TEACHING / TRAINING MODULE

ZOOLOGY

CLASS-XI & XII

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ST & SC DEVELOPMENT DEPARTMENT
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FOREWORD

The ST and SC Development Department, Government of Odisha, has initiated an innovative effort by setting up an ***Academic Performance Monitoring Cell*** (APMC) in Scheduled Castes and Scheduled Tribes Research and Training Institute (SCSTRTI) to monitor the Training and Capacity Building of teachers of SSD Higher Secondary Schools and Ekalabya Model Residential Schools (EMRS) under the administrative control of the ST & SC Development Departme. This innovative program is intended to ensure quality education in the Higher Secondary Level of the schools of the ST & SC Development Department.

The modules and lesson plans are prepared for the +2 Science and Commerce stream' in all the subjects such as Physics, Chemistry, Botany, Zoology, Mathematics, Information Technology, Odia, English and Commerce for both the years in line with the syllabus of Council of Higher Secondary Education (CHSE).

These modules/lesson plans are self contained. The subiect experts who are the best in their respective subjects in the State have been roped in for the exercise. They have given their precious time to make the module as activity based as possible.

I hope, this material will be extremely useful for the subject teachers in effective class room transactions and will be helpful in improving the quality education at the Higher Secondary Level. I also take this opportunity to thank all the subject experts of different subjects for rendering help and assistance to prepare the modules/lesson notes and lesson plans within a record time.

Prof. (Dr.) A.B.Ota
Director and Special Secretary,
SCSTRTI

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SCHEME OF LESSON IN ZOOLOGY 2018 – 19

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UNIT - I

DIVERSITY OF LIVING WORLD

What is Living

An organism or a living form possesses or shows the characteristics of life or being alive. The distinctive characters the Living organisms possess such as growth, movement or locomotion, digestions, respiration, excretion, circulation, reproduction and response to stimulus and adaptation to the changing environment. Internal mechanisms like metabolic processes, enzyme and hormone actions, functioning of immune system and many more also play a vital role in living beings. Some important mechanisms are discussed below:

(a) **Metabolism**: The metabolism is further divided into anabolism (constructive process) such as synthesis of protein etc, and catabolism (destructive process) such as breakdown of glucose molecule in cellular respiration etc. Many such processes are similar in microbes, plants and animals etc.

(b**)** **Growth** : Organisms like animals have a characteristic features of growth upto certain age but plants grow throughout life. In unicellular organisms, single-celled body grows only by mass, while in multicellular organisms there is increase in mass and nos. of cells. Growth is a quantitative character, while development is a qualitative character.

(c) **Reproduction and Continuation of Race** : Reproduction is an important characteristics of life. Basically it is of 3 types - Vegetative, Asexual and Sexual. Plants and animals generally show both asexual and sexual type, where as vegetative is exclusively confined to plants. Organisms generally grow from inside.

(d) **Response to Stimuli** : Living organisms respond to surroundings. They respond to various physical, chemical and biological stimuli. Organisms are influenced by external stimuli such as light, temperature, water and pollutants etc. All organisms are self-replicating, self-regulating, and evolving systems.

Biodiversity

Biodiversity means the variability among living organisms from all sources including interalia, terrestrial, marine and other aquatic systems and the ecological complexes of which they are apart including diversity within species, between species and of ecosystems. The term ‘Biological diversity’ was first used by Jenkins and Lovejoy, but W.G.Rosen (1985) cut short the usage, Biological Diversity and coined the term ‘Biodiversity’. E.O.Wilson (1988) first used the term in one of his publications.

Need for Classification

Each organism is a species and possess unique character by which they differ from one another, for example plants bearing flowers and enclosed seeds (angiosperms), naked skined frogs and toads (amphibia), animals with hairy skin (mammal) etc. Both Hydra and Starfish are radially symmetrical but they are placed in different groups. Hence organisms are need to be classified basing on morphological, anatomical and embryological characters etc.

Plants and animals are called in different vernacular names in different parts of the world. It creats communication problems among different regions of the world. A scientific standardised name is given to each and every organism throughout the world called biological nomeneclature. The International Code for Botanical Nomenclature (ICBN) and International Code for Zoological Nomenclature (ICZN) has framed principles for naming plants and animals respectively.

Three Domains of Life

Accordingly to Linnaeus, Kinddom is the highest category in the classifications of organisms. Carl Woese proposed the three domain system of biological classifications in 1977. He introduced

the three domain of classification, such as archaea, bacteria and eukaryota. Under each domain, there are a few kingdoms with distinctive characters. Each domain emphasized on evolutionary lines of descent. Each organism is first placed under a domain, then under kindgom followed by phylum in a descending order upto species.

(a) **Domain Archaea**

The Kingdom Archaebacteria comes under archaea domain. The organisms are prokaryotes without nuclear membranse, a unique biochemistry and RNA characteristics different from bacteria. These are oldest organisms. Examples are methanogens (methane producing) acidophils (surviving in highly acidic environment), thermophils (surviving in extreme heat) and halophils (surviving in high salt conditions).

(b) **Domain Bacteria**

The kingdom Eubacteria comes under it and are prokaryotes. These have diacyl glycerol diester lipid in cell membrane, no nuclear membrane and contain bacteria r-RNA. It includes mostly pathogenic bacteria. Examples of these are cyanobacteria (carryout photosynthesis), bacteria pathogens (which cause tuberculosis and skin infections), spirochaetes (gram-negative bacteria like syphilis), and firmcutes (gram positive bacteria found in human gut).

(c) **Domain Eukaryota**

The domain includes all eukaryotes. These have nuclear membrane and DNA. Membrane bound organels are also found. Kingdom Protista, Fungi, Plantae and Animals come under this. These undergo both mitosis and meiosis.

Taxonomy and Systematic

All living organisms are classified into different taxa and this process of classification is called taxonomy. External and internal structures, along with structure of cell, development process and ecological informations are essential and form the basis of modern taxonomic studies. Taxonomy is an older branch of study than Systematics, which deals with the evolutionary relationship that exist between different groups of organisms. It tries to determine the organismas and / or groups of organisms, which share common ancestry. The word ‘Systematics’ has been derived from the Latin word ‘Systema’ meaning systematic arrangement of the organisms. Linnaeus has enlisted many plants and animals in his book ‘Systema Naturae’. It helps us to form the phylogenetic tree of life and understand evolutionary history of life.

Concept of Species and Taxonomical Hierarchy

The largest taxonomical group is Kingdom. Kingdom Animalia is divided into 11 animal phyla. Each kingdom is divided into classes and each class into orders and sub-orders. In this descending manner, finally divided into species.

Kingdom

Phylum

Class

Order

Family

Genus

Species

As time passed, more animals discovered. To overcome these difficulties taxonomists introduced sub-kingdom, sub-phylum, sub-classes, super orders, sub-orders, sub-family etc.

1.7.1 Scheme of Classification:

The scheme of classification begins with concept of a species and is a category used in hierarchical classification.

1. **Species** (Plural; species) : Species is defined as a group of individuals, which have the capacity to interbreed amongst themselves to produce fertile offsprings. This is the basic unit of classification and it helps us to understand taxonomy and evolution. Normally, species is the lowest and indivisible taxonomic category, but *Panthera leo* (Lion), *Panthera tigris* (Tiger), *Panthera pardus* (Leopard) are species of the same Genus, Panthera. Asiatic lion is scientifically named as *Panthera leo persica*. Here, persica is the sub-species.

2. **Genus (**Plural, Genera) : Two or more species having common ancestry and similar features are grouped into a genus. Otherwise speaking, a genus is a group of related species with common ancestry. The genus occupies a significant position in classification. In binomial nomenclature, a species cannot be named unless it is assigned to a genus. The genus may be monotypic or polytypic. In monotypic, it has only a single species [e.g.; *Homo sapiens* (Man)]. Conversely in polytypic, it has many species [e.g.; *Panthera leo* (lion), *Panthera tigris* (tiger) *Panthera pardus* (leopard), and *Panthera onca* (jaguar)].

3. **Family :** This category includes one or more related genera and is separated from other related families by important and characteristic differences. The genera *Panthera* (tiger, lion, leopard etc.,) and *Felis* (cat) are included in the same family Felidae. The family, Felidae is quite different from the family Carnivorae (dog, fox, wolf etc.). Both families belong to the same order, Carnivora.

4. **Order** : It is the next higher taxonomic category and includes related families. Families, Felidae (cat), Viverridae (civet), Hyaenidae (hyena), Canidae (dog), Ursidae (bear) are all included in the same order Carnivora.

5. **Class** : This category includes two or more related orders. Orders like insectivore (hedgehog, mole), Chiroptera (bat), Primates (monkey and man), Rodentia (hare and squirrel), Edentata (ant eater), Carnivora (cat and dog), Catacea (whale and dolphin) and Proboscidea (elephant) are included in the class Mammalia.

6. **Phylum or Division** (Plural; phyla) : Classes of different organisms having some common features are included under a phylum or division. The phylum Chordate includes a number of classes like Cyclostomata, Osteichthyses, Chondricthyses, Amphibia, Reptilia, Aves and Mammalia.

7. **Kingdom** : This is the highest taxonomic category. Two or more related phyla come under one kingdom. According to the Linnaean system of classification, all plants come under the Kingdom, Plantae, while all animals come under the Kingdom, Animalia.

1.8. TOOLS FOR STUDY OF TAXONOMY

Correct identification and classification of animals, plants and microbes is of vital importance. It requires methodical and detailed study of organisms in the field as well as in the laboratory. For such taxonomic study, collection of actual specimens of animals and plants is very much essential. The actual specimens are thoroughly studied and their characters enlisted, which then leaders to their correct classification and nomenclature. It requires a thorough training in systematic for carrying out such studies. Procedures and techniques have been formulated for identification, preservation of the biological specimens. The information gathered on such accounts is stored in databases and made available to others. Biologists need the help of some taxonomical tools or aids such as museums, zoos, herbaria and botanical gardens for carrying out such studies.

Museums

Museums are generally set up in educational institutes such as schools and colleges. It contains many preserved specimens of animals and plants. Complete skeletons, disarticulated bones and hard parts of animals and completed animals are preserved. Natural History museums are also set up. Preserved specimens of animals are kept in jars with formalin and alcohol, insects in insect boxes and higher animals are usually preserved as stuffed specimens.

Zoos (Zoological Parks)

Wild live animals are kept in protected places like zoos. They are given natural habitats. The main aims of establishing zoos are for visit of public, behavioral study of animals and breeding of endangered species to increase their populations. Awareness is developed amongst visitors for conservation of wild animals and different forms of biodiversity.

Herbaria

Herbarium is a store house of collected plant species that are dried, pressed and preserved on sheets, which are arranged accordingly to a universally accepted system of classification. These specimen along with their description on herbarium sheets are store house for future use. Herbaria serve as quick referral system in taxonomical studies.

Botanical Gardens

These gardens are dedicated to the collection, cultivation and display of a variety of plants with labeled botanical names and families. The collections are big tree, shrubs, herbs, different cactus and aquatic species. Towers, educational displays, art exhibitions, open – air theatrical and musical performances are conducted in these gardens.

QUESTIONS

Objective type questions

Choose the correct answer from the choices, give under each bit:

1. Who is referred as the 'Father of Taxonomy' ?
   (i) W.G.Rosen (ii) E.O.Wilson
   (iii) John Ray (iv) Carolus Linnaeus
2. Who proposed the three domain system of biological classification ?
   (i) Carl Woese (ii) R.H.Whittaker
   (iii) Charles Darwin (iv) Robert Hooke
3. The scientific names are derived from which language ?
   (i) English (ii) French
   (iii) Latin (iv) Greek
4. Who proposed Binomial nomenclature ?
   (i) Carolus Linnaes (ii) R.H.Whittaker
   (iii) J.B.Larmarck (iv) J.B.S. Haldane
5. Name the botanical garden present in Calcutta ?
   (i) Lal Bagh (ii) Empress Garden
   (iii) Indian Botanical Garden (iv) Malampuzha garden

6. Richness of the living species on earth is termed as :

(i) Ecosystem (ii) Community

(iii) Biodiversity (iv) Population

7. Which of the following is the energy currency of the cell ?

(i) ADP (ii) ATP

(iii) DNA (iv) RNA

8. Who wrote the book ‘Systema Naturae’ ?

(i) Charak (ii) Linnaeus

(iii) John Ray (iv) T.H.Morgan

9. Which is the basic unit of classification ?

(i) Genus (ii) Species

(iii) Kingdom (iv) Sub – species

10. The first phylogenetic system of classification was given by :

(i) Hutchinson (ii) Linnaeus

(iii) Bentham and Hooker (iv) Engler and Prant

2. Give the answer in one or more words :

1. In which kingdom, unicellular eukaryotes are placed ?

2. Who is the father of Zooloy ?

3. Who was the first to observe bacteria ?

4. The study of the evolutionary history of a species or a group of species is called as ?

5. Who proposed the two kingdom classification ?

3. Differentiate between :

a. Anabolism and Catabolism

b. Museum and Herbarious

c. Genus and Species

d. Phylogeny and Ontogeny

e. Artificial and Natural System of classification

f. Plantae and Animalia.

4. Fill in the blanks :

a. A group of related genera are classified as _____.

b. The common features of species within a genus are known as _____

c. Actinomycetes belong to the kingdom _____

d. The largest aquarium in India is _____ aquarium.

e. The Father of Botany is _____

LONG QUESTIONS

1. Enumerate the characteristics of living organism.
2. Give an account of three domains of life
3. Write an essay on scheme of classification
4. Describe the different tools for taxonomic study

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UNIT –II

MODULE

I b.

Salent features & classified of animals non-chandidates up to plyla level.

According to 5 kingdom classification by R.H. Whittakar (1969) kingdom protista is divided into five phyla which together are referred to as Phylum

1. **Phylum – Phytoflagellata (Plant flagellates)**

   Members of this phylum bear one or more flagella. They are autotrophs & capable of photosynthesis due to presence of chlorophyll.

   Example : Euglena, Chlamydomonas, Volvax.

2. **Phylum – Zooflagellata (Animal flagellates)** members of this phylum have one or more flagella. They are without chlorophyll.

   They devour their food by phagocylosis or absorb the nutrients through their body wall.

   Example : Trypanosoma, Leishmania, Giardia.

3. **Phylum – Sarcodina**

   Pserdopodia are produced during locomotion. Heterotrophic nutrition. Intake of food by phagocylosis. Example – Amoeba, Entamoeba.

4. **Phylum Ciliophera.**

They have cilia used for locomotion.

Heterotrophic nutrition & food is ingested by phagocytosis. Siggle eukaryotic cell containing a macronucleus & micronucleus.

Ex- Paramecium, Vorticella, Suctoria.

Phylum – Sporozoa.

These are parasites. No locomotory structure. More by wriggling movement of the body. They reproduce by producing numerous spores.

Ex – Plasmodium, Monocystis

The kingdom Animalia is divided into two sub kingdoms Parazoa & Metazoa.

Sub – Kingdom Parazoa

Phylum Porifera :

These are popularly called sponges. Body wall consist of two layers outer pinacoderm & inner choanoderm. Two are cemented by a mesenchyme. Spicules present. Asexual reproduction by budding & gemmule.

Ex- Sycon, Spongilla, Euspongia.

Sub- kingdom metazoan : It is divided into two grades such as Radiata and Bilateria.

Gracle, Rad:ata:

Phylum Coelentereta :

These are diploblastic animals, outer ectoderm & inner endoderm cemented together by mesoglea. Two types of forms polyp & medusa exist. Tentacles with nematoblasts. Gastro-vascular cavity without anus.

Ex- Hydra, Obelia, Aurelia.

Gracle II, Bilateria: On the basis of presence or absence of coelom divided into three groups.

Groups I, Acoelomata.

Phylum Platyhelminthes :

Mostly endoparasitic animals known as flat worms.

Suckers & hooks for clinging. Excretory system consists of protonephridia.

Ex-Planaria, Fasciola, Taenia.

Group II, Pseudocoelomata.

Phylum Nemathelminthes :

It includes animals known as roundworms. Ectoderm is syncytial. Most are endoparasites. Ex-Ascaris, Hook worm.

Group III, Coelomata. It is divided into Protostomia and Deuterostomia based on nature & origin of coelom.

a) **Protostomia:** It includes three phyla characterized by schizocoetic coelom.

1. Phylum Annelida :

Body is metamerically segmented. First body segment is known as peristomium. Setae present. Excretion by nephridia and Chloragogen cells.

Ex-Earthworm, Nereis, Leech.

2. Phylum Arthropoda :

Paired jointed appendages. Body divided into head, thorax & abdomen, cuticle made of chitin. Respiration by gills, trachea, book lungs. Double ventral nere cord.

Ex-Palaeman, Crab, Scorpion.

3. Phylum Mollusca :

Body divided into head, foot & visceral mass. Mantle secretes shell. Sense organs like tentacle, eyes, osphradium present. In Pila torsion takes place.

Ex-Pila, Unio, Octopus.

b) Deuterostomia : under it three phyla are present. Coelom is enterocoelic.

1. Phylum Echinodernmata :

Marine animals having pentamerious radial sysmmetry. The skin bears spines & dermal ossicles. Water vascular system with tube feet. Haemal system is of open type. Larval forms as bipinnaria, pluteus etc., Ex- Star fish, sea lily, sea cucumber.

2. Phylum Hemicherdata:

Body is vermiform, divided into proboscis collar & trunk. Buccal diverticulum present. Presence of pharyngeal gill slits. Larval form is tornaria larva.

Ex- Balanoglossis, Saccoglossus.

3. Phylum chordate : It is divided into three sub-phyla.

a) Subphylum Urochordata : Body is covered with attest of tunicin. Notochord is present in larval form Retrogressive metamorphosis takes place.

Ex- Herdmania, Botryllus.

b) **Sub-phylum Cephalochordate :** Notochord extents along the length of the body. Pharynx with endostyle and dorsal lamina.

Ex- Amphioxus

c) **Sub- phylum vertebrata or chordate :** It is divided into two super-classes.

Super –class Agnatha : These are jaw-less vertebrates.

Divided into two classes.

Class cyclostomata : These are marine jaw-less vertebrates. Body is eel-like, Larval stage is ammocoetes. Ex-Petromyzon, myxine.

Super – class Gnathostomata : Paired appendages are present. It is divided into two series.

Series, Pisces : Body covered by dermal scales. Fins present. Internal gills. It is divided into first three classes which are extinct & four living classes.

PISCES

First 3 classes are Extinct	Class IV Elasmobranchi e.g.; Scoliodon Torpedo	Class V Holocephali e.g.; cat fish	Class VI Dipnoi e.g;Potopterus Lepidosren	Class VII Teleostomi All bony fishes

Series Tetrapod on : Two pairs of limbs present. Limbs are pentadactyle. It includes four classes.

1. **Class Amplibia :** Skin smooth & moist with mucous glands, no scale. It is amphibious in habit. Respiration is cutaneous, buco-pharyngeal & pulmonany. There is a cloaca. Ex-Frog, Toad.
2. **Class Reptilia ;** Skin covered by epidenmal scales Respiration pulmonary. Heart three chambered. Cold blooded animals. Shelled cledoic eggs are laid on land.

   Ex-Wall lizard, Turtie, Snake.
3. **Class Aves :** Body covered by feathers. Horny beak present, no teeth. Forelimbs modified as wings. A voice box, syrinx is present.

   Ex- Crow, Parrot, Peacock.
4. **Class mammalian :** The skin is hairy bearing sebaceous & sweat glands. Mammary glands present. External ear present. Heart is fair chambered.

   All are viviparous except Platypus.

