enzymes.
- Digest worn-out or unnecessary parts of the cell, or even whole cells by process called 'Autophagy'.

10. RIBOSOMES

- Sites of protein synthesis (Ribosomes are inactive for protein synthesis, but after combining with mRNA form polyribosomes which play important role in protein synthesis)

11. VACUOLES

- Found in plant cells only.
- Membrane surrounding the vacuole in tonoplast.
- Function: Regulation of water, in osmoregulation, in storage and in digestion.

12. PLASTIDS

- Chloroplast: Green, contains the pigment chlorophyll. Contains the matrix (fluid), stroma which has many flat membranous structures called thylakoids.
- Leucoplasts: Colorless, occur in large no in cells of fruits, seeds, etc. They store nutrients (eg. Amyloplasts of potato store starch)
- Chromoplasts: Colored, containing fat soluble yellow, orange and red pigments (chiefly carotinoids) Found in flowers and fruits.

Centrosomes—Plays an important role in the formation of spindle during cell-division.

Ribosomes—Act as factories of the cell and synthesize proteins from amino acids.

DNA and RNA

- DNA stands for Deoxyribose Nucleic Acid while RNA stands for Ribose nucleic Acid.
- Made up of Nucleotide monomers (Polynucleotides)

DNA MOLECULE

- Long and highly complex, spirally twisted, right-handed double helix, ladder like structure formed by 2 polynucleotides strands.
- Wilkins, Watson and Crick (1953)—Noble prize for DNA Structure.
- DNA contains 'BLUE PRINT' of life.

ORIGIN OF LIFE

- Theory of Spontaneous Generation or Abiogenesis held that life originated repeatedly from non-living materials by spontaneous generation.
- The 1st scientific account of the origin of life was given by Russian scientist A.I. Oparin in his book 'Origin of Life'.

DARWINISM

- The theory of natural selection was given by him.
- He, in his book Origin of species; mentioned the following factors for the formation of species by natural selection.
- The organisms show struggle for existence.
- The advantageous variations in organisms results in 'Survival of the Fittest'.

MUTATIONS

- Darwin in his theory explained the origin of species due to some changes.
- Hugo de Vries was the 1st to give much importance to these discontinuous variations.

FATHERS OF BIOLOGY

Aristotle	Father of Zoology, biology, political science
Theophrastus	Father of botany
Linnaeus	Father of modern botany
G.J. Mendel	Father of Genetics
Bateson	Father of Modern Genetics
Robert Koch	Father of Bacteriology
Edward Jenner	Father of immunology
Louis Pasteur	Father of microbiology
Francis Galton	Father of eugenics
Hugo de Vries	Father of Mutation
Robert Hooke	Father of Cytology
Micheli	Father of Mycology
Hippocrates	Father of Medicine

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Landsteiner	Father of Blood groups
Empedocles	Father of Evolutionary ideas
V.Korenchevsky	Father of Gerontology
Thomas Addison	Father of Endocrinology
Stephen Hales	Father of plant physiology
Prof. R. Mishra	Father of Indian ecology
Prof. Birbal Sahani	Father of Indian palaeobotany
Carolus Linnaeus	Father of Taxonomy and Nomenclature
Pavlov	Father of Conditional Reflex
Einthovan	Father of ECG
William Harvey	Father of Blood circulation
Kolreuter	Father of Polygenic inheritance
Basu	Indian Med. Plant
Bujwani	Father of Indian embryology
Khatwal	Indian botanist
Reiter	Ecology coined UV rays
Hershell	IR rays

Biological Evaluation

Evidence of Organic Evolution

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

Homologous Organs

- The organs which are similar in basic structure and origin but dissimilar in functions are called homologous organs, e.g., wings of bat, cat's paw, front foot of horse, human's hand and wings of birds.
- These show divergent evolution.

Analogous Organs (Homoplastic)

- These are developed in widely different organism phylogenetically due to similar habitats and modes of life e.g., wings of insects, birds and bats eyes of octopus and mammals.
- Analogous structures are a result of convergent evolution.