5. Ex-Human being, Porcupine, Whale

Sample questions

Q. 1. Choose the connect answer :

i) Spicules are present in the animals of the phylum.

a) Porifera b) Annelida c) Coelentereta d) Protozoa

ii) Find out the diploblastic animal

a) Obelia b) Earthworm c) Nereis d) Fasciola

iii) Class Aves includes animals with

a) Scales b) Hair c) Feathers d) Moist skin

iv) The chief distinguishing feature of mammal is

a) Pinna & teeth b) Hairy skin & oviparity c) Mammary gland & teeth

d) Mammary gland & hair

v) Viviparily is not seen in which animal ?

a) Bat b) Platypus c) Monkey d) Whale.

Q.2. Answer following in one or more words, whenever necessary :

i) Give an example of a diploblastic animal

ii) In which phylum mantle is present

iii) In which phylum medusa is present ?

iv) Platypus belongs to which class ?

v) Two important features of class Aves are:

Q.3. Differentiate between two :

i) Urochordata & Cephalochordata

ii) Amphibia & Reptilia

iii) Annelida & Anthropoda

iv) Non-chordata & chordate

v) Acroanata & Craniata.

◆◆◆

UNIT III

ANIMAL TISSUES

Epithelial tissue : These cells are closely placed without inter-cellular space & matrix. Cells are placed in basement membrane. Based an number of layers, it is two types. 1. Simple Epithelium – It is formed of single layer of cells. These are 9 type.

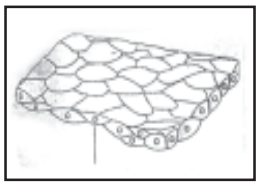


Fig. 1: Squamous Present in walls of blood cells & air sacs of lungs

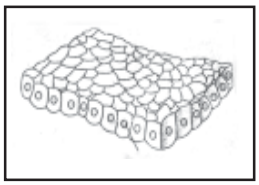


Fig. 2: Cuboidal present in ducts of glands & tubular parts of nephrons

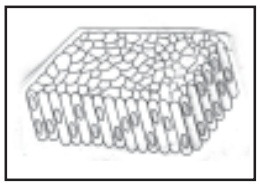


Fig. 3: Columnar present in living of stomach & intestine

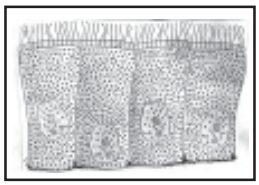


Fig. 4: Ciliated present in inner surface of bronchioles & fallopian tubes.

5. Glandular. They are Unicellular & multicellular. According to nature of secretion glands are serous, mucous & mixed. According to mode of secretion merocrine, apocrine & holocrine. According to presence of ducts, ductless glands are endocrine and exocrine glands are with ducts.

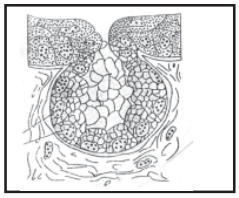


Fig. 5 Glandular

6. Germinal Epittelium present in testis & Ovarian follicles.
7. Pigment epithelium present in retina of eye.
8. Sensory epithelium innervated by a nerve fibre.
9. Pseudo stratified, they are ciliated present in nasophorynx. 2, Compound or Stratified epithelium – It has two or more loyers of epithelial cells. It is classified as squa, mous, cuboidal, columnar. Columnar ciliated transitional according to shape of cells of the surface layer. Stratified squamous epithelium is two types : non-keratinized & keratinized present in lining of oral cavity, vagina & palm & sole. Stratified cubodial are present in living of ducts of salivary gland & pancreas stratified columnar is present in lining of larynx, pharynx, stratified columnar ciliated present in lining of soft palate.

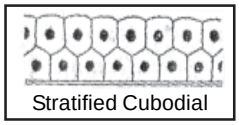


Fig. 6

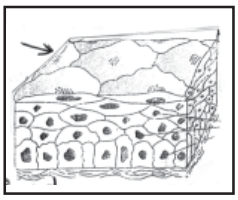


Fig. 8

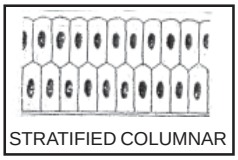


Fig. 9

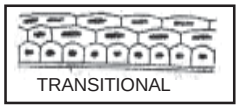


Fig. 7

Transitional epithelium present in wall of distended urinary bladder.

Connective tissue : It consists of diffrent kinds of cells and inter-cellular material or matrix. Matrix consist of connective tissue fibers, ground substance & tissue fluid. It is of 3 types.

1. Connective tissue proper, 2. Skeletal connective tissue 3. Fluid connective tissue.

1. Connective tissue proper : Here matrix is soft, jelly-like. It is 3 types :

i) Loose (Areolar) found below the skin & around blood vessels, nerves, muscles, in wall of alimentary canal. Cells found here are fibroblast, macrophages, must cells, plasma cells, lymphocytes, adipose cells, eosinophils. Fibers are collagenous fibers, reticulum fibers, yellow elastic fibers.

ii) Dense connective tissue : The cells are few & ground substance is less. It is of two types – Irregular dense present in dermis & sheaths of organs. Regular dense present intendon & ligament.

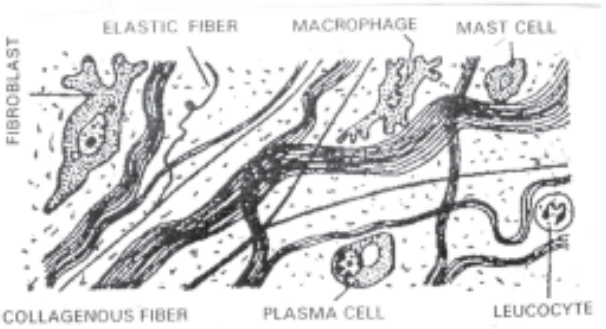


Fig. 10: Loose (areola) connective tissue

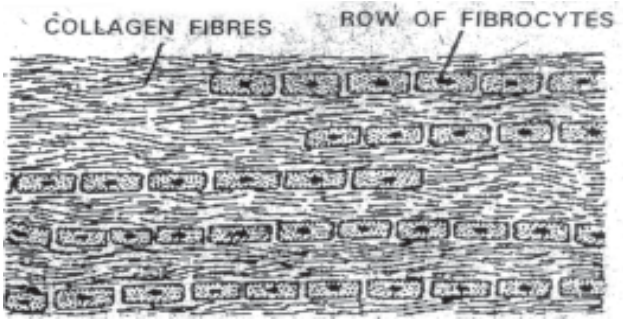


Fig. 11: Dense fibrous connective tissue

iii) Reticular connective tissue : Here reticular cells & reticular fibers are presnt. Present in lymphoid tissue & bone marrow.

iv) Adipose tissue : It is an aggregate of adipocytes. Adipocytes with reticular fibers present in subcutaneous tissue.

v) Pigmented connective tissue have melanin present in iris of eye.

2. Skeletal connective tissue : It is divided into cartilage & bone.

i) Cartilage – it consists of cells, fibers & matrix. Cells are called chondrocytes which secrete intercellular matrix chondrin. Cartilage are of three types hyalin, elastic & fibrocartilage. Articular surface of long bones, end of rib, nose, trachea are all hyaline cartilage. Hyaline cartilage looks bluish white covered by perichondrium. Elastic cartilage is flexible present in external ear, epiglottis. Fibro cartilage present in inter vertebral disc, public symphysis

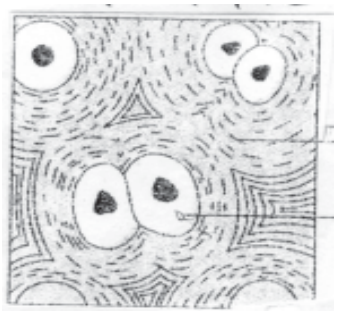


Fig. 12

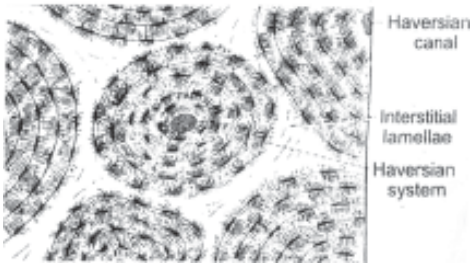


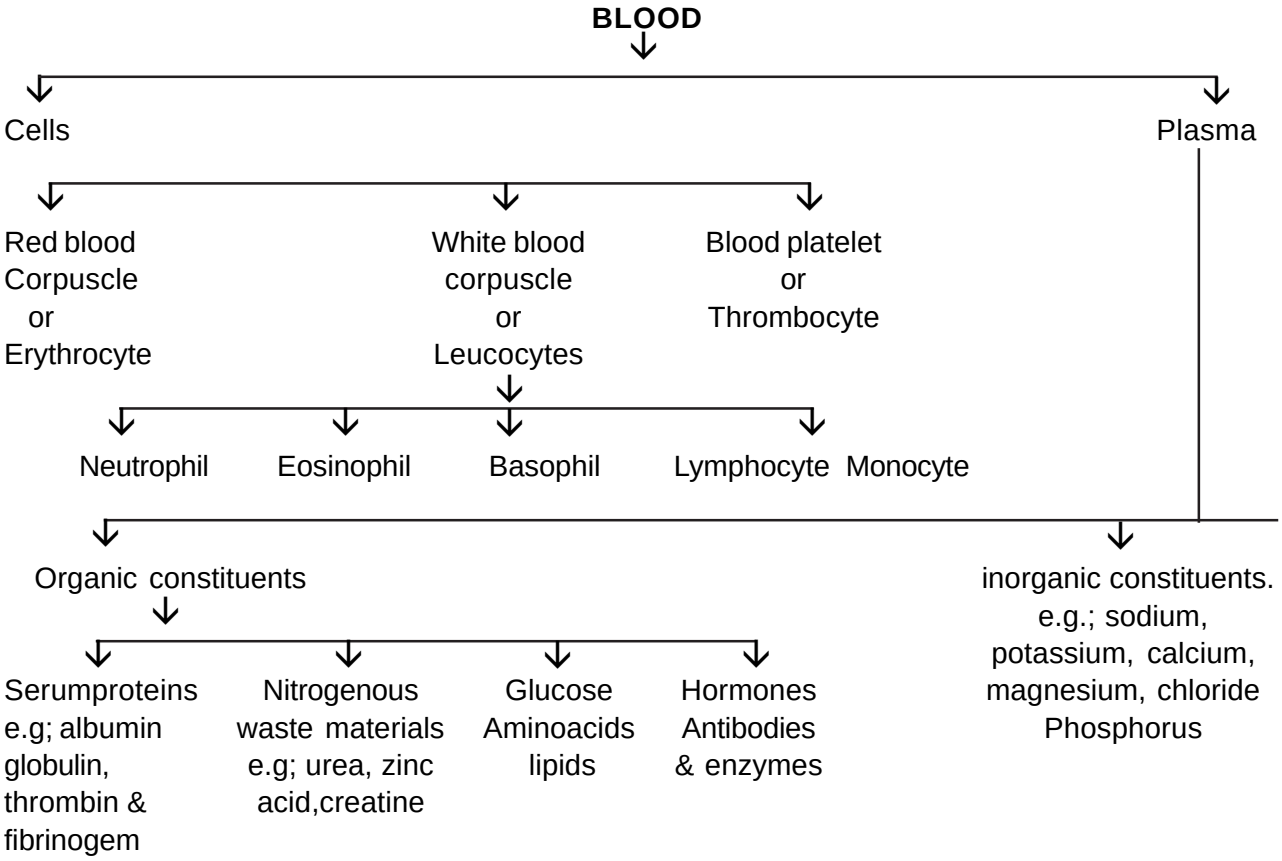
Fig. 13

ii) Bone – It contains bone cells, fibers & matrix. Bone cells called osteocytes, lie inside a lacuna. Lacunae spreads out branching canaliculi. Matrix of bone is made of ossein. Two types of bones:

a) Chancellous bone which are spongy & consist of trabeculae. Each trabeculus. Each trabeculus consists of number of lamellae containing asteocyles.

b) Compact bone where lamellae are compact. It is covered by tough sheath Periosteum. Inner hollow cavity is marrow cavity, which is lined by endosteum. The haversian system is uniqueness of compact bone. It consist of rings of lamellae. Each lamellae contains osteoytes, trapped in lacunae. Canaliculi radiate from lacunae. The lamellae surround a canal called Haversian canal. The haversian canals are interconnected by volkmann's canals. Bone matrix consists of collagen fibers & organic and inorganic compounds.

3. Fluid connective tissue : it includes blood & lymph. Here different types of corpuscles are suspended in fluid matrix known as plasma. Fibers are absent.



Lymph – It is a colourless fluid filtrate of blood capillaries. It circulates in lymphatic vessels. Details of blood refer to Unit V (c)

Muscular tissue : It is made up of muscle cells or myocytes. Cytoplasn of myocyte is sarcoplasm which is covered by sarcolemma. Three kinds of muscles are smooth, skeletal & cardiac. Smooth muscle cells form bundles known as fasciculi. They are involuntary, unstriped, nonstriated present in wall of alimentary canal, urinary bladder. Skeletal muscle surround by epimysium.

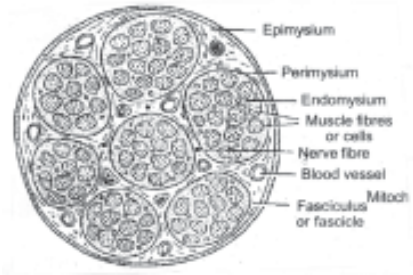


Fig. 14: Three levels of organization (muscle → muscle fiber →myofibril → myofilament) of skeletal muscle with respective connective tissue sheaths

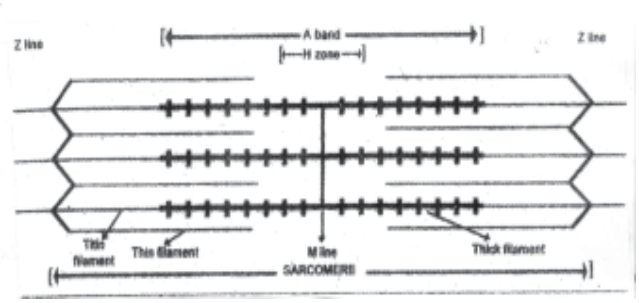


Fig. 15: Organization of a sarcomere with titin filaments anchoring thick (myosin) filaments to Z-lines

A muscle fiber is made myofibrils which consists of two types of protein myofilaments : actin & myosin. The role of these proteins discussed in unit v (e). Myofibril are striated due to presence of alternate dank (A) & light (I) bands. The arrangement of myosin & action filament with alternating A & I bands imparts striated appearance to skeletal muscle which is voluntary.

Cardiac muscle : Present in wall of heart. They are striated in appearance & involuntary. Here the fibers are branched which anastomoise to from intercalated disc. Its muscle cell has central nucleus. Like skeletal muscle myofilaments have myosin and action filaments.

Fig. 16: Cardiac muscle

Nervous tissue : It is made up of tissue that is specialized for conducting impulses. Neurons' are units of nervous system. Neuroglia are non conducting supporting cells of the CNS.

Structure of neuron – It consists of a cell body that gives off neuritis. Cell body has nucleus, missile body. Neuritis are axon & Dendron. When axon is covered with a sheath it called nerve fiber. Nerve fibers are myeinated & non-myelinated. Axons associate with Schwann cells. Due to myelin sheath there is node & inter node. Axon forms a junction with dendrite of another neuron known as synapse. Basing on number of neuritis there are four types of neurons. (Fig) sensory neurons carry impulses from sense organic to CNS motor neurons carry impulses from CNS to effectors (muscle and glands).

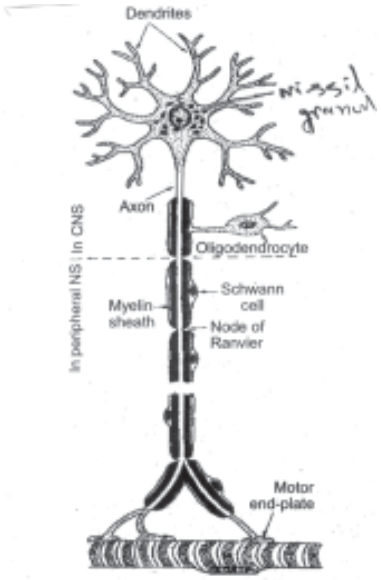


Fig. 17: A neuron exhibiting the structures both of the CNS (see above the broken line) and PNS (see below the broken line).

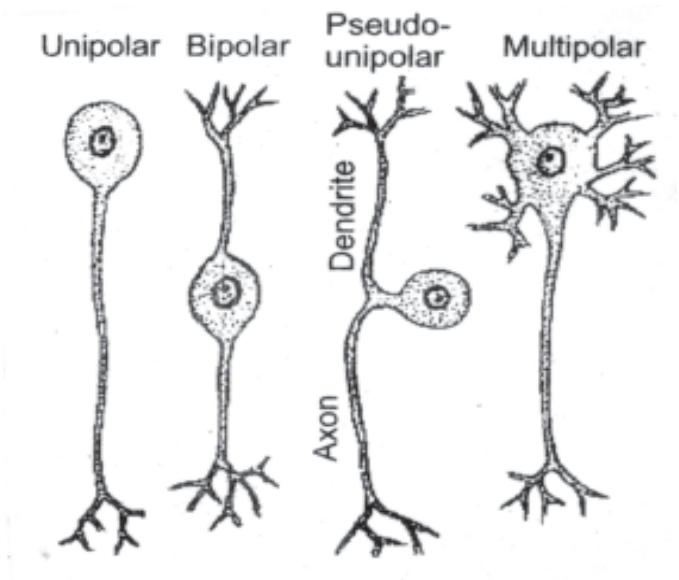


Fig. 18: Types of neurons based on the number of neurities.

COCKROACH : Included under class insect of phylum-Arthropoda. Body divided into head, thorax, abdomen. Abdomen has 10 segments. Head has a pair of compound eyes, antennae & mouth parts. Thorax bears a pair of wings & three pairs of walking legs. Abdomen in male has a pair of anal styles absent in female. In both sexes 10^{th} abdominal segment bears a paid of anal cerci.

Digestive system : Alimentary canal divided into foregut, midget & hindgut. Foregut comprised of mount, pharynx, oesophagus, crop & gizzard. Digestive glands are salivary glands, hepatic caecae.
Respiratory system : Consists of trochea, that open through 10 pairs of spiracles.

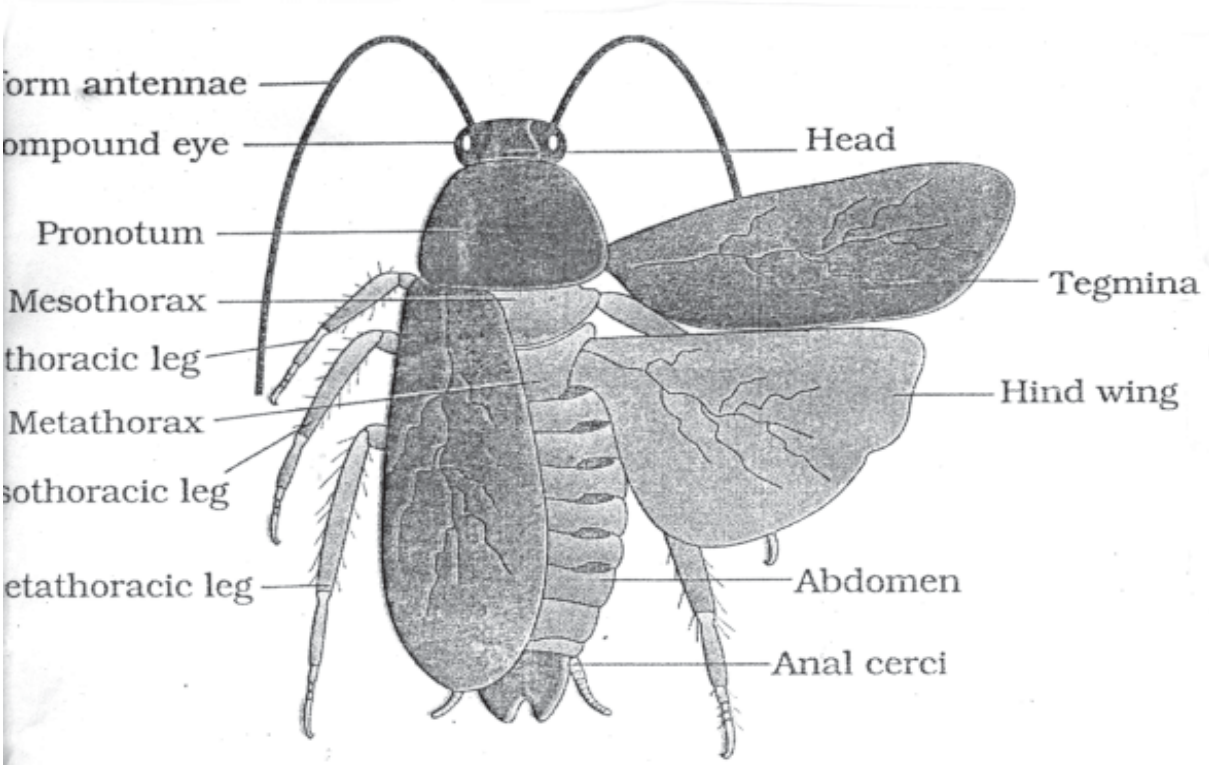


Fig. 19: External features of cockroach

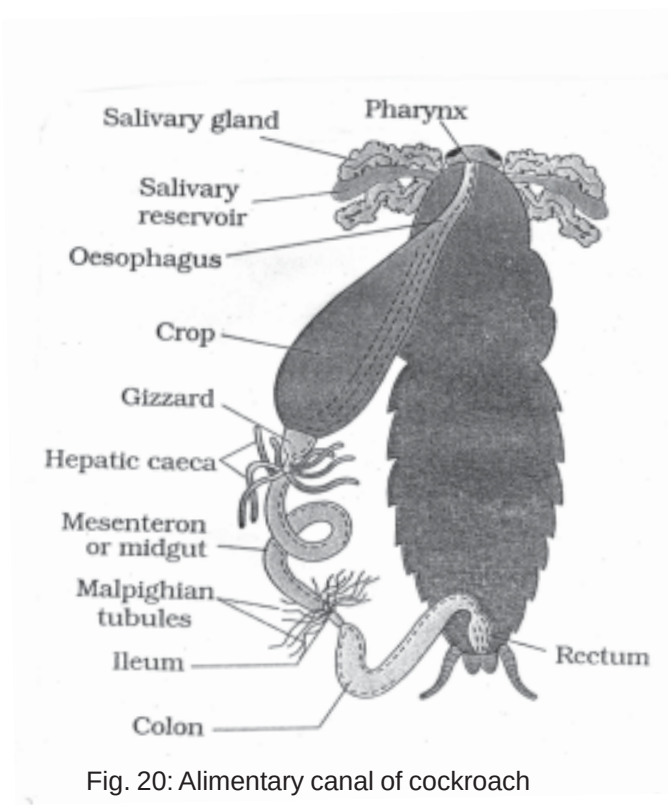


Fig. 20: Alimentary canal of cockroach

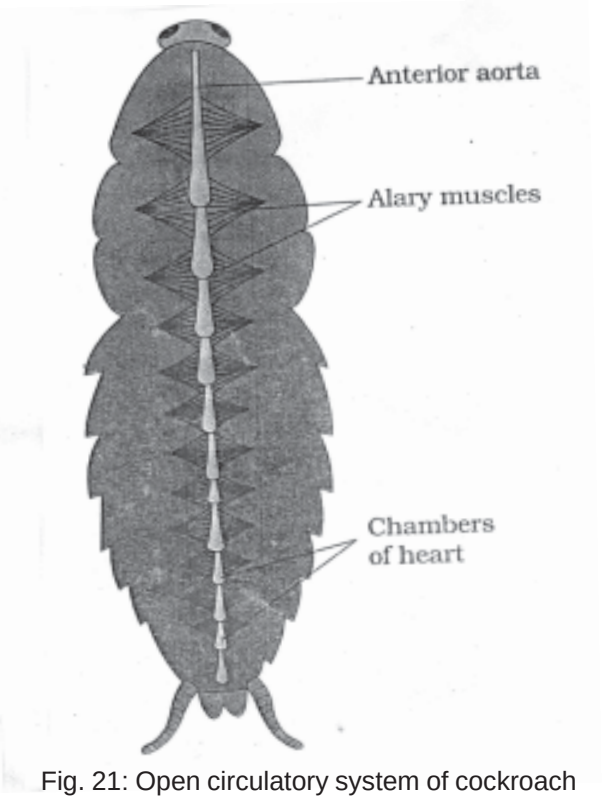


Fig. 21: Open circulatory system of cockroach

The trachea divide into tracheoles. Exchange of gases by tracheoles in simple diffusion.

Cardio-vascular system : Cockroach has open circulation. Blood vessels open into haemocoel. Body fluid known as haemolymph composed of colourless plasma & haemocytes. Hearts consists

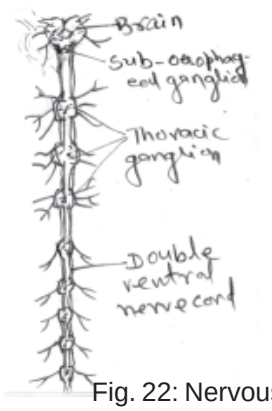
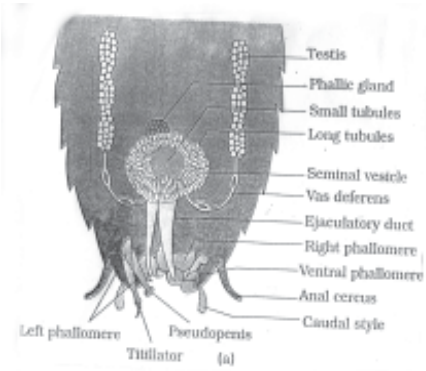


Fig. 22: Nervous System of Cockroach



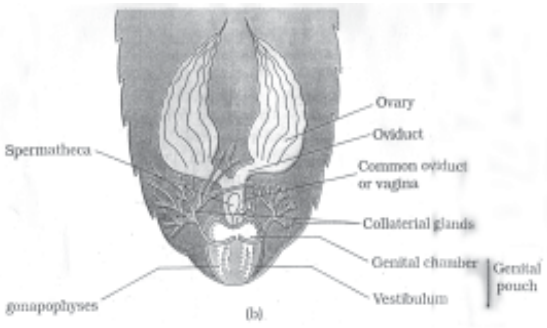


Fig. 23:

of thirteen contractile chambers. Blood from sinuses enter heart through ostia is pumped arterially to sinuses again.

Nervous system : Head consists a pair of supraoesophageal ganglia or brain from it Two circum oesophagal. Connective arise & join with sub oesophageal ganglion below oesophagus. A double ventral nerve cord arise from it. Nerve cord has 3 large thoracic ganglia. There are 5 small ganglia & 6th abdominal gangli is largest. Nerves arise from CNS & supply to different parts.

Reproductive system : Cockroach are dioecious male reproductive organs consist of a pair of testes, from it vas deferens arise opens into ejaculatory duct through seminal vesicle. Mushroom gland is present. Female reproductive organs are a pair of large ovaries formed of ovarioles. Oviducts of each ovary unite into median oviduct.

Sample questions

Q1. Choose the correct answer :

i) Non-cellular basement membrane is a feature of :

a) Nervous tissue b) Vascular tissue c) epithelial tissue d) Connective tissue

ii) Voluntary muscle is present in

a) Lung b) Liver c) Heart d) Hind limb

iii) Schwann cells & nodes of Ranvier are present in

a) Bone cells b) Neurons c) muscle cells d) Chondrocytes

iv) Transitional epithelium is found in

a) Kidney b) Urinary bladder c) Trachea d) Blood vessel

v) Larynx & trachea contain

a) Hyaline cartilage b) Elastic cartilage c) Bone d) Fibro cartilage

vi) Which type of connective tissue is a tendon ?

a) Dense b) Loose c) Fluid d) Skeletal

vii) Intercalated disc is found in :

a) Neuron b) Skeletal muscle c) Cardiac muscle d) Junction of muscle

viii) In cockroach number of spiracles are

a) 8 pairs b) 10 pairs c) 12 pairs d) 14 pairs

ix) Cockroach respires by:

a) Cuticle b) Lungs c) Trachea d) Back lung

x) Muscles associated with heart of cockroach are

a) Pericardial muscles b) Spiral muscles c) Alary muscles d)Trego-sternal muscles

Q2. Fill in the blanks with appropriate words :

i) Junction of two neurons is called _____

ii) _____ is the structural functional unit of nerve.

iii) Nissil granules are found in _____

iv) Heart contains _____ muscle

v) Haversian canal is found in _____

Q3. Differentiate between the following :

i) Axon & Dendron

ii) Ii) Cartilage & Bone

iii) Muscle cell & nerve cell

iv) Striated muscle & non-striated muscle

v) Epithelial tissue & connective tissue.

◆◆◆

UNIT - IV

HUMAN PHYSIOLOGY

DIGESTION AND ABSORPTION

Alimentary canal of man : It consists of 1 .Mouth 2. Buccal cavity 3. Pharynx 4. Oesophagus 5. Stomach 6. Small intestine 7. Large intestine 8. Rectum 9. Anal canal 10. Anu S. Mouth opens into buccal cavity which has palate, tongue, teeth (32 nos.) and three pairs of salivary glands. It opens into pharynx which divided into nasopharynx, oropharynx, laryngopharynx. It opens into oesophagus through gullet to larynx through glottis. The oesophagus conducts food to stomach by successive contraction and relaxation of muscle layers of oesophageal wall. This phenomenon is known as peristalsis. The stomach has four regions cardiac, fundus, body, pyloric. Small intestine is divided into duodenum, jejunum & ileum. The opening of ileum into caecum is guarded by ilea-caecal valve. Large intestine consists of caceum, colon & rectum. The caecum is extended as vermiform appendix. Cellulose digesting bacteria are present which digest cellulose Peyer's patches are present in small intestine. Histologically alimentary canal consists of 4 primary layers : outer most serosa, muscular layer, submucasa, innermost mucosa.

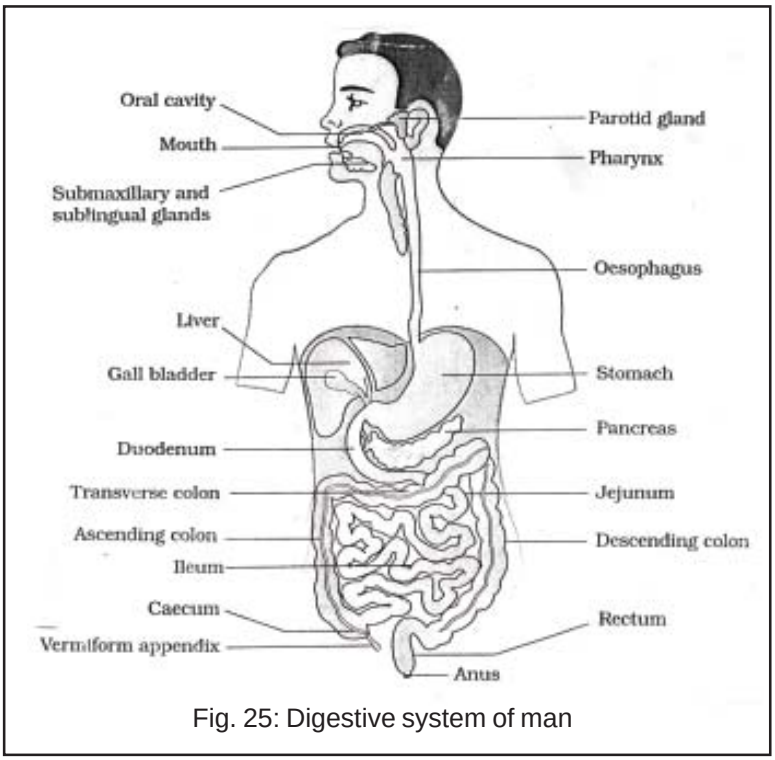


Fig. 25: Digestive system of man

Digestive glands secrete digestive juices for digestion of food. They are – Salivary glands – Saliva, Gastric glands – gastric juice, intestinal glands- succus entericus, Brunnerus glands – mucous, pancreati juice, liver-bile.

Pancreas – It is the second largest gland, functions as both exocrine & endocrine gland. The endocrine part consists of islets of Langerhans. The exocrine part formed of lobules. Lobules secrete pancreatic juice. The pancreatic juice helps in digestion of food.

Liver – It is the largest gland of the body. It is divided into two lobes - large right lobe and small Left lobe. Gall bladder present on lower surface of right lobe, stores bile. Common bile duct & pancreatic duct forms hepato-pancreativc duct opens into duodenum. Liver is made up of hepatic lobules. Bile

helps in emulsification of fats. Glycogenesis. Glycogenolysis, gluconeogenesis takes place in liver. Heparin is formed in liver.

Digestion of carbohydrates – in oral cavity saliva present contains ptyalin.

Starch $\xrightarrow{\text{Ptyalin}}$ Maltose + Maltotriose

In stomach gastric juice is secreted. Here no enzyme is secreted to digest starch. When chyme reaches duodenum it mixes with pancreatic juice. This juice contains pancreatic amylase which hydrolyses chyme to maltose. Now maltose comes to small intestine which mixes with four enzymes- sucrose, maltose, lactase, isomaltose.

Sucrose $\xrightarrow{\text{Sucrase}}$ Glucose + Galactose
Maltose $\xrightarrow{\text{Maltase}}$ Glucose + Glucose
Lactose $\xrightarrow{\text{Lactase}}$ Glucose + Galactose

Digestion of Proteins – As soon as food reaches stomach, hormone gastrin is secreted by mucosa of pyloric antrum which stimulates gastric glands to produce gastric juice. It contain pepsinogen enzyme.

Pepsinogen (Inactive) $\xrightarrow[\text{oxyntic cells of gastric gland.}]{\text{HCL form pepsin}}$ Pepsin (active)

Protein $\xrightarrow{\text{pepsin}}$ Proteoses + Peptones & Polypeptides

Prorennin $\xrightarrow{\text{HCl}}$ Rennin

Casein $\xrightarrow{\text{Rennin}}$ paracasein

Paracasein + Calcium – Calcium panacaseinate

Calciumparacaseinate $\xrightarrow{\text{pepsin}}$ peptone

When chyme reach duodenum it mixes with pancreatic juice. It contains several proenzymes.

Trypsiongen (Inactive) $\xrightarrow{\text{Enterokinase}}$ Trypsin (Active) $\xrightarrow[\text{and Polypeptide}]{\text{Proteins and Peptones}}$ Trypsin and Chymotrypsin

Chymatripsinogen (Inactive) $\xrightarrow{\text{trypsin}}$ Chymotrypsin (Active)

Procarboxypeptidase (Inactive) $\xrightarrow{\text{Trypsion}}$ Carboxpeptidase (Active)

Proteose + Peptone + Polypeptides $\xrightarrow[\text{chymotrypsin}]{\text{Trypsin}}$ Small peptides $\xrightarrow{\text{Carboxpeptidase}}$ Amino acid

Small intestine secretes intestinal juice succus entericus which contains peptidases. They hydrolyze peptide bonds small polypeptides.

Small Polypeptides aminopeptidase Amino acids

Dipeptids Dipeptidase Amino acids

Digestion of Fats : In stomach, gastric lipase is weak fat splitting enzyme. In small intestine, duodenum receives bile & pancreatic juice. Bile salts emulsify fats globules. Pancreatic lipase acts on fat globules.

Emulsified fats $\xrightarrow[\text{and enterice enzymes}]{\text{Pancreatic lipase}}$ Fatty acids + Glycerd In micelles Dissolved

Absorption – No absorption of glucose, amino acids & fatty acids inmouth & stomach, mainly takes place in small intestive.

Absorption of carbohydrates as monosaccharides.

Fructose carried down by facilitated tronsport. Glucose & galactose by carrier proteins. A carrier protein with one receptor site for glucose & other for sodium ion present on brush boarder of epithelial cells. Absorption of proteins : - Absorption of amino acids takes place by same principle of sodium co-transport theory. Four types of carrier proteins are used to transport aminoacids.

Absorption of fats : Micelles are absorbed through carriers. Short chain fatty acids pass directly into lacteals. All esterified products form chylomicrons which are absorbed directly into lymph vessels.

Assimilation – The required amount of absorbed food is transported from blood to the tissues of different parts. Caloric value for one gram of carbohydrate is 4.1 k.cal. For one gram of protein is 4.1 k.cal & for one gram of lipid is 9.3 kcal. Egestion is elimination of undigested residual food.

Source of all digestive enzymes are saliva, pancreatic juice, Gastric juice, intestinal juice. Gastro – intestinal hormones are Gastrin, Cholecystokinin, panerezymin & secretin, Malnutrition leads to protein energy malnutrition. Two diseases due to PEM are marasmus and kwashiorkor. Indigestion or Dyspepsia is a condition in which food is not properly digested. The disorder constipation is caused when faeces in retcum is not removed properly. Vomiting takes place due to violent contraction of stomach. Jaundice is a yellowish pigmentation of skin caused by high blood bilirubin level. Diarrhoea is caused due to infection of intestive by virus or bacteria or parasite.

Sample Questions

Q.1. Choose the correct answer : -

i) Which gland functions as both exocrine & endocrine glands ?
   a) Salivany gland b) Gastric gland c) Pancreas d) liver
ii) The end product of fat digestion are fatty acids &
   a) Cholesterol b) Glycerol c) Phosphoric d) Glycolipid
iii) Gastrin is secreted from mucosa of
   a) Antrum b) Body c) Fundus d) Pylorus
iv) Kwashiorkar is caused due to deficiency of
   a) Carbolydrates b) lipids c) Vitamins d) Protein

Q.2. Fill in the blanks with appropriate words : -

i) The gastro – intestinal hormone that stimulates secretion of enzymes into the pancreatic juice is known as _____

ii) There are _____ pairs of salivary glands in human

iii) Bile is secreted by _____ & stored in _____

iv) Intestinal juice is known as _____

v) The yellow colour of stool is due to presence of a pigment _____

Q.3. Write short notes on –

a) Gastric glands

b) Gastro – intestinal hormones

c) Jaundice

d) Protein deficiency disorders

e) Peyer's patches.

◆◆◆

UNIT V
BREATHING & RESPIRATION

Modes of respiration are four depending on the organs

Cutaneous respiration – Here respiration takes place through skin or integument or body wall. In earthworm, the skin is thin, moist & supplied with minute capillaries. By diffusion gaseous exchange occurs. In frogs. cutaneous respiration accounts for about 25% of bodys oxygen requirement.

Tracheal respiration – This type of respiration is seen in insects, centepedes & millipedes. It consists of tracheae & their branches atracheates. They carry 0_2 to the tissues directly. The air enters into the system through stigmata or spiracles present on the lateral sides of the body. Typical example in cockroach, there are ten pairs of spiracles. By alternative contraction & relaxatation of tergo. sterna muscles expiration & inspiration takes place.

Branchial respiration – Highly vascularised gills present in sea stars, crustaceans, many amphibian larvae & all fishes. Gills are of two types external & internal. Internal gills are enclosed in a bronchial cavity covered by an operculum. In bony fishes gills are filliform where as in cartilaginous fish gills are lamelli branch.