Vestigial Organs

- These are degenerate, non-functional organs which were functional earlier.
- Human body has been described to possess about 90 vestigial organs. Some of these are muscles, ear, pinna, canine, teeth and third molar teeth, body hairs, vermiform appendix, nictitating membrane of eye, caudal vertebral (coccyx or tail bone), etc.

Atavism or Reversion

Compiled by Rex Christopher

- It is the sudden reappearance of some ancestral features. Appearance of thick body hair, large canines, monstrial face, short temporary tails, addition, fairs of nipples, etc., examples of atavism.

Evidence from connecting Links

- Connecting link is one which exhibit characteristics of more than one groups.

Intermediate Forms between Two groups of Organisms

Organism	Connecting Link Between
Virus	Living and non-living
Euglena(Protozoa)	Plants and animals
Proterospongia (Protozoa)	Protozoa and Porifera
Peripatus (Arthropoda)	Annelida and Arthropoda
Neopilina (Mollusca)	Annelida and Mollusca
Balanoglossus (chordata)	Non-chordata and chordata
Dipnoi (Lung fish)	Pisces and Amphibia
Archaeopteryx (Aves)	Reptiles and Aves
Prototheria (Mammalia)	Reptiles and Mammalia

Theories of Evolution

Lamarckism

- Jean-Baptiste de Lamarck give the idea than an organism can pass on characteristics that it acquired during its lifetime to its offspring (also known as heritability of acquired characteristics)
- Lamarck's theory of evolution was published in Philosophie Zoologique and had four propositions viz.
 - i. Living organisms and its parts are tend to increase in size due to internal force of life.
 - ii. Formation of new organs is the result of a new need and new involvement.
 - iii. Use and disuse-Individuals lose characteristics they do not require (or use) and develop characteristics that are useful.
 - iv. Inheritance of acquired traits Individuals inherit the traits of their ancestors.

Mutation Theory

- Hugo de Vries proposed the theory of mutation, working while on Oenothera lacerations plant.
- Mutations are discontinuous variation.
- Mutations are due to changes in chromosomes, genes and DNA.
- These may or may not be inherited.

Synthetic Theory

According to it the five basic factors are:

- i. Gene mutation
- ii. Changes in chromosomes structure and number.
- iii. Genetic recombinations
- iv. Natural selection
- v. Reproductive isolation

First three factors are responsible for genetic variability.

Note:

- Devonian period is known as Age of fishes.
- Mesozoic era is known as Age of reptiles.
- Caenozoic era is known as Age of Mammals.
- South America is known as Bird Continent.

Classification of Organisms

In Linnaeus time, a two kingdom system of classification with Plantae and Animalia kingdoms was developed. The system did not distinguish between the eukaryotes and prokaryotes, unicellular and multicellular and photosynthetic organisms.

PH Whittaker (1969) proposed a five kingdom classification. The kingdom named were Monera, Protista, Fungi, Plantae and Animalia.

Characteristics of the Five Kingdoms

Character	Monera	Protista	Fungi	Plantae	Animalia
Cell type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell wall	Non-cellulosic	Present in some	Present (without cellulose)	Present (cellulose)	Absent
Nuclear membrane	Absent	Present	Present	Present	Present
Body Organization	Cellular	Cellular	Multicellular/loose tissue	Tissue/organ	Tissue organ/organ system
Mode of nutrition	Autotrophic	Autotrophic	Heterotrophic	Autotrophic	Heterotrophic

Classification of Animals

Storer and Usinger classified animals into following phylums.

Phylum-Protozoa

- These are unicellular animals, i.e., made up of only one cell.

- In these, all the metabolic activity like digestion, respiration, excretion and reproduction takes place in unicellular body.
- Respiration and excretion take place through diffusion.
Example- Amoeba, Paramecium, Euglena, etc.

Phylum- Porifera

- These all are found in marine water and have porous body. The pores are called ostia.
- These are multicellular animals.
- Their skeleton is made up of minute calcareous or silicon spicules.
Example- Sycon, Sponge, etc.

Phylum-Coelenterata

- These are aquatic animals have thread-like structures called tentacles around the mouth which help in holding the food.
- They have specialized cnidoblast cell to help in catching the food.
Example- Hydra, Jelly fish, Sea Anemone, etc.

Phylum- Platyhelminthes

- Animals of this phylum have alimentary canal with single opening, anus is absent.
- Excretion takes place by flame cells.
- There is no skeleton, respiratory organ, circulatory system, etc.
- These are hermaphrodite animal. Example- planaria, Liver fluke, Tape worm, etc.

Phylum-Ascheleminthes

- These are long cylindrical, unsegmented worms.
- Their alimentary canal is complete in which mouth and anus both are present.
- There is no circulatory and respiratory systems but nervous system is developed. Excretion takes place through protonephridia.
- They are unisexual.
- Most form are parasitic but some are free living in soil and water.
Example- Ascaris, Thread worm, etc.

Phylum-Annelida

- Their body is long, thin soft and metamerically segmented.
- Alimentary canal is well-developed.
- Nervous system is normal and blood (called haemolymph) is red (Iron rich haemoglobin)
- They respire through skin, in some animals it takes place through coelom.
- Excretion by nephridia.
- They move through setae made up of chitin.
- Example – Earthworm, Nereis, Leech, etc.

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Phylum-Arthropoda

- Jointed leg is their main feature.
- Their body is divided into three parts-Head, thorax and abdomen.
- Circulatory system is open type. Cockroach's heart has 13 chambers.
- Trachea, book lungs, body surface are respiratory organs.
Example-Cockroach, Prawn, crab, bug, fly, mosquito, bees, etc.

Phylum-Mollusca

- Their body is soft divided into head and muscular foot.
- Mantle is always presents in it, which secretes a hard calcareous shell.
- Their alimentary canal is well developed.
- Respiration takes place through gills or ctenidia.
- Blood is colourless.
- Excretion takes place through kidneys.
Example- pila, Aplysia (Sea rabbit), Doris (Sea lemon), Octopus (Devil-fish), Sepia (Cuttle-fish)

Phylum-Echinodermata

- All the animals in this group are marine.
- They have water vascular system
- Brain is not developed in nervous system
- They have a special capacity of regeneration.
Example – Star fish, sea urchin, sea cucumber, etc.

Phylum-Chordata

- They have notochord. A dorsal hollow tubular nerve cord and paired pharyngeal gill slits.
- This phylum is sub-divided into two sub-phylum i.e., protochordates and Vertebrata. Some main classes of phylum Chordata are

Pisces

- These are aquatic animal (cold-blooded animals)
- Their heart pumps only impure blood and have two chambers.
- Respiration takes place through gills.
Example – Scoliodon, Torpedo etc.

Amphibia

- These are found both on land and water. All these are cold-blooded.
- Respiration takes place through gill, skin and lungs.
- They have three chambered heart Example – Frog, Necturus, Toad, Ichthyophis, Salamander.

Reptilia

- These are crawling animals.
- These are cold blood and contains two pair of limbs.
- The skeleton is completely flexible.
- Respiration takes place through lungs.
- They have $3\frac{1}{2}$ chambered heart. (from chambered in crocodile)
- Their eggs, are covered with shell made up of calcium carbonate. Example – Lizard, snake, tortoise, crocodile, Trutle, Sphendon, etc.

Aves

- The animals of this groups are warm-blooded tetrapod vertebrates with flight adaptation.
- Their fore-feet are modified into wings to fly.
- They respire through lungs.
- Birds have no teeth, beak helps in feeding.
- They have single ovary and pneumatic bones.
Example- Crow, Peacock, Parrot etc.

Mammalia

- These are warm-blooded animals.
- Tooth comes twice in these animal. (diphyodont)
- There is no nucleus in their red blood cells (except in camel and llama)
- Skin of mammals have hair.
- External ear is present.
- Mammalia is divided into three sub-classes
 - i. Prototheria It lays eggs, e.g., Echidna.
 - ii. Metatheria It bears the immature child e.g. Kangaroo
 - iii. Eutheria It bears the well developed child, e.g., human. They give birth to young one, but Echidna and duck billed platypus are the egg laying mammals.

Integumentary system

The human skin (integumentary) is composed of a minimum of three major layers of tissue, the epidermis, the dermis and hypodermis.

Epidermis

- The top layer of skin made up of epithelial cells and does not contain blood vessels.