Pulmonary respiration – Here respiratory organ is lungs. Two types of lungs. I) diffusion lungs found in snails, some spiders ii) ventilation lungs present in vertebrates.

Respiratory system in Human :

The respiratory tract begins with nose having external nostrils larynx trachea bronchi bronchioles alveoli.

The air ways beyond larynx can be divided into two zones : the conducting zone from trachea to terminal bronchiole and the respiratory zone from the respiratory bronchiole to the alveolar ducts.

Mechanism of breathing : Inspiration & expiration together constitute breathing. Inspiration is an active process which is brought about by contraction of external intercostals muscle & relaxation of internal

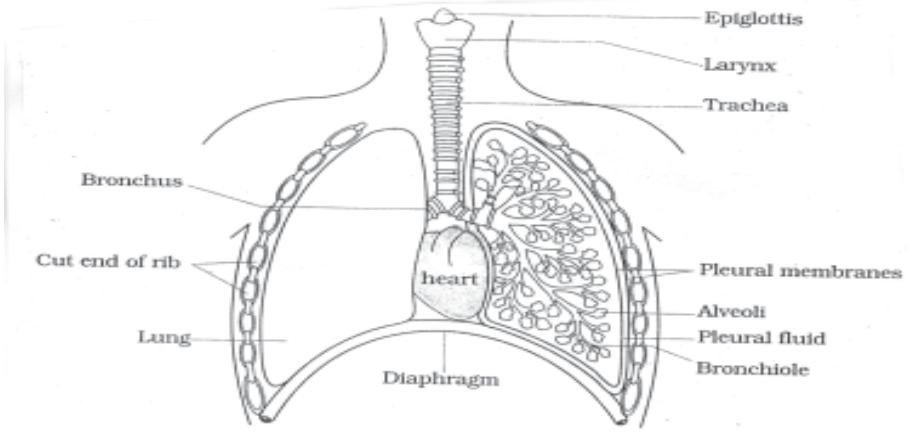


Fig. 26: Diagrammatic view of human respiratory system (Sectional view of the left lung is also shown)

intercostals muscle. Expiration is a passive process. Here events are reversal. Control of breathing involuntary control is brought by breathing center located in pons and medulla oblongata of brain. It has inspiratory & expiratory centre.

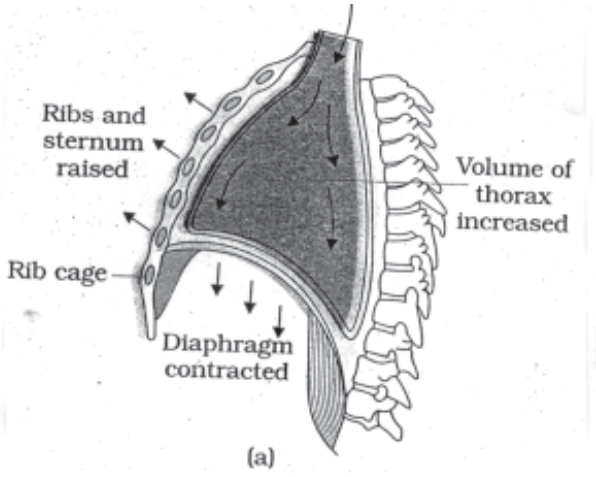


Fig. 27 (a) Air entering lungs

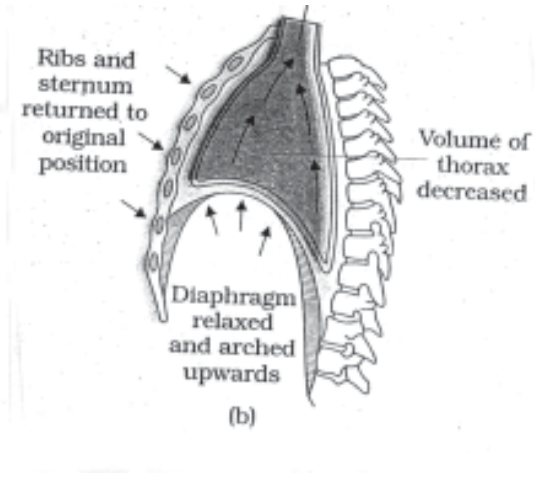


Fig. 27 (b) Air expelled from lungs

Exhange of gases – Alevoli are primary sites of exchange of goes. 0_2 & CO_2 are exchanged between blood & tissues by diffusion based on concentration gradient.

Transport of gases – Oxygen is transported from lungs to different parts of body & CO_2 from different parts of body to lungs.

Transport of 0_2 – It is transported by blood in two forms i) As dissolved oxygen ii) As oxyhaemoglobin. The quantitative relationship between percentage is artificiation of haemo globin & PO_2 is presented by oxygen dissociation curve.

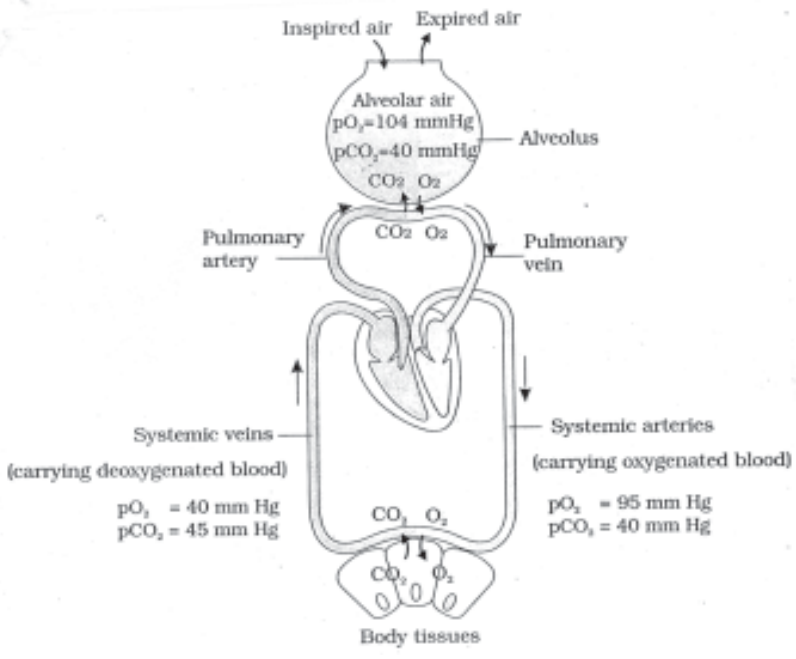


Fig. 28: Gaseows exchange of blood

Transport of carbon dioxide : Occurs in three major forms. i) As dissoloved carbon dioxide ii) As carbamino – haemoglobin iii) As bicarbonates.

$CO_2 + H_2O$ Carbonic anhydrate H_2CO_3 Carbonic anhydrate $HCO_3^- + H^+$

Two process, chloride shift & Haldane effect have been described to explain gaseous exchange at tissue and alveolar levels.

Respiratory volumes : - Tidal volume (TV) : Volume of air inspired or expired during normal respiration. About 500 ml. Inspiratory reserve volume ; (IRV) Additional volume of air, a person can inspire by forcible inspiration. It is about 3000 ml. expiratory reserve volume (ERV) : Additional volume of air, a person can expire by forcible volume of air remaining in lungs after maximal expiration. It is 1100 ml to 1200 ml.

Disorders of Respiratory System :

Asthma – Difficulty in breathing causing wheezing due to inflammation of bronchi & bronchioles.

Emplysema – is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased. One of the major cause of this is cigarette smoking.

Occupational Respiratory disorders : Workers in environments in several industries are exposed to potential harmful chemicals, gases, dust particles. silicosis, asbestosis result from a chronic exposure to fine particles of silica, asbestos & cement. They settle down on walls of airways & alveoli causing irritation & blockage.

Sample questions

Q.1. Choose correct answer :

i) The exchange of gases in lung, alveoli occurs by

   a) Active transport b) Passive transport c) Diffusion d) None of the above

ii) The respiratory centre that regulates breathing is located in which part of the brain ?

   a) Cerebral hemisphere b) Diencephalon c) Hypothalamus d) Medulla oblongata

iii) Which structure in pharynx prevents the entry of food into respiratory tract ?

   a) Larynx b) Gullet c) Glottis d) Epiglottis

iv) The enzyme involved in CO_2 transport by blood is

   a) Carboxylic b) Carboxylinase c) None d) Carbonic anhydrase

v) The quantity of 500 ml of air during quiet breathing in man refers to

   a) Residual volume b) Tidal volume c) Vital capacity d) Dead space air

Q.2. Differentiate between :

(i) Cutaneous respiration & pulmonary respiration

(ii) Inspiration & expiration

(iii) Tidal volume & Residual volume

(iv) Tracheal respiration & Branchial respiration.

(v) External intercostals muscle & internal intercostals volume

Q.3. Describe the mechanism of breathing its regulation in man.

Q.4. Describe the transport of respiratory gases in blood of human.

Q.5. Draw a neat labeled diagram of the respiratory organs of human. (Description not required).

◆◆◆

UNIT VI

BODY FLUID CIRCULATION

Composition of Blood

Blood constitutes corpuscles suspended in plasma. Plasma has water 91-91% rest are organic include plasma proteins, such as albumin, globulin, prothrombin & fibrinogen. Straw yellow color of plasma is due to bilirubin & carotene. The inorganic substances like ions of sodium, potassium, calcium bicarbonate present in plasma.

Corpuscles are RBC, WBC & platelets RBC : are without nuclei. Respiratory pigment hamoglobin present in RBC. It is a conjugate protein i.e. a protein part known as globin & non –protein part heme. RBCs have an average life span of 120 days. Spleen is the graveyard of RBCs.

WBC or leucocytes : Colourless, nucleated. Number is in range of 4000-10000 ml of blood. Based on presence or absence of granules they are of two types' granulocytes & agranulocytes.

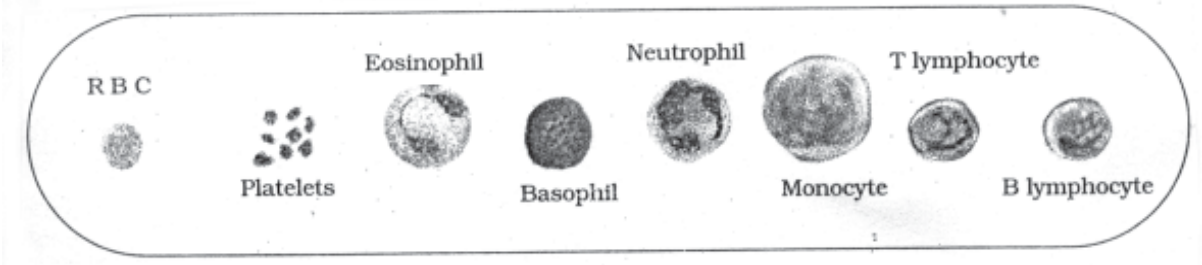


Fig. 29: Diagrammatic representation of formed elements in blood

3. Thrombocytes or platelets are anucleate, pinched off from a giant cell known as megakaryocytic. They are involved in coagulation of blood.

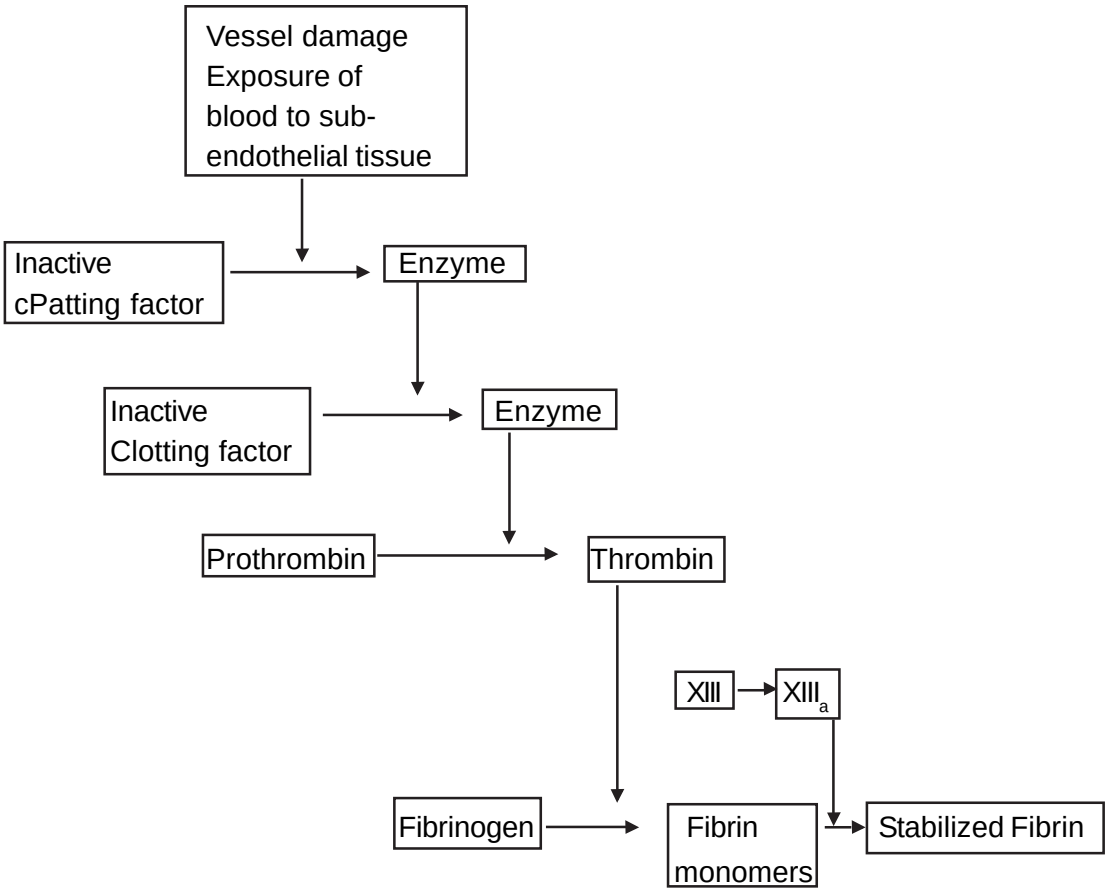
Blood groups : The ABO Blood groups & their compatibility

Group	Blood cell antigens	Serum antibodies	Can give blood to	Can receive blood from	Genotype
A	A	anti - B	A, AB	O, A	$^{A}I^{A}$ or $I^{A}i$
B	B	anti - A	B, AB	O, B	$I^{B}I^{B}$ or $I^{B}i$
AB	A & B	None	AB	AB Universal receipants	I^{A} I^{B}
O	None	anti - A,B	All Universal doner	O	ii

Table 2: ABO blood groups and their compatibility

There are two main systems of human blood grouping ABO system & Rh system. When blood of donor & recipient mismatch RBCs agglutinate which is caused due to antigen antibody reaction.

Rh Factor – Alexander S.Wiener discovered another group of antigen named as Rh factor. There are a number of antigens in this group, such as C.D & E. if D antigen are present on red cell surface of a person, person is considered as Rh positive & if absent Rh negative.



Coagulation of blood:

The conversion of fibrinogen into fibrin mesh occurs via two pathways i) intrinsic pathway ii) extrinsic pathway.

Composition of lymph : Lymph is a colourless fluid containing specialized lymphocytes which are responsible for the immune responses of the body. It lacks RBCs & plasma proteins. They have large numbers of WBCs. They have less O_2 but rich in CO_2. Lacteals are lymph capillaries used for absorption of fatty acids & glycerol.

Human circulatory system : It consists of heart & blood vessels & blood.

HEART – Structure is conical, four chambered having two atria & two ventricles. Atria separated from ventricles by coronary sulcus. It is enclosed by pericardium two atria separated by inter – atrial septum. Superior & inferior venacavae open into right atrium, pulmonary veins open into left atrium. Right atrium opens into right ventricle by right atrio-ventricular orifice guarded by tricuspid valve.

The left atrium open into left vent ricle by left atrio-ventricular orifice, guarded by bicuspid valve. The conducting tissue of heart are SA node present in right upper corner of right atrium & Av node in lower lft corner of right atrium.

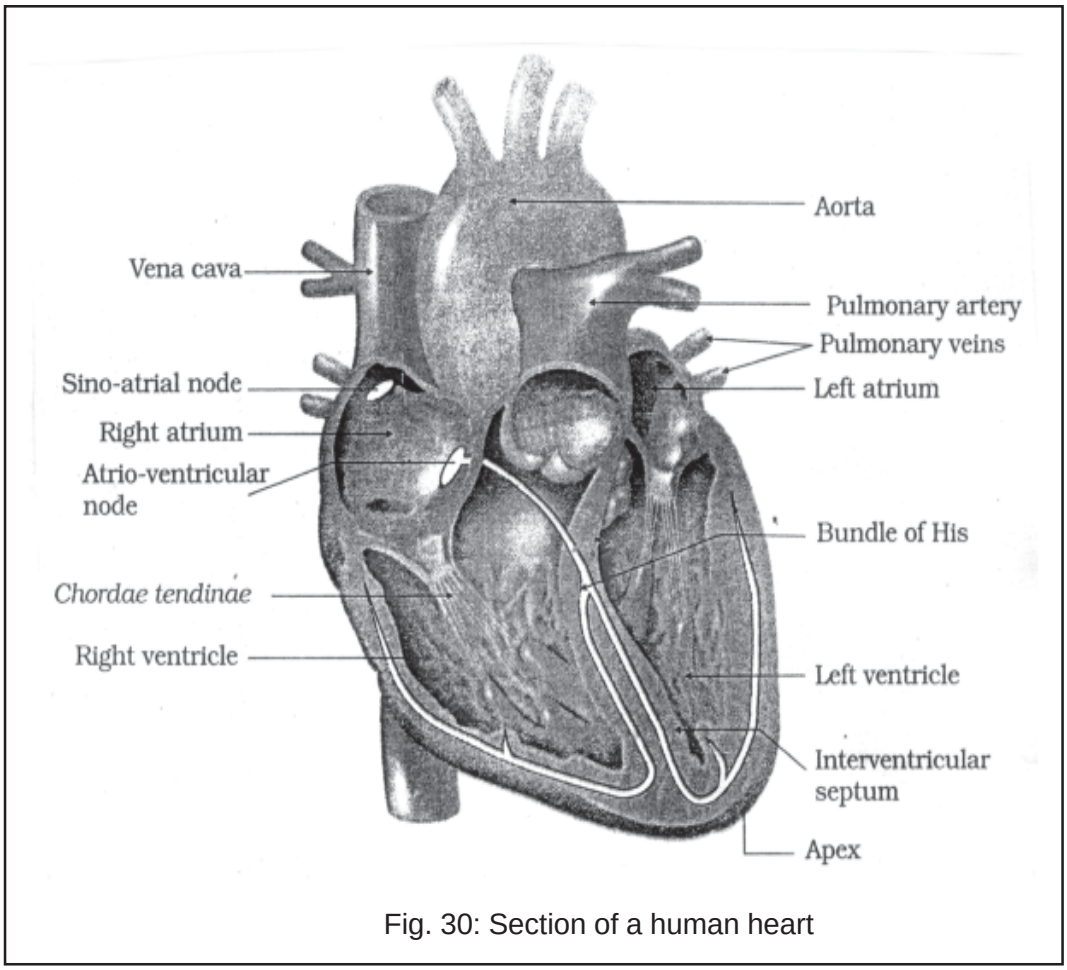


Fig. 30: Section of a human heart

Working of the heart : Two atria undergo systole & their contents are emptied into ventricles. Deoxygnated blood from all parts of body is poured into right atrium via venacavae. Left atrium receives oxygenated blood from pulmonary viens. After systole of atria ventricle will start contracting. For a brief period atria & ventricle remain in diastole. Then ventricle undergo systole & deoxygenated blood from right ventricle is forced into pulmonary trunk & oxygenated blood in left ventricle is forced into aorta. The valves ensure unidirectional flow of blood, with this, the cycle is completed.