Dermis

- It gives elasticity to the integument, allowing stretching and conferring flexibility, while also resisting distortions, wrinkling and sagging.

Hypodermis

- It is made up of adipose tissue.
- It performs several important functions:
 - i. Protect against invasion by infectious organisms.

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- ii. Protect the body from dehydration.
- iii. Maintain homeostasis
- iv. Act as a receptor for touch, pressure, pain, heat and cold.
- v. Protect the body against sunburns by secreting melanin.
- vi. Generate vitamin-D through exposure to ultraviolet light.
- vii. Store water, fat, glucose and vitamin-D

Vaccination

- It is the process of artificial introduction of germs or the germ substance called antigen into the body for developing resistance to a particular disease. The material introduced into the body is called vaccine.
- A vaccine is dead or weakened microbes. They are unable to produce disease as they are less in number but they stimulate the body to produce antibodies.
- World Health Organization (WHO) in 1974 officially launched a global vaccination programme to protect children from six fatal diseases. Diphtheria, pertussis, tetanus, polio, TB (Tuberculosis) and measles. It was launched in India in 1985.

Genetics

It is the study of heredity and variations. The term 'Genetics' was coined by W Bateson in 1905. Gregor John Mendel (commonly called Father of Genetics) proposed three laws.

- (a) **Law of Dominance** It states that crossing of plant with red and white flower produced plants only with red flower i.e., dominant appear and recessive disappeared.
- (b) **Law of Segregation** It states that allele of a gene separate during gamete formation. It is also called law of purity of genetics or law of splitting of hybrids. It gives 3 : 1 ratio in F₂ generation.
- (c) **Law of Independent Assortments** It states that two or more genes assort independently during inheritance. It gives 9 : 3 : 3 : 1 ratio in F₂ generation. Linkage is an exception to this law.
- The 7 characters studied by Mendel were present as four different chromosomes. To know heterogeneity of F₁, he crossed F₁ hybrid with recessive parent, this is called test cross.
- There are a number of exceptions to Mendelian characters like incomplete dominance in *Mirabilis jalapa* giving pink colored flowered in F₁ generation by crossing red and white flowered plants.
- Pleiotropy is the phenomenon, where a gene affects many aspects of phenotypes.

- Haemophilia and colour blindness are two important sex-linked diseases in human, whose allele is found on x-chromosome.

Biotechnology

- It is the use of micro-organisms, their parts or processes for the manufacture of useful or commercial substances. It has two core techniques i.e., genetic engineering and technique to facilitate the growth and multiplication of only desired microbes. In genetic engineering (also called recombinant DNA technology) restriction endonucleases are most useful. They cleave the DNA at specific locations called restriction sites.
- Vectors are organisms or their parts used to transfer the desired DNA from one organism to another. The common vectors are bacteriophage, cosmids, phagemids, plasmids etc.
- Polymerase Chain Reactor (PCR) developed by Kary Mullis (1983) can clone or amplify the small amount of DNA. It involved denaturation, primer annealing and polymerization in the definite sequence.

Applications of Biotechnology

A number of transgenic plants, medicines, acids are produced through genetic engineering.

Bt cotton

- It was developed to reduce the heavy reliance on pesticides.
- The bacterium *Bacillus thuringiensis* (Bt) naturally produces a chemical harmful only to a small fraction of insects

Bt Brinjal

- It is transgenic brinjal (also known as an egg plant or aubergine) created by inserting a crystal protein gene (cry IAc) from the soil bacterium *Bacillus thuringiensis* into the genome of various brinjal varieties.

Golden Rice

- It is a variety of *Oryza sativa* rice produced through genetic engineering to biosynthesize beta-carotene, a precursor of pro-vitamin-A in the edible parts of rice. Golden rice was developed as a fortified food to be used in areas, where there is a shortage of dietary vitamin-A
- **Golden Rice 2** produces up to 23 times more beta-carotene than the original variety of golden rice. Golden rice was created by Ingo Potrykus of the Institute of Plant Sciences at the Swiss Federal Institute of Technology, working with Peter Beyer of the University of Freiburg.