Cardiac cycle : The healthy human heart beats 75 times per minute. Each beat has a phase of contraction (systole) & a phase of relaxation (diastole). One systole & one diastole forms a cardiac cycle. It is completed in 0.8 sec. There are four events in the cardiac cycle : atrial systole, atrial diastole ventricular systole & ventricular diastole.

Cardiac out put : It is given by the product of stroke volume (ml/beat) and cardiac rate (beats/min).

Thus, cardiac output = 75 ml /min X 75 beats /min = 5.5 L (approx)

Double circulation: There are two circuits of circulation.

Regulation of cardiac activity: Normal activity of heart is regulated intrinsically. Medulla oblongata can moderate cardiac function through autonomic nervous system. Neural signals through sympathetic nerves increase the rate of heart beat. Parasympathetic neural signals decrease the rate of heart beat.

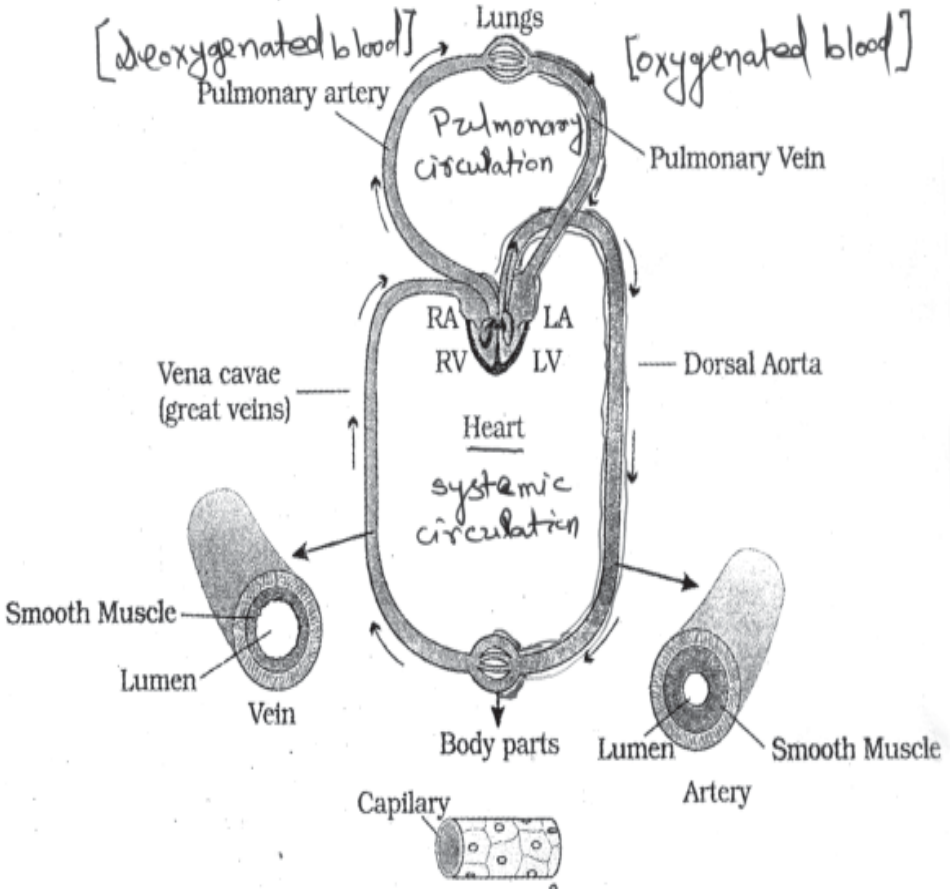


Fig. 31: Schematic plan of double blood circulation in human

Blood vessels : are arteries, capillaries & veins. From the heart blood enters into arteries, the arteries divide to form capillaries the capillaries unite to form veins and veins empty their blood back to heart. Arteries carry blood away from heart, middle smooth muscular layer is thicker than vein & lumen of artery is smaller than vein. The veins at intervals possess semilunar valves.

ECG : Electrocardiogram is a record of electrical events in the heart on a piece of mailing paper. ECG may be recorded by using a single electrode, known as active electrode (unipoloar) or by using two electrodes (bipolar).

Disorders of circulatory system :

Hypertension – High blood pressure is the term of blood pressure that is higher than normal (120 / 80). It leads to heart diseases. Coronary artery disease often referred as atherosclerosis, affects the vessels that supply to heart muscle.

Angina pectoris – It occurs due to conditions affect the blood flow.

Heart Failure – It is the state of heart when it is not pumping blood effectively enough to meet the needs of the body.

Sample questions

Q.1. Fill in the blanks with appropriate words :

i) Blood circulation in human was discovered by _____

ii) In double circulation, there are two circuits. One is pulmonary & other is _____

iii) The average longevity of human erythrocyte is _____ days

iv) The respiratory pigment in human blood is known as _____

v) The venacavae open into _____ of the heart.

Q.2. Choose the correct answer :

i) Which of the following is not a granulocyte.

a) Neutrophil b) Monocyte c) Eosinophil d) Basophile

ii) Myogenic heart is present in

a) Annelids b) Arthropods c) Mollus d) Vertebrates

iii) Pacemaker is synonymous with

a) SA node b) Bundle of his c) AV node d) purkinge fibers

iv) A man of blood group AB can receive blood from donors of blood group

a) A b) B c) AB d) all

v) Heart rate is under control of

a) Vagus nerve b) Glossopharyngeal nerve c) Autonomic system d) None of these

Q.3. Differentiate between:-

i) Blood & lymph

ii) Artery & vein

iii) Atrium & ventricl

iv) Bicuspid & tricuspid valve

v) Granulocytes and agranulocytes

Q.4. Long answer type –

i) Describe the constitution & functions of human blood.

ii) Describe the structure & working of human heart.

◆◆◆

UNIT – VII

EXCRETORY PRODUCTS AND THEIR ELIMINATION

Excretion is the process by which metabolic waste is eliminated form an organism. In vertebrates this is primarily carried out by the lungs, kidneys and skin. This is in contrast with secretion, where the substance may have specific tasks after leaving the cell. Excretion is an essential process in all forms of life, for example, in mammals urine is expelled through the urethra, which is part of the excretory system. In unicellular organisms, waste products are discharged directly through the surface of the cell.

Types of excretory wastes in different animals

- Metabolism of Carbohydrates and fats produces Co_2 and H_2O, which are easy to remove. They are effectively removed through Lungs (expired air), Skin (sweat) or Kidneys (urine).
- Other excretory products such as bile pigments (formed by the breakdown of RBCs), drugs etc., are removed in liver.
- Metabolism of Protein produces nitrogenous wastes such as ammonia which is the basic nitrogenous catabolites of proteins, formed by breakdown of amino acids is finally removed from kidney.
- Depending upon the form in which nitrogenous waste is excreted from the body, the organisms are grouped under into three categories – Ammonotelic, Ureotelic and Uricotelic

Modes of Excretion

1. Ammonotelic Organisms:

- These animals, which excrete their nitrogenous waste in the form of ammonia are known as ammonotelic.
- Ammonia is highly soluble in water with which it forms ammonium hydroxide (NH_4OH), which can damage cells directly by its alkaline caustic action.
- Excretion of ammonia requires large amounts of water, so that more water loss from the body. That is why such a mode is suitable for aquatic organism, which have a constant access to water.
- Ammonia is first metabolic waste product of protein metabolism and no energy is required to produce ammonia.
- Example – All aquatic invertebrates, bony fishes and aquatic amphibians.

2. Ureotelic Organisms:

- Those animals that excrete their nitrogenous waste mainly in the form of urea are known as ureotelic and the phenomenon is known as ureotelism.
- Urea can be stored in the body for considerable period of time and is least toxic. It is eliminated in the form of urine.
- Examples – semi terrestrial animals, e.g. adult amphibians and mammals

3. Uricotelic Organisms

- Those animals which excrete their nitrogenous waste mainly in the form of uric acid and urates are known as uricotelic.
- The Phenomenon is known as uricotelism.
- Elimination of uric acid requires lesser amount of water, comparatively less soluble in water and is less toxic as compared to ammonia.
- Examples – All terrestrial animals like insects, reptiles and birds

Human excretory system – Structure and function

The urinary system of man consists of two kidneys, two ureters, a urinary bladder and urethra in male or vestibule in females.

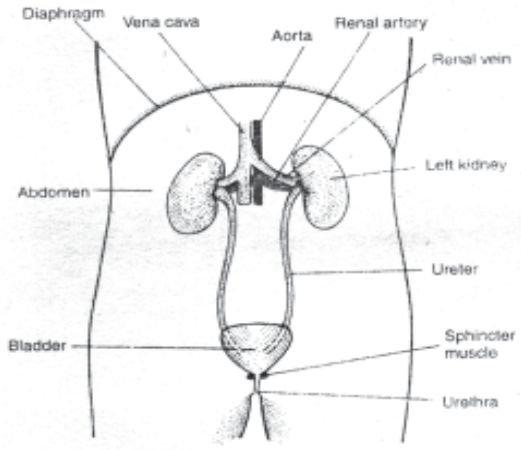


Fig. 32: Position of kidney in the body

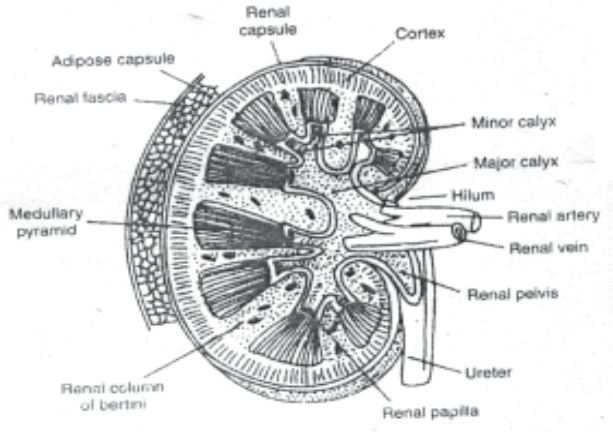


Fig. 33: L.S. through kidney

KIDNEY

The kidneys are darkred, bean shaped, about 10 cm. long and 5 cm. wide and 4 cm. thick. They are placed just below the diaphragm, one on either side of lumbar vertebrae. Kidneys are metanephric covered by peritoneum on the ventral side only. The left kidney lies at a little higher level than the righter kidney. Each kidney has concavity called hilus. Blood vessels, lymph vessels, nerves and ureters enter or leave the kidney through hilus. The longitudinal section (L.S) of the kidney shows the following parts:

(i) Cortex – Outer part of kidney. It contains Malpighian corpuscles, PCT and DCT.

(ii) Medulla – Inner part of kidney, which contains loop of Henle and collecting tubules

(iii) Pyramids- Cortical processes formed by the projections of medulla into pelvis (6-20 pyramids in each kidney). The broad base of each pyramid face the cortical area and their conical ends called renal papillae and directed towards the centre of the kidney.

(iv) Columns of Bertini – This is the part of the cortex continued inside medulla between pyramids.

(v) Pelvis – It is also called renal sinus or renal pelvis which forms a large funnel shaped space towards the concavity of kidney. The edge of the pelvis contains cuplike extensions called major and minor calyces. Each minor calyx receives urine drains into the pelvis and out through the ureter.

(vi) Hilum – There is a longitudinal opening, the hilum on the margin of the kidney, through which renal artery and nerves enter and renal vein and ureter leave the kidney.

(vii) Ureters – The ureters are 35-40 cm long tube opening into the urinary bladder. The urinary bladder hold about 0.5 to 1.0 litre of urine. Bladder leads into urethra or vestibule, which openout by urinary aperture in females and by urinogenital aperture in males .

(viii) Nephron – The functional unit of kidney are nephrons or uriniferous tubules. The total length of each nephron is about 40-60 mm.

Structure of a nephron

Each nephron is a coiled tubule with the following regions:

(i) Bowman's capsule

Each nephron begins with a Bowman's capsule with a double walled sac like structure. Inner wall consists of podocytes. The cells with finger like projections coiled around capillaries of glomerulus.

(ii) Glomerulus – The cavity of Bowman's capsule contains a mass of blood capillaries called glomerulus from afferent arterioles and comes out through efferent arterioles. Blood is filtered in glomerulus. Bowman's capsule with glomerulus is called malpighian body.

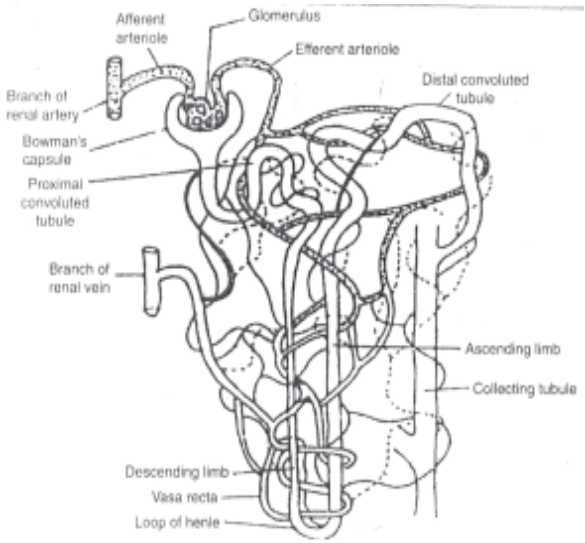


Fig. 34: Structure of nephron and blood supply

(iii) Neck – Bowman's capsule is followed by neck, which has ciliated epithelium.

(iv) Proximal Convoluted Tubule (PCT) – Present behind neck and is convoluted and coiled. Made up of columnar epithelium

(v) Loop of Henle – It is a narrow U-shaped tubule having descending limb which extends into medulla and an ascending limb

(vi) Distal Conducted Tubule (DCT) – It is the most distal part of nephron. It is also convoluted and forms few coils. The narrow terminal part of each pyramid is called renal papilla. Minor calyces join to form major calyces, which form renal pelvis, which leaves the kidney through hilus and forms the ureter.

Types of Nephron

There are two types of nephrons – Cortical nephrons and Juxtamedullary nephrons.

(a) Cortical nephrons – Small sized present in cortex, with short loop of Henle

(b) Juxtamedullary nephrons – Large sized with long loop of Henle extending deep into medulla.

Blood supply to Nephron

Kidneys receive a very rich supply of blood. An adult kidney receives 1 to 3 litres of blood per minute. Blood to each kidney is supplied by a renal artery and is drained by the renal vein. The renal artery divides and redivides to send an afferent arteriole to each glomerulus. It forms capillaries and rejoin to form efferent arteriole, which again forms a network of peritubular capillaries around PCT and DCT. Long harping like loops of blood vessels are given off, which are called vasa recta.

Functions of Kidney :

1. Regulation of water and inorganic iron balance
2. Removal of metabolic wastes from the body and their excretion in the urine.
3. Acid-Base balance of the body and thereby the regulation of the hydrogen ions of body fluids.
4. Acts as a homeostatic organ. Regulates the chemical composition of the body fluids.
5. Secretion of hormones like erythropoietin, which controls RBC production in the body; rennin controls formation of angiotensin that influences BP and sodium balance.

Mechanism of Urine formation

Urine formation consists of 3 steps :

(a) Ultrafiltration

(b) Selective reabsorption

(c) Tubular Secretion

(a) Ultrafiltration – It occurs in the glomeruls, hence glomerular filtration. Ultrafiltration pressure comes from the blood pressure and is due to Net Filtration Pressure :

(i)	The glomerular Hydrostatic Pressure	-	75 mm of Hg	
(ii)	The osmotic pressure of blood	-	30 mm of Hg	
(iii)	The Capsular Hydrostatic Pressure	-	10 mm of Hg	Bowman's
(iv)	The Hydrostatic Pressure of Interstitial fluid	-	10 mm of Hg	Capsular Pressure

Net Filtration Pressure= Glomerular Hydro static Pressure - (Osmotic Pressure of Blood + Bowman's Capsular Pressure)

= 75 mm of Hg – (30mm of Hg + 20 mm of Hg)

= 75 mm of Hg – 50 mm of Hg

= 25 mm of Hg

25 mm of Hg causes filtration in the glomerulus. The glomerular filtrate contains glucose, amino acids, sodium, potassium, calcium irons, vitamins, urea, uric acids, ammonia, creatine, ketone bodies and large amount of water.

(b) Selective reabsorption – The cells of the proximal tubule reabsorb all essential elements by two ways like back diffusion and active transport. The glucose, amino acids, vitamin C and inorganic irons are reabsorbed. About 80% of the filtrate is reabsorbed in the proximal part of the tubule – obligatory reabsorbtion. In the descending limb, 5% of water is reabsorbed by osmosis.

In the ascending limb, K^+ and Na^+ irons are reabsorbed by diffusion. 13% of water is reabsorbed, due to Anti-diuretic hormone (ADH). Distal tubular reabsorbtion is called facultative reabsorbtion.

(c) **Tubular Secretion** – Cells of the distal tubule excrete additional wastes from the blood stream into the filtrate by active transport. This process adds creatinine, K^+, Na^+ irons, NH_3, drugs and little amount of uric acid. Removal of hydrogen irons and ammonia from the blood help to maintain a proper acid-balance in the body.

Osmoregulation and regulation of Kidney function

Osmoregulation is the control of water level in the body. When there is excess of water in the body, kidney produces large volume of dilute urine and brings the water levels to correct position. In deficiency of water, kidney helps to conserve body water by producing small volume of concentrated urine. Kidney produces large quantities of dilute urine by reducing tubular reabsorption of water due to absence of ADH.

The ability of the human kidneys to produce a hyperosmotic urine enables the body to survive without water for a long period. Sodium and water more together. Whenever, water is lost sodium is lost with it. The major factor determining the rate of tubular reabsorption is aldosterone. It also stimulates sodium absorption in the gut and decrases loss of sodium in sweat, both these effects tend the blood by osmosis, raising its volume and pressure. This process is called Rennin – Angiostensin Aldosterone system (RAAS)

Aldosterone is the most important controller of sodium reabsorption, another peptide hormone known as Atrial – Natriuretic Factor (ANF) acts on the kidneys to inhibit sodium reabsorption. It also inhibits the secretion of both rennin and aldosterone, which results in less sodium reabsorption. Secretion of ANF is increased when there is an excess of sodium in the body, the stimulus being an increase in atrial distension.

Role of other organs in excretion

LUNGS - Lungs eliminate about 18 liters of Co2 per hour and about 400 ml of water per day in resting condition. In hot humid condition, water loss via lungs is small and large in cold dry climate.

SKIN – Sweat and sebum are secreted by sweat gland and sebaceous gland respectively by the human skin. Sweat is an aqueous fluid containing Nacl, Lactic acid, urea, amino acids and glucose. Sweat cools the body due to evaporation. Sebum keeps the skin oily and their secretion eliminates some lipids, hydrocarbons and fatty acids.

LIVER – Cholesterol, bile pigments (bilirubin and biliverdin), some steroid hormones, vitamins and drugs are eliminated by the liver. Liver secrets these substances in bile leading to discharge in intestine. Finally excreted along with faecal matter.

DISORDERS

(i) Uremia – It is the accumulation of nitrogenous waste products of metabolism in the blood due to kidney failure. The effects are nausea, vomiting, oedema, itching, bleeding, anaemia, confusion and seizure etc. Classical signs are progressive weakness and muscular dystrophy etc.,

(ii) Renal failure – It is the failure of kidney to adequately filter waste products from the bold. The main cause is acute kidney injury, which is often reversible. There may be problems of increased fluid and acid levels in the body, raised K levels, decreased level of Ca, increased level of phosphate and anemia.

Symptoms : A high level of urea can cause :

- Vomiting and / or diarrhoea
- Weight loss

- Nocturnal urination / Difficulty in urination
- Appetite loss
- Swelling of the leg, face and hands
- Difficulty in sleeping

(iii) Renal Canaliculi (Kidney Stone)

Renal canaliculi is other wisely known as Kidney Stone. It is a solid piece of material, which is formed in the Kidneys from minerals in urine. It causes blockage of ureter leading to pain. The symptoms are nausea, vomiting, fever, blood in urine and painful urination. High dietary animal protein intake, sodium, refined sugars, oxalate, grape juice may increase the risk of kidney stone formation.

(iv) Nephritis – Nephritis is the inflammation of kidney. It is of 2 types :

(i) Glomerulonephritis – It is inflammation of glomerulus.

(ii) Interstitial nephritis – It is the inflammation of the spaces between renal tubules.

It is caused by infections and toxins bud mostly caused by autoimmune disorders .

(v) DIALYSIS – This is a condition when kidneys can no longer excrete water and irons at rates to maintain body balances nor they can excrete wastes as fast as they are produced. Dialysis means separation of substances using a semi or a selectively permeable membrane. It is of 2 types –Haemodialysis and Peritoneal dialysis

(1) Haemodialysis – It functions as on artificial kidney on the same principle as the real kidney. The blood is pumped out of the body, filtered to remove the waste materials and then returned. The patient is connected to the machine by inserting a catheter into an artery in the worm or in the leg connecting this to a flexible tube leading to the machine and then returning the washed blood into a vein.

(2) Peritoneal dialysis – This uses the lining of the person's own abdominal cavity (peritoneum) as a dialyzing membrane. A thin plastic tube is inserted into the abdominal cavity through a small slit. The peritoneal membrane acts as a dialyzing membrane. This method is cheaper and simpler.

QUESTIONS

Objective type questions

Choose the correct answer from the choices given under each bit :

1. Bowman's capsule occurs in :

   (i)Pancreas (ii) Kidneys

   (iii) Pituitary body (iv) Adrenal gland

2. Urea is transported by :

   (i) Blood plasma (ii) Leucocytes

   (iii) Haemoglobin (iv) Erythrocytes

3. Blood vessels leading into a glomerulus is called :

   (i) Afferent arteriole (ii) Efferent arteriole

   (iii) Renal artery (iv) Renal vein

4. Which blood vessel carries least percentage of urea ?

(i) Pulmonary vein (ii) Renal artery

(iii) Renal vein (iv) Hepatic portal vein

5. The yellow colour of the urine is due to :

(i) Uric acid (ii) Urea

(iii) Urochrome (iv) Bilirubin

6. Kidney regulate the amount of :

(i) Salts (ii) Hormones

(iii) Proteins (iv) Enzymes

7. Functional unit of kidneys is :

(i) Nephron (ii) Nephritis

(iii) Neuron (iv) Loop of Henle

8. Urea is formed from the breakdown of :

(i) Carbohydrate (ii) Proteins

(iii) Fats (iv) Nucleic acids

9. If a person is suffering from a disease muscular dystrophy, he will eliminate in urine great amount of :

(i) Sulphate (ii) Glucose

(iii) Creatine (iv) Relaxin

2. Give the answer in one word only :

a. What is the nature of urine ?

b. Where is urea produced ?

c. What is the net filtration pressure in mm. of Hg ?

d. What is the term used for urination ?

e. Which is the hormone responsible of diabetes insipidus ?

3. Differentiate between

a. Ureter and Urethra

b. Ammonotelism and Ureotelism

c. Affarent arteriole and efferent arteriole

d. PCT and DCT

e. Ascending limb and Descending limb of loop of Henle

4. Fill in the blanks:

a. The capillaries around the loop of Henle are called _____

b. Most of the urea is produced in the _____

c. The structural and functional units of kidneys are _____

d. The wall's of the Bowman's capsule consists & a single layer of _____ cells.

e. Human urine in _____ elimination, making the urine hypertonic

f. Glucose is actively reabsorbed the _____ convoluted tubule.

g. The _____ organism requires a huge amount of water in their media.

LONG QUESTIONS

1. Give an account of the structure of human kidney.
2. Give an account of the mechanism of urine formation.
3. Give an account of the role of human kidney in osmoregulation.

◆◆◆

UNIT – VIII

LOCOMOTION AND MOVEMENT

The phenomenon of changing displacement with time is known as locomotion. Movement is one of the characteristic of living organisms. Locomotion includes walking, running, creeping, flaying, swimming etc. It is helpful for animals in the following ways:

(i) Shifting form an unfavourable environment to favourable conditions.

(ii) Going in for search food, water and shelter

(iii) Finding partner for reproduction and proper place for laying of eggs or giving birth to young ones.

A cell constitutes building block of life also exhibits movement. The protoplasm shows streaming movement in a defined way.

Types of movement

1. Ciliary and Flagellar movement

   The members of the class ciliata (e.g. *Paramoecium*) and Flagellata (e.g. Euglena) exhibit these types of movement. The cilia and flagella are thin and delicate protoplasmic threads. Except size and number, their microscopic structure is essentially similar. A cilium is shorter and more numerious than a flagellum.

Mechanism of flagellar / ciliary locomotion:

The flagella / cilia are contractile protoplasmic threads due to the presence of microtubules. These contract and relax rhythmically in response to external stimuli. This rhythmic beating is known as **undulation**. The flagellum/ cilium is held rigidly and bends to one side. Accompanied bending, undulations pass from the tip to the base. In doing so. It strikes the water like an mechanical energy is generated, which propels the animalcule a little forward. This stroke known as effective stroke [Figs. 35 & 36. Following the completion of the effective stroke, the flagellum / cilium returns back to its normal position in a relaxed manner. This constitutes another stroke, known as recovery stroke [Figs. 35 & 36.

There is a single flagellum in *Euglena.* Therefore, it is propelled forward in a **screwed** or **spiral manner** [Fig. 19.6 (a)]. However , in *Paramecium,* there are numerous cilla, arranged in two rows: transverse and longitudinal. The transverse rows undulate at different times **causing metachronous rhythm** (Fig. 37).

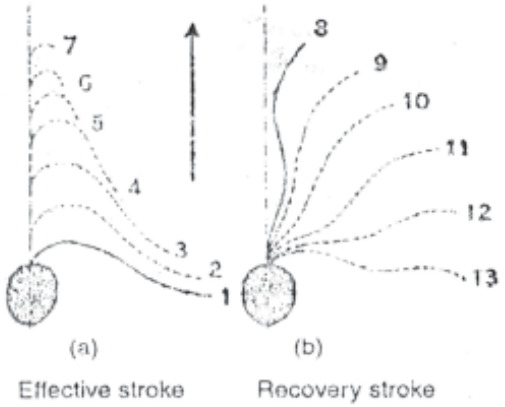


Fig. 35 : Undulations of a flagellum in *Euglena*

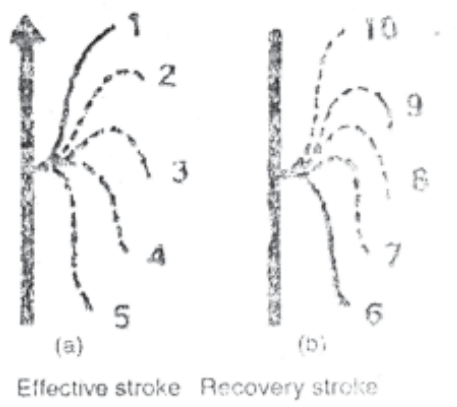


Fig. 36: Undulations of a cilum of *Paramecium*

The beating of the cilia generates mechanical energy, which peoples *Paramecium* in a forward direction. Like *Euglena,* it also follows a spiral path, due to the presence of more cilia on the oral groove side. The caudal tuft of Paramecium acts as a radder and helps to change the direction as and when necessary.

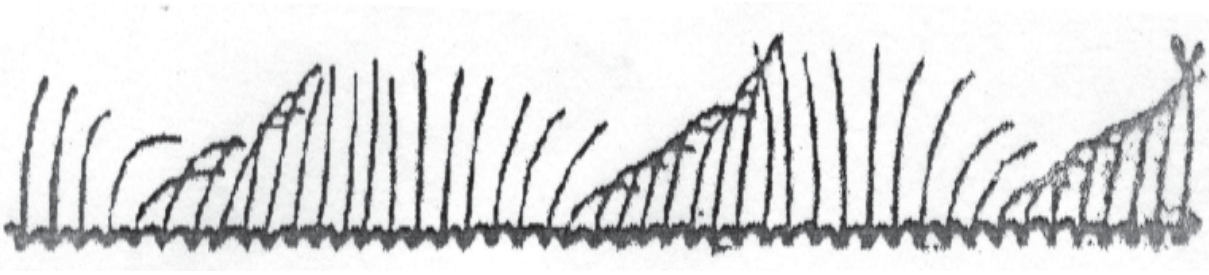


Fig. 37: Beating of longitutinal row of cilia, causing a metachronous rhythm

ULTRASTRUCTE OF SKELETAL / STRIATED MUSCLE

The striated muscles are found in the body wall, limbs, tongue, pharynx, and beginning of oesophagus. It consists of long, narrow, cylindrical fibers. Each muscle fibers is bounded by an elastic sarcolemma and contains many elongated fibrils called **myofibrils**. The myofibrils show alternating dark and light cross-bands or striations, hence the name of the muscle. The dark bands are anisotropic and are called **A bands**. Each A band has at its middle a light zone termed Hansen's line or **H-zone**. The light bands are isotropic and known as I-bands. Each I-band is provided with a dark membrane present in the centre called **Z-line** or membrane of Krause. The part of the myofibril between two successive Z-lines functions as a contractile unit termed the **sarcomere**. The sarcomere of A-band and half of each adjacent I-band.

Each sarcomere consists of two kinds of even smaller structures called **myofilaments** : primary and secondary.

(i) The primary filaments are thicker and present in the A-band only. They are composed of high molecular weight protein called **myosin** and bear minute projections called **crossbridges**.

(ii) The secondary filaments are thin and occur in I-band and also extend for some distance into the A-band between the primary filaments. They are composed of the protein actin, have a smooth surface, and are attached to Z-lines by one end, being free at the inner end. This partial overlapping of the primary filaments by the secondary filaments gives dark coloration to the A-band. The secondary filaments are more numerous than the primary filaments.

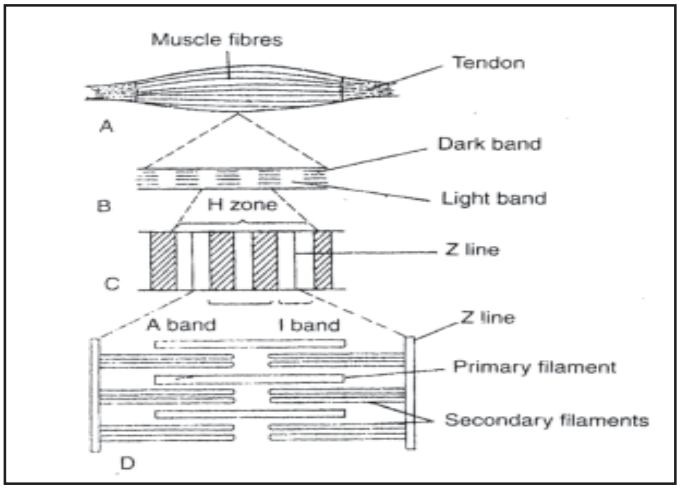


Fig. 38: Ultrastructure of striated muscle fibre.

The striated muscles are supplied by nerves from the brain and spinal cord. These muscles contract fast but soon gets fatigued. They are under the control or will of a person therefore, also called **voluntary muscles**. They are richly supplied by blood capillaries and also contain numerous mitochondria and glycogen granules for the supply of energy. The thick and thin filaments interact by **cross-bridges**, which emerge at regular intervals from the thick filaments, only during contraction. They bridge a gap of 130 A between the surfaces of the thick and their

MECHANISM OF MUSCLE CONTRACTION (Fig. 31)

According to Huxley's theory (1954), the filaments do not shorten during the contraction of a muscle fibre but begin to slide over one another. The mechanism of muscle contraction is described stepwise below :

(a) Myosin heads or cross-bridges come close in contact with thin filaments and rotates on them.

(b) The thin filaments are pulled towards the middle of the sarcomere.

(c) The Z-lines come closer together and sarcomere becomes short.

(d) Length of A-band remains constant, I-band shorten and H-zone disappears

(e) This results into shortening of entire myofibril.

(f) This mechanism is called **sliding filament theory** because thin filaments slide over the thick filaments.

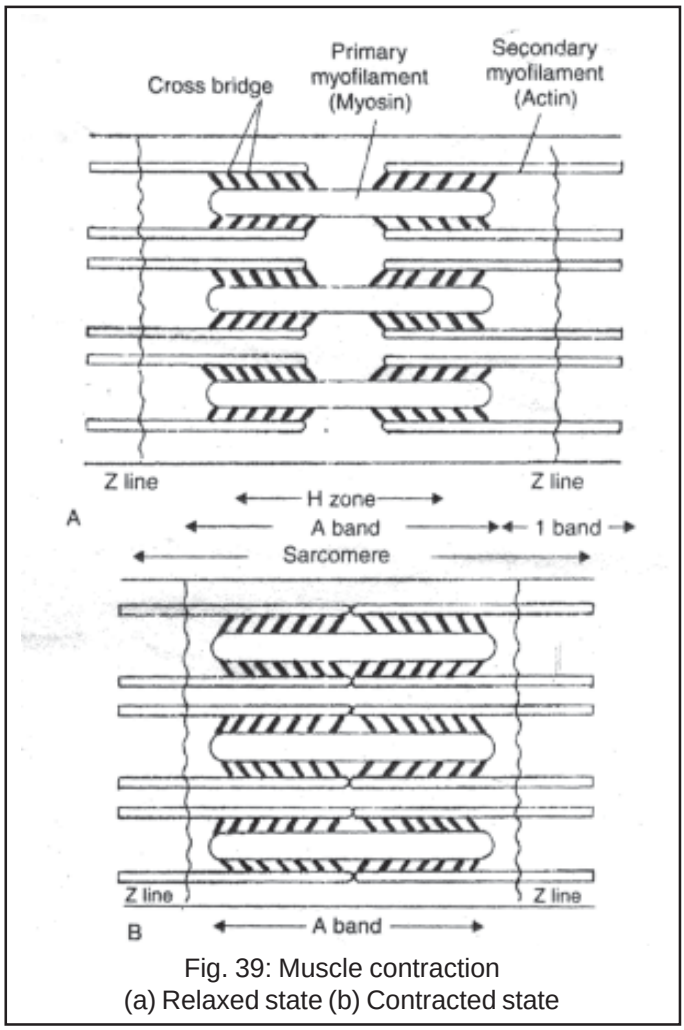


Fig. 39: Muscle contraction
(a) Relaxed state (b) Contracted state

CONTRACTILE PROTEIN

The contractile proteins are the following :

1. **Myosin** – The thick filaments are made up of myosin molecules. Each myosin molecule contains two identical heads with two paris of helical strands, which form the tail. The upper surface of each globular head contains actin binding site and ATP binding site.
2. **Actin** – It is the main constituent of thin filaments. The actin filament resembles two strings of beads twisted into a double helix. Each bead is a molecule of G-actin (globular actin) having 55A^{o} diameter. It shows a high affinity for calcium iron. In the presence of salts and ATP, it is converted into fibrous actin (F-actin).
3. **Tropomyosin** – It is a two stranded L-helical rod which is located in the groove between the two helical strands of actin. A troponin complex is attached to the tropomyosin at regular intervals of about 385A^{o}
4. **Troponin** – It is a globular protein consisting of three polypeptide chains. It is an important control protein.

HUMAN SKELETAL SYSTEM

The human skeletal system is divided into axial skeleton and appendicular skeletons. Axial skeletons consists of bones of skull, vertebral coloumn, ribs and sternum, where as appendicular skeleton consists of bones of limbs and girdles.

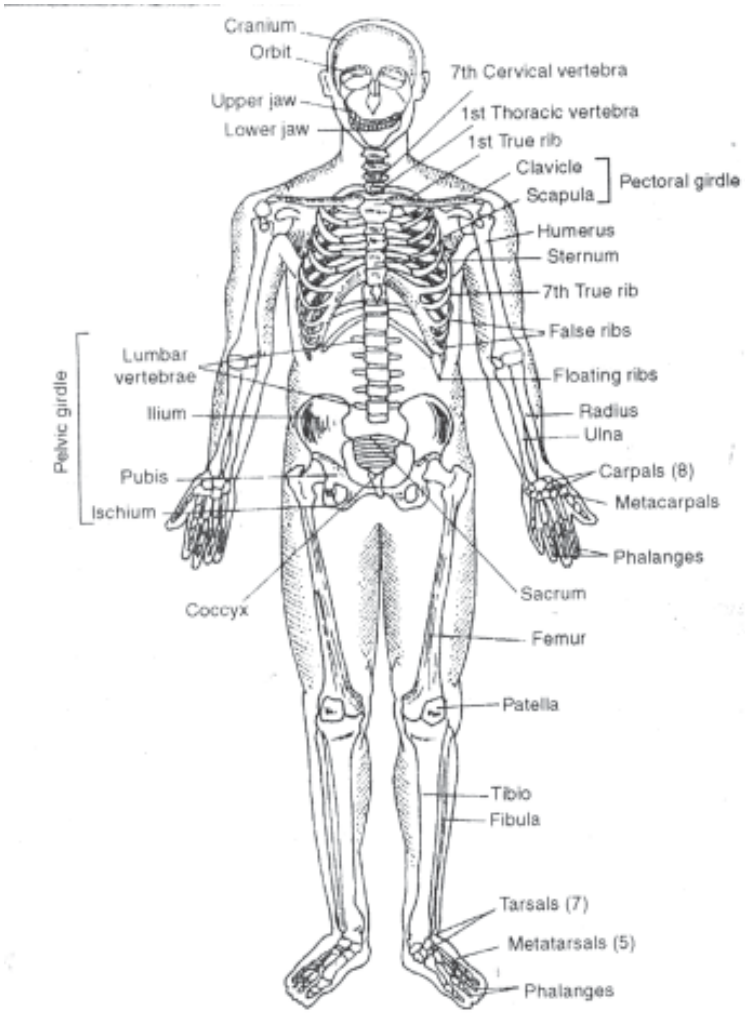


Fig. 40: Articulated human skeleton

A. AXIAL SKELETON

It occupies the longitudinal axis of the body and includes four structures: skull, vertebral column, ribs and sternum. The total bones in axial skeleton of adult are 80.

(a) **Skull** – Skull is dicondylic (with two occipital condyles). It lies at the upper end of the vertebral column. It consists of cranium and face. The bone common to cranium and face is Frontal.

(i) **Cranium** – It is the large and hollow part of the skull. Its cavity is called cranial cavity, which encloses the brain. The cranium has a large opening at the posterior end, foramen magnum, through which spinal cord is connected.