BIOLOGY

- Carotene gives carrots their orange colour and is the reason why genetically modified rice is golden. For the golden rice to make beta-carotene three new genes are implanted: two daffodils and the third from a bacterium.

FlavrSavr

By the use of antisense RNA technology the enzyme polygalacturonase, which causes damage to pectin is deactivated and the tomato is kept afresh for longer duration.

Canola

- It is the oil of either rape seed (*Brassica napus* L) or field mustard (*Brassica campestris* L or *Brassica rapa*). Its seeds are used to produce edible oil suitable for consumption by humans and livestock. The oil is also suitable for use as biodiesel.
- Cheese is prepared by the coagulation of casein and other minor milk proteins (curdling of milk) by an enzyme rennin extracted from calf gastric mucosa.
- *Streptococcus* and *Lactobacillus* species are involved in the manufacture of most cheese.
- In cheese manufacture, micro-organisms are important in both souring and ripening processes.
- Semisoft blue Roquefort cheese of France is produced using the mold *Penicillium roqueforti*.
- Yoghurt is a preserved milk product having a distinct taste and a thick texture than milk.
- Yoghurt is made by fermenting whole milk with a mixture of *Lactobacillus bulgaricus*, *Streptococcus lactis* and *S. thermophilus* at 40° to 46°C.
- Vitamin C was the first vitamin to be produced by a fermentation process using *Acetobacter*, a wild bacterium.
- Bacteria used for industrial production of vitamin B12 are *propionibacterium shermanii*, *P. freudenreichii* and *Pseudomonas denitrificans*.
- Vitamin B2 (Riboflavin) is synthesized by many micro-organisms including bacteria, yeasts and fungi. The fungus, *Ashbya gossypii* is used for the microbial production of vitamin B2.
- **Monoclonal antibodies** are made outside the body by the hybrid cell cultures known as hybridomas.
- Monoclonal antibodies (mAb) are antibodies that are identical because they were produced by one type of immune cell and are all clones of a single parent cell.

- **A biochip** is a discrete collection of gene fragments on a stamp-sized chip that can be used to screen for the presence of particular gene variants.
- Biochips allow rapid screening gene profiles, a tool that promises to have a revolutionary impact on medicine and society.
- Biochips can **help in identifying precise forms of cancer**.
- **Gene therapy** is the treatment of disease by replacing, altering or supplementing a gene that is absent or abnormal and whose absence or abnormality is responsible for the disease. Gene therapy is unique in that it employs the genetic material, DNA itself as the means of treatment.
- DNA finger printing is the technique, in which the banding pattern of DNA fragments is compared and can be used in many species, including human, to indicate relatedness (used for rape victim, paternity, other criminals).
- **Human insulin or humulin** is the first genetically engineered pharmaceutical product, developed by Eli Lilly and company in 1982.
- Genentech, a California-based company, have produced human growth hormone (HGH) from genetically engineered bacteria.
- Somatostatin is the first polypeptide, which was expressed in *E. coli* as a part of the fusion peptide.
- **BST or Bovine Somatotropin** is produced for a large quantity of milk production in cows.
- It is possible to cure phenylketonuria disease by using recombinant DNA techniques in early period of pregnancy.
- **Urokinase** is involved in dissolution of blood clots. It has been synthesized in huge quantity by using genetically engineered bacteria with urokinase genes.

Organic Acids synthesized by Various Microbes

Micro-organism	Organic Acid
Lactic Acid	<i>Lactobacillus delbreuckii</i> , <i>L. bulgaricus</i> , <i>Streptococcus lactis</i> and <i>Rhizopus</i> species
Acetic acid (Vinegar)	<i>Acetobacter acetii</i>
Citric acid	<i>Aspergillus niger</i> , <i>Penicillium</i> sp. And <i>Mucor</i> sp.
Gluconic acid	<i>Aerobacter acetii</i> , <i>Aspergillus niger</i> , <i>Penicillium</i> and <i>Chrysogenium</i>
Propionic acid	<i>Bacterium Propionicum</i>
Butyric acid	<i>Clostridium acetobutyricum</i>
Oxalic acid	<i>Aspergillus</i> sp

Gallic acid	Aspergillusniger
Same amino acids	Escherichia coli

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