(ii) **Face** – It forms the front and lower part of the skull and is formed of 14 bones. These include paired nasals, maxillae, palatines, cheek bones or zygomatics, lacrymals, inferior turbinals and unpaired vomer and mandible

(b) Vertebral Column

It is also called backbones. It is a bony, curved, vertical rod about 70 cm. long. It consists of a row of 33 morally articulated ring-like bones called vertebrae. The vertebral formula of man is $C_7T_{12}L_5S_5CO_5$

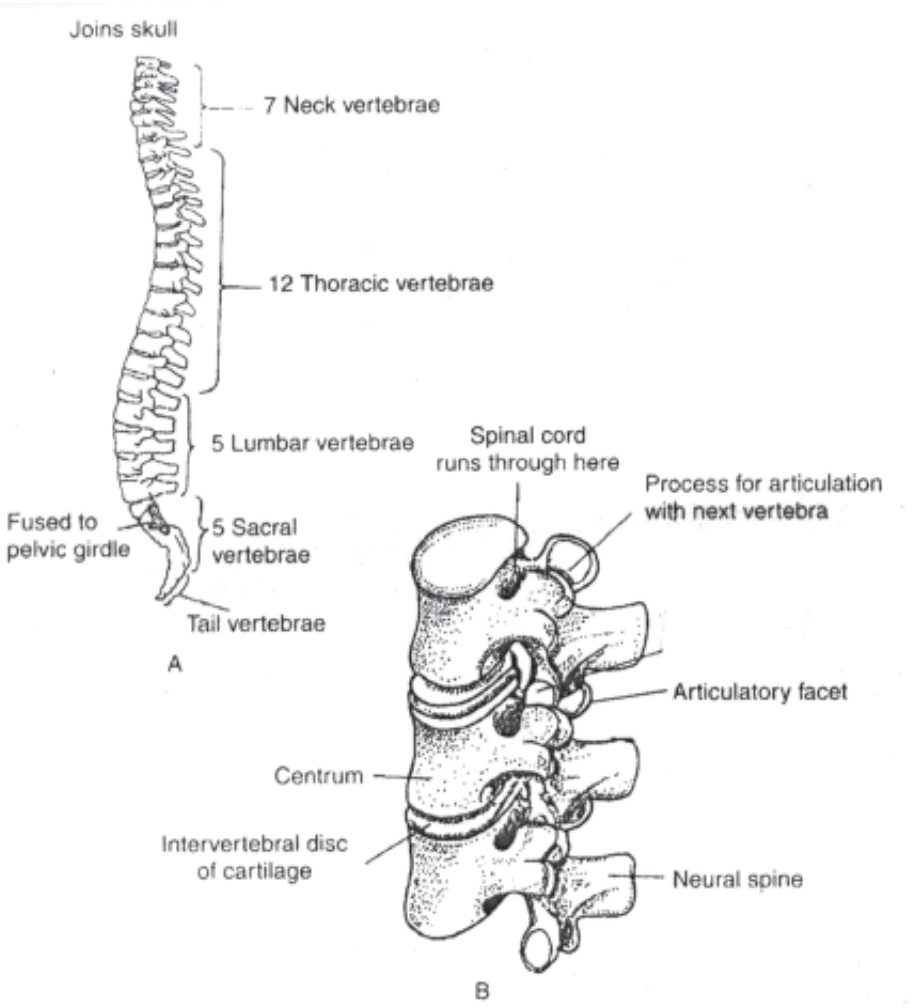


Fig. 41: (a) Spinal column (b) Lumbar vertebrae

Table 9.1

Category	*Name of Vertebrae*	*Number*	*Region*	*Curve*
1.	Cervical	7 (1st Atlas) (2nd Axis)	Neck	Cervical curves forwarded
2.	Thoracic	12	Chest	Thoracic curves backward
3.	Lumbar	5	Abdomen	Lumbar curves forward
4.	Sacral	5 (fused to form a single sacrum)	Palvis	Sacral curves backwad
5.	Coccygeal	4 (fused to form a single coccyx)	Vestigeal tail	Coccyx curves forward

(a) Ribs – These are 12 pairs of curved ribs present in the thoracic region. Each rib has cartilaginous part called Sternal part and bony part known as Vertebral part. The first 7 pairs of ribs have direct connections with the sternum called true ribs. The next 3 pairs of ribs are attached with the 7th pair of ribs and not to the sternum directly – called false ribs. The last 2 pairs of ribs do not reach the sternum – floating ribs.

(b) Sternum – Sternum of mammals is composed of a series of paired and segmental ossifications, the sternebrae, which in man are fused to form single plate, the gladiolus.

B. APPENDICULAR SKELETON

The appendicular skeleton of man consists of 126 bones. This includes skeletons of limbs and girdles. The limbs are fore limbs and hind limbs, where as girdles are pelvic and pectoral.

(i) Pectoral girdle – There are two pectoral girdles, which lie laterally and on the upper region of the thorax. Each girdle is composed of 2 bones clavicle (caller bone), scapular (shoulder bone). Glenoid cavity and acromion process are present.

Axial skeleton		*Apprendicular skelecon*		
Cranium		**Fore limbs**		
Frontal	01	Humerus		02
Parietal	02	Radius		02
Temporals	02	Ulna		02
Occipital	01	Carpals	8 x 2	16
Sphenoid	01	Metacarpals	5 x 2	10
Ethmoid	01	Phalanges	14 x 2	28
	08			60

Face		**Hind limbs**		
Nasals	02	Femur		02
Maxillae	02	Tibia		02
Zygomatic	02	Fibula		02
Lacrimal	02	Patella		02
Palatines	02	Tarsals	7 x 2	14
Inferior nasals	02	Metatarsals	5 x 2	10
Mandible	01	Phalanges	14 x 2	28
Vomer	01			
	14			60

Vertebral column		**Girdles**		
Cervical	07	Pectoral	2 x 2	04
Thoracic	12	Pelvic	1 + 1	02
Lumbar	05		Total bones =	126
Sacrum	01 (5)			
Coccyx	01 (4)			
	26 (33)			

Total bones = Axial skeleton + Appendicular skeleton

Ribs	12 x 2	24
Sternum		01
Hyoid		01
Ear ossicle	3 x 2	06
Total bones		= 80

= 80 + 126

= 206

(ii) Pelvic girdle – These are two in number and located in the lower part of the trunk. Each pelvic girdle is made up of 3 bones – ilium, ischium and pubis. All the three bones are fused to form a single, stout Osinnominatum. The inner margin of each pubis is joined together by cartilaginous strip to form a slightly movable joint, pubic symphysis.

LIMB BONES

(a) For limbs –

Bone	Region	Number
Humerus	Upper arm (Brachium)	1
Radius and Ulna	Fore arm (Antebrachium)	2
Carpels	Wrist (Carpus)	8
Metacarpels	Palm	5
Phalanges	Fingers / Digits	14

Digital formula of hand is 2,3,3,3,3. The humerus has head, deltoid ridge, and trochlea. Head fits into glenoid cavity of pectoral girdle. Radius is thinner and outer longer than ulna. There are olecranon process and sigmoid notch in radius – ulna.

HIND LIMBS

Each leg contains 30 bones:

Bone	Region	Number
Femur	Thigh	1
Tibia and Fibula	Shank	2
Patella	Knee	1
Tarsals	Ankle	7
Metatarsals	Sole	5
Phalanges	Toes	14

Digital formula of feet is 2,3,3,3,3. Female is the longest, strongest and slightly S-Shaped bone with rounded head, shaft and condyle. The tibia is longer and thicker and fibula is comparatively very thin.

JOINTS – A joint is the meeting place of two bones. These joints act as levers to bring about specific types of movements. The joints can be classified into 3 types :

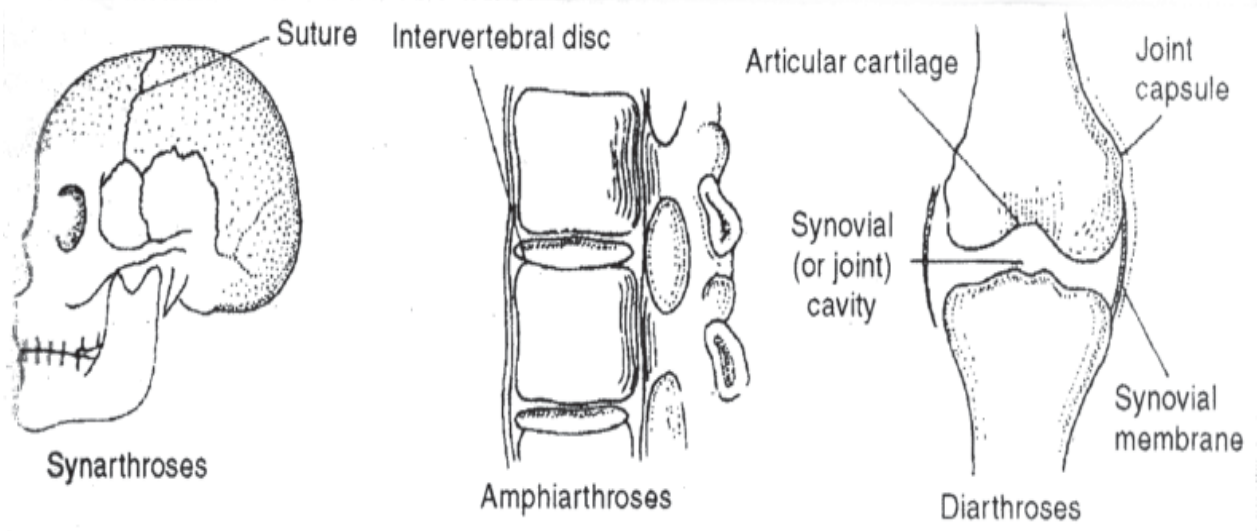


Fig. 42: Three main types of joints

(a) Immovable or Fibrous or Synarthrose joins.

(b) Slightly movable or cartilaginous or Amphiarthrose joints

(c) Freely movable or synovial or Diarthrose joints

(a) Immovable or Fibrous joint – In this joint, there is no movement because bones are firmly fixed together by white collagen fibers, e.g. Skull bones.

(b) Slightly movable or Cartilaginous joint – These joints are found between centra of vertebrae in the form of inter vertebral disc at the public symphysis and between ribs and sternum.

(c) Freely movable or Perfect joint – These joints are freely movable and exist between the limb bones and girdles. In such bones both the ends of hyaline cartilage, called articular cartilage. The adjacent bones are often so shaped that a head like enlargement of one fits into a hollow cavity, called synovial cavity in the other. The synovial joint is further sub-divided into the following types depending on shape and mode of movement :

(i) Ball and Socket Joint – Here, one of the 2 bones has a ball like spherical head, which fits into a cuplike depression of other bone, e.g. shoulder joint and hip joint. Balls of humerus and femur fit into the glenoid cavity and acetabulum respectively.

(ii) Hinge joint – This joint allows movement in one plane only, e.g. ankle joint, knee joint etc., are example.

(iii) Gliding joint – Here, two bones slide upon each other, permitting only back and forth and side-to-side movement, e.g. between radio-ulna, between sternum and clavicles etc.,

(iv) Pivot Joint – In such type, one of the bones is fixed in its place and bears a peg like projection or the pivot. The other, fitting over the pivot by a concave depression. The elbow joint is a combination of hinge and pivot joints.

(v) Angular, Ellipsoid or Condy Loid Joint – This joint allows movement in two directions like back and forth and side-to side, e.g. joints between metacarpals and phalanges.

(vi) Saddle Joint – It resembles ball and socket joint but both structures are poorly formed, e.g. metacarpals of the thumb and the corresponding carpals.

Disorders of Muscular and Skeletal System

(1) Myasthenia gravis – It is an autommune disorder. Self antibodies are generated against acetylcholine receptors at the neuro – muscular junction. Receptors are blocked and destroyed. Motor nerve fibers fails to transmit signal, which leads to serve muscle weakness.

(2) Tetany – When a muscle is stimulated rapidly and repeatedly, contraction occurs before it is relaxed. The individual contraction responses fuse into one continuous contraction. This response is known as tetanus.

(3) Muscular dystrophy – This refers to a disorganization of the skeletal muscle fibers, e.g. Duchenne Muscular Dystrophy (DMD). It is an X-linked disorder. Persons having this disorder die around 30 years. Due to mutation of a muscle protein, dystrophin, it is not synthesized.

(4) Arthritis – Arthritis is an inflammatory condition of the joints causing pain and swelling. It is of three types :

(i) Rheumatoid arthritis – It is an autoimmune disorder, where immune system fails to recognize the self antigens. It occurs at synovial joint to chronic inflammation due to destruction of buny and cartilage material.

(ii) Osteoporosis – This is the common bone disorder in elderly people. It occurs due to loss of minerals and organic matrix from bone, reducing bone mass and density. It occurs more in women than men.

(iii) Gout – This is other form of arthritis. It is characterized by an elevated level of uric acid in the body fluid. It causes excessive deposition of insoluble crystals of sodium urate at the joints. The most prevalent cause of gout is an improper exertion of uric acid.

QUESTIONS

1. Choose the correct answer from the choices given under each bit:

1. Ends of long bone we covered with :
   (i) Ligaments (ii) Hyaline Cartilage
   (iii) Muscles (iv) Blood cells
2. The number of 'floating ribs' in human body is :
   (i) 6 pairs (ii) 5 pairs
   (iii) 3 pairs (iv) 2 pairs
3. Which of these is the contractile protein of a muscle ?
   (i) Tubulin (ii) Myosin
   (iii) Tropomyosin (iv) All of these
4. Sprain is due to excessive pulling of :
   (i) Ligaments (ii) Muscles
   (iii) Nerves (iv) All of these
5. The contraction and relaxation period of muscle constitute:
   (i) Muscle beat (ii) Muscle stimulus
   (ii) Muscle twitch (iv) Muscle conduction
6. During fatigue :
   (i) Blood circulation in muscles stop (ii) Muscles fail to relax
   (iii) Muscles fail to be stimulated (iv) Motor nerves does not respond to muscles.
7. Myoglobin is found in :
   (i) White fibers (ii) Red fibers
   (iii) Can be traced in both (iv) Cardiac muscles only
8. The joint between sternum and ribs is:
   (i) Hinge (ii) Cartilaginous
   (iii) Fibrous (iv) Angular
9. Which molecule provides ATP during muscle contraction ?
   (i) Myoglobin (ii) Creatine phosphate
   (iii) Hemoglobin (iv) Myosin
10. One of these is true for muscle contraction ?
   (i) A-zone is constant (ii) I-zone expands
   (iii) H-zone contracts (iv) None

2. Give the answer in one or more words only:

a. What is mycology ?

b. What is the alternate name of breast bone?

c. What do you call the bones of the wrist ?

d. How many Lumbar vertebrae are there in human?

e. What is a vibrate limb having five digits known as ?

f. What is the alternate source of energy in a skeletal muscle ?

3. Differentiate between :

(a) Actin and Myosin

(b) Appendicular skeleton and Axial skeleton

(c) Skeletal muscle and cardiac muscle

(d) Red muscle fiber and white muscle fiber

(e) Striated muscle fiber and Non-striated muscle fiber

4. Fill in the blanks :

(i) There are _____ nos. of cervical vertevbrae in all mammals

(ii) Knee joint is a _____ type if joint

(iii) A muscle gets fatigued by an accumulation of _____

(iv) There are _____ number of revtebrare in the human vertebral columns.

(v) Total nos. of bones in the human skull are _____

(vi) Knee joint is a _____ type of joint

(vii) Stiffening of the body after death of a person is known as _____

LONG QUESTIONS

1. Describe the mechanism of muscle contraction
2. Give an account of striated muscle fiber

◆◆◆

UNIT - IX

NEURAL CONTROL AND COORDINATION

The functions of the organ / organ systems in our body must be co-ordinated to maintain homeostasis. Co-ordination is the process through which 2 or more organs interact and complement the functions of one another. The increased supply of oxygen necessitates an increase in the rate of respiration, heart beat and increased blood flow via blood vessles. The functions of muscles, lungs, heart, blood vessels and kidney etc.. are co-ordinated while doing physical work. The neural systems and endocrine systems are co-ordinated and integrate in all activities of our body.

Neurons and Nerves

The functional units of the nervous system are the nerve cells or neurons. Structurally, a neuron is specialized in having an elongated shape with many process arising from it. Functionally, it is also specialized in possessing an excitability property unlike a majority of cells. Hence, it has a property of conduction of impulses from one place of the body to the brain and vice versa.

Structure of Neuron

A neuron is a microscopic structure composed of three major parts namely, cell body dendrites and axon (Figure). The cell body contains cytoplasm with typical cell organelles and certain granular bodies called Nissl's granules. Short fibers which branch repeatedly and project out of the cell body also contain Nissl's granules and are called dendrites. These fibers transmit impulses towards the cell body. The axon is a long fiber, the distal end of which is branched. Each branch terminates as a bulb-like structure called synaptic knob which possess synaptic vesicles containing chemicals called neurotransmitters. The axons transmit nerve impulses away from the cell body to a synapse or to a neuro-muscular of axon and dendrites, the neurons are divided into three types, i.e. multipolar (with one axon and two or more dendrites; found in the cerebral cortex), bipolar (with one axon and one dendrite, found in the retina of eye) and unpolar (cell body with one axon only; found usually in the embryonic stage). There are two types of axons, namely, myelinated and non-myclinated. The myelinated nerve fibres are enveloped with Schwann cells, which form a myelin sheath around the axon. The gaps between two adjacent myelin sheaths are called nodes of Ranvier. Myelinated nerve fibers are found in spinal and cranial nerves. Unmyelinated nerve fibre is enclosed by a Schwann cell that does not form a myelin sheath around the axon, and is commonly found in autonomous and the somatic neural systems.

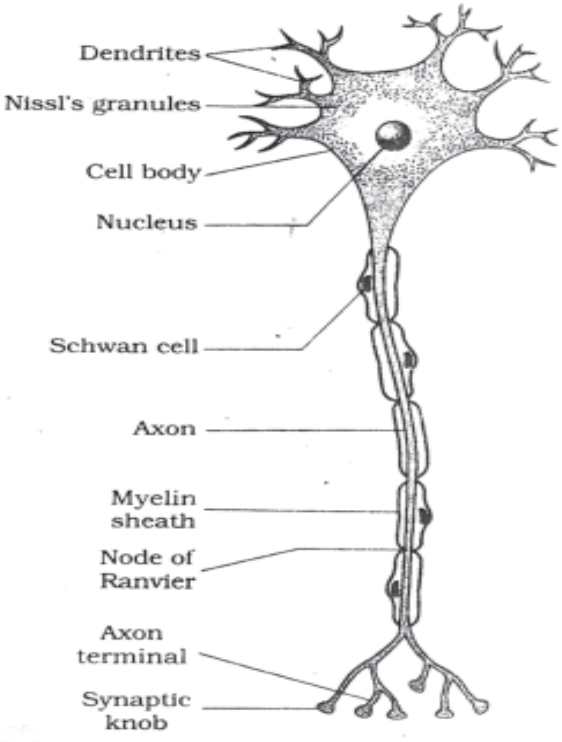


Fig. 43: Structure of neuron

HUMAN NERVOUS / NEURAL SYSTEM

The human neural system is divided into two parts :

(i) The central neural system (CNS)

(ii) The peripheral neural system (PNS)

The CNS includes the brain and the spinal cord and is the site of information processing and control. The PNS comprises of all the nerves of the body associated with the CNS (brain and spinal cord). The nerve fibers of the PNS are of two types.

(a) Afferent fibres
(b) Efferent fibres
The afferent nerve fibres transmit impulses from tissues / organis to the CNS and the efferent fibres transmit regulatory impulses from the CNS to the concerned peripheral tissues / organs.

The PNS is divided into two divisions called somatic neural system and autonomic neural system. The somatic neural system relays. Impulses from the CNS to skeletal muscles while the autonomic neural system transmits impulses from the CNS to the involuntary organis and smooth muscles of the body. The autonomic neural system is further classified into sympathetic neural system and parasympathetic neural system.

Central Nervous System (BRAIN)

Structurally, as well as functionally, the brain is divisible into three main parts – fore-brain, mid brain and hind brain. The hind brain continues into spinal cord. The classification or division of three main parts of the brain are as follows:

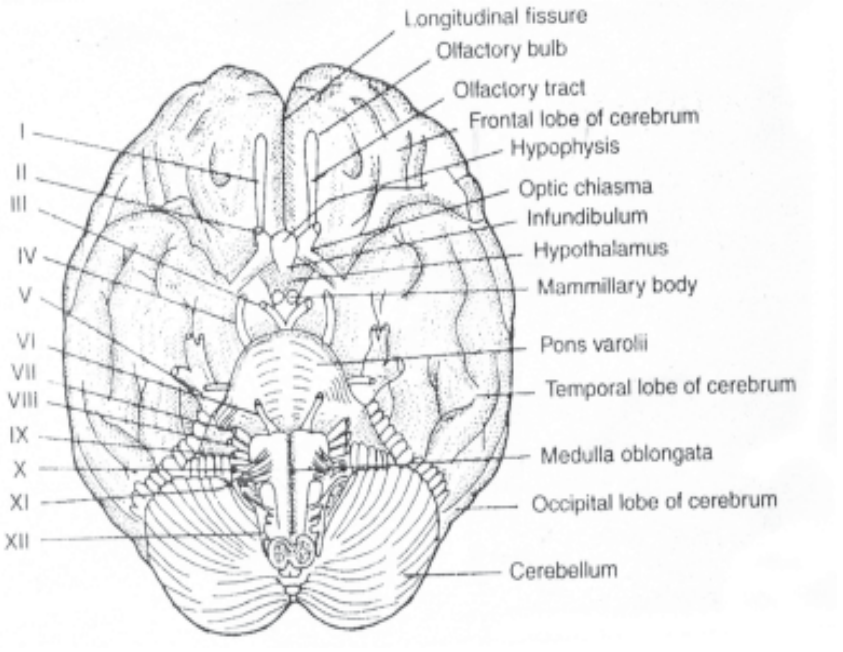


Fig. 44: Human brain in ventral view.

A. **Fore brain** (Prosencephlon)

(i) Olfactory lobes

(ii) Cerebral hemispheres (cerebrum)

(iii) Diencephalon

B. **Mid brain** (Mesencephalon)

(iv) Corpora quadrigemina

(v) Crura cerebri

C. **Hind brain** (Rhombencephalon)

(vi) Cerebellum

(vii) Medulla oblongata

(viii) Pons varolii

(i) Olfactory lobes – (Rhinen cephalon) – these lobes are a pair of small, solid, club shaped bodies widely separated from each other. They are completely covered by the cerebral hemisphere. Each olfactory lobe consists of anterior olfactory bulb and posterior olfactory tract.

(ii) Cerebrum (telencephalon) – It is the largest part of the brain. The cerebrum at the bottom are joined by a thick band of nerve fibres called corpus callosum. The surface of hemisphere is made up of grey matter. The surface shows many folds called gyri separated by depressions called sulci. Three deep fissures or sulci divide each hemisphere into 4 lobes.

(a) Central Sulcus demarcates the anterior frontal lobe and middle parietal lobe.

(b) Parieto – occipital fissure demarcates the parietal lobe from the posterior occipital lobe

(c) Lateral or Sylvian fissure demarcate the parietal and frontal lobes from the temporal lobe.

(iii) Dincephalon (thalamencephalon) – It is a small, unpaired and median squarish part of the brain which remains covered from dorsal side by cerebrum and visible as hypothalamus from ventral side. The hypothalamus can be identified by the presence of optic chiasma. An sac like out growth called infundibulumc arises from the behind of optic hiasma. A small rounded by called hypophysis occurs behind the infundibulum and both are attached by Rathke's pouch and forms an endocrine gland, Pituitary gland. At the tip of pineal stalk, a rounded pineal body occurs.

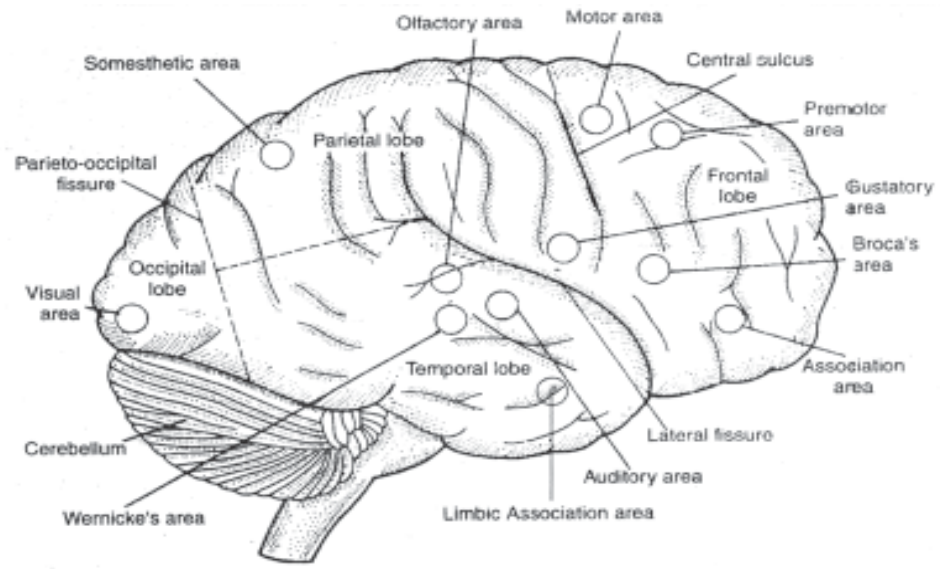
(iv) Corpora quadrigemina : The mid brain is very small and is covered by cerebral hemispheres. The dorsal surface of the mid brain on each side consists of superior and inferior colliculi or corpora bigemina and of both sides are as corpora quadrigemina or optic lobes as termed in other vertebrates.

(v) Crura Cerebri : the crura cerbri or Cerebral peduncles are a pair of thick bands of nerve fibres present on the ventral side of the midbrain. It connects medulla oblongata of hind brain with cerebrum of the forebrain.

(vi) Cerebellum (metencephalon) It is large and well developed. It is solid structure and has a core of while matter (arbor vitae) surrounded by a sheath of grey matter, which is greatly folded. It has two lateral folds, the Cerebellum hemispheres and a central small fold, the vermis.

(vii) Medulla oblongata (myelencephalon) : It is the poster for most part of the brain. The lower end of medulla extends in the form of spinal cord, which leaves the skull through foramen magnum.

(viii) Pons varolli : A band of nerve fibres lies between the medulla and the midbrain on the ventral side. It carries impulses from one part of the cerebellum to the other.



Functional area of the brain

Ventricles of Brain : The internal cavities present in the brain are called ventricles. These cavities remain filled with cerebrospinal fluid. The ventricles are :

Ventricle I – in right cerebral hemisphere
Ventricle II – in Left cerebral hemisphere
Ventricle III – in diencephalon
Ventricle IV – in medulla oblongata

Ventricle I and II are called paracoels or lateral ventricles. It opens to ventricle III of diencephalon by foramen of magnum. Ventricle II of diocoel is a small cavity. Ventricle III opens into ventricle IV of medulla by way of a narrow tube, iter.

Functions of Brain

1. Olfactory lobe – This is the centre of sense of smell
2. Cerebrum – The sensory area of the parietal lobe perceives sensations like pain, touch, taste, temperature. The visual area in the occipital lobe are the centre of sight. Broca's area is related with speech.
3. Diencephalon – It is the centre of recognition of heat, cold, pain and anger. It also controls hunger, thirst, sweating, sleep, fatigue, sex and emotions etc. It also controls carbohydrates fat and water metabolism.
4. Corpora quadrigemina – It is concerned with sense of sight, hearing and also controls muscle tone.

5. Crura cerebri – It serves to transmit motor impulses to limb muscles from cerebrum.
6. Medulla oblongata – It controls swallowing of food, coughing, sneezing and vomiting. It also controls heart beat and blood pressure. It is also concerned with equilibrium and auditory functions of ear.
7. Pons Varolii – It serves as neuronal link between the cerebral cortex and the cerebellum

SPINAL CORD

Spinal cord is an extension of medulla oblongata, which leaves the skull through foramen magnum. It is located in the neural canal of the vertebral column. The spinal cord is slightly flattened dorsoventrally and has two enlargements : Upper cervical and lower lumbar. The T.S. of spinal cord reveals the presence of an inner zone of 'H' shaped grey matter. Dorsal fissure and Ventral fissure are present. A pair of spinal nerves arise, one from each side of spinal cord. Each nerve originates by a dorsal nerve root and a ventral nerve root.

Functions of Spinal Cord

(i) It conducts nervous impulses to and from the brain.
(ii) It is concerned with spinal reflex actions.

REFLEX ACTION – All living organisms show two types of actions. Voluntary and involuntary. A voluntary action is performed by the consent of the brain of a person. The person can exercise its choice and plan to achieve definite objectives, for example efforts for defense, offense, courtship, copulation etc.,

An involuntary action occur automatically without the consent of brain. This action is not under the control of will. It is very quick and animal has no choice in it. The involuntary actions are known as reflex action, e.g. blinking of eye, sneezing by nose.

REFLEX ARC (Fig. 10.12)

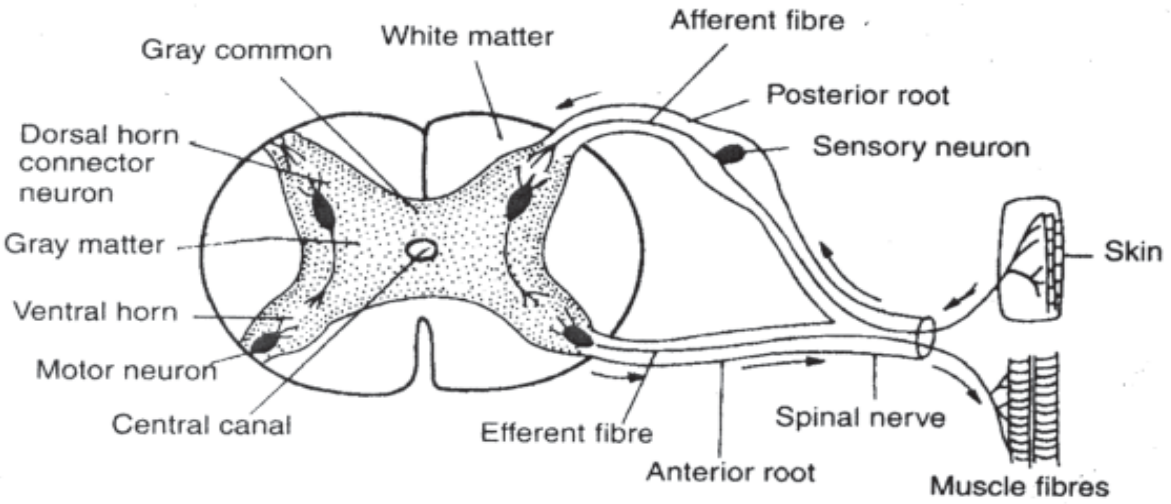


Fig. 46: Reflex are (Simple).

The path travelled by an impulse in a reflex action is called the reflex arc. It consists of five parts :

(i) A receptor or skin, the neurons of which start a sensory impulse.

(ii) An afferent nerve, which brings sensory impulse from the receptor to the central nervous system.

(iii) The neurons present in the spinal cord change the sensory impulse into the motor impulse.

(iv) An efferent nerve, which carries the motor impulses from the spinal cord to the specific effectors like muscles fibres or gland cells.

(v) An effector, where impulse terminates and response is given.

A nerve impulse can flow only in a single direction in a reflex arc. Repeated stimulations of a receptor may cease the reflex response for some time because the synapses in the reflex are get fatigued.

PERIPHERAL NERVOUS SYSTEM

Nerves, which originate from brain are called cranial nerves and those originate from spinal cord are called spinal nerves.

THE CRANIAL NERVES

Name	Fibers	Comments
I. Olfactory nerve	Afferent	Tract of brain; not true nerve, Carries input from receptors in olfactory (smell) epithelium.
II. Optic nerve	Afferent	Tract of brain; not true nerve. Carriers input from receptors in eye.
III. Oculomotor nerve	Efferent	Innervates skeletal muscles that move eyeball up, down, and medially and raise upper eyelid; innervates smooth muscles that constrict pupil and alter lens shape for near and far vision.
IV. Trochlear nerve	Afferent	Transmits information from receptors in muscles.
	Efferent	Innervates skeletal muscles that move eyeball downward and laterally.
V. Trigeminal nerve	Afferent	Transmits information from receptors in muscles.
	Efferent	Innervates skeletal chewing muscles.
VI. Abducens nerve	Afferent	Transmits information from receptors in skin, skeletal muscles of face, nose, and mouth; and teeth sockets.
		Efferent Innervates skeletal muscles that move eyeball laterally.

VII. Facial nerve	Afferent	Transmits information receptors in muscle.
	Efferent	Innervates skeletal muscles of facial expression and swallowing; innervates nose, palate, and lacrimal and salivary glands.
	Afferent	Transmits information from taste buds in front of tongue and mouth.
VIII. Vestibulocochlear nerve	Afferent	Transmits information from receptors in ear.
IX. Glossopharyngeal nerve	Efferent	Innervates skeletal muscles involved in swallowing and parotid salivary gland.
	Afferent	Transmits information from taste buds at back of tongue and receptors in auditory-tube skin.
X. Vagus nerve	Efferent	Innervates skeletal muscle and glands of thorax and abdomen.
	Afferent	Transmits information from receptors in thorax and abdomen.
XI. Accessory nerve	Efferent	Innervates neck skeletal muscles.
XII. Hypoglossal nerve	Efferent	Innervates tongue skeletal muscles.

SPINAL NERVES: There are 31 pairs of spinal nerves in man. They are categorized into five groups:

(i) Cervical – 8 pairs in neck region

(ii) Thoracic – 12 pairs in thoracic region

(iii) Lumbar – 5 pairs in Upper part of abdomen

(iv) Sacral – 5 pairs in Lower part of abdomen

(v) Coccygeal – 1 pair in vestigial tails region

GENERATION AND CONDUCTION OF NERVE IMPULSE

The nerve cells are capable of conducting excitations along their membrane. Nerve cells are specialized for receiving stimulus and transferring impulses from one to the other.

Nerve fibres : The impulses travel through nerve cells, which is always unidirectional. A typical neuron consists of cell body, 5 to 7 branched dendrites and a single axon. The synaptic knob of one neuron lie upon dendrites of adjacent neurons. The dendrites and cytons constitute the impulse receiving parts, which receive impulses from receptors. The conductioin of impulse in a nerve fibre is essentially an electro-chemical process.

Membrane or Ionic theory of nerve fibre : This theory was put forward by Hodgkin and Huxley. The resting nerve fibre is a long tube, the plasma membrane (axolemma) of which separates two solutions

of different chemical composition. In the external medium (tissue fluid), sodium ions (Na^+) and chloride (Cl) predominate, whereas within the fibre (axoplasm) potassium ions (K^+)

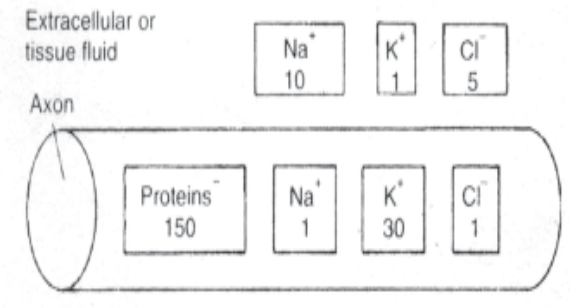


Fig. 47: Distribution of ions in and around an axon

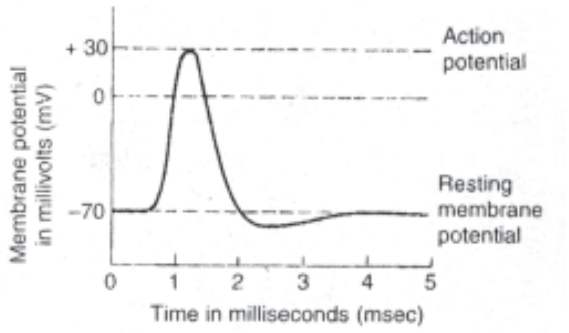


Fig. 48: Record of potential changes of a nerve impulse

The membrane of the resting nerve fibre is more permeable (50 to 100 times more) to K^+ ions leaves faster than Na^+ ions enter in it. This makes the membrane polarized or resting potential. Any type of stimulus results in leakage of Na^+ ion into the nerve fibres. The membrane becomes more permeable to Na^+ ions than to K^+ ions. This results in the positive charge inside and negative charge outside. The nerve fibre is said to be in action potential and it is depolarized. The resulting potential inside the membrane is – 70 mV and action potential is about +30 mV.

After the stimulus is over, the permeability of the membrane to Na^+ ions drops and it becomes more permeable to K^+ ions, with the result membrane turns to its normal condition and gets depolarized or resting potential. The Na^+ ions moves out and K^+ ions move into the fibre by active transport in which considerable amount of energy (ATP) is spent. This is called the 'Sodium – Potassium Pump' of the cells. It operates with the help of Na^+ - K^+ - ATPase enzyme. The period between depolarization and depolarization is called refractory period. In modulated (white) fibres impulse jumps from node to node, it is called 'Saltatory Propagation'.

SENSORY RECEPTION

The sensory organs or receptors make the animal aware, of conditions and changes both outside and inside its body.

EYES – These are the organs of sight. The eye is attached to the wall of skull's orbit by six muscles. These are averaged in 2 groups rectus and oblique. The rectus are superior rectus, inferior rectus, internal rectus and external rectus. The oblique group are superior oblique and inferior oblique.

The eye consists of three layers :

1. The outer fibrous coat – Sclera and cornea
2. The middle vascular coat – Choroid, Ciliary body ribs
3. The inner nervous coat – Retina

1. Fibrous Coat: It protects the eye ball and maintains its form. The outer most coat provides firm surface for

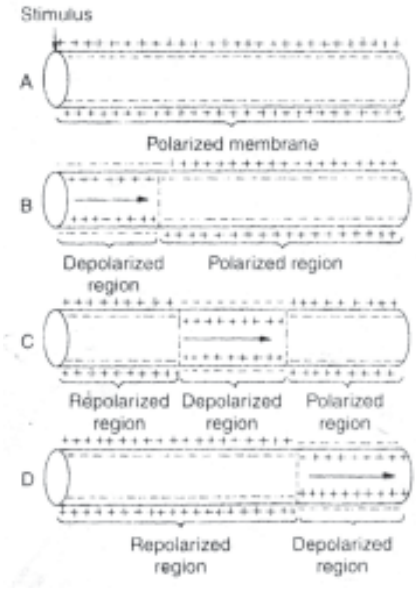


Fig. 49: Transmission of nerve impulse

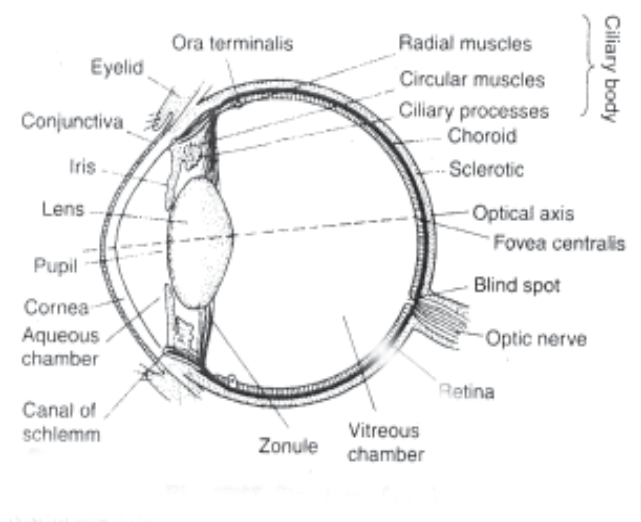


Fig. 50: Structure of eye bell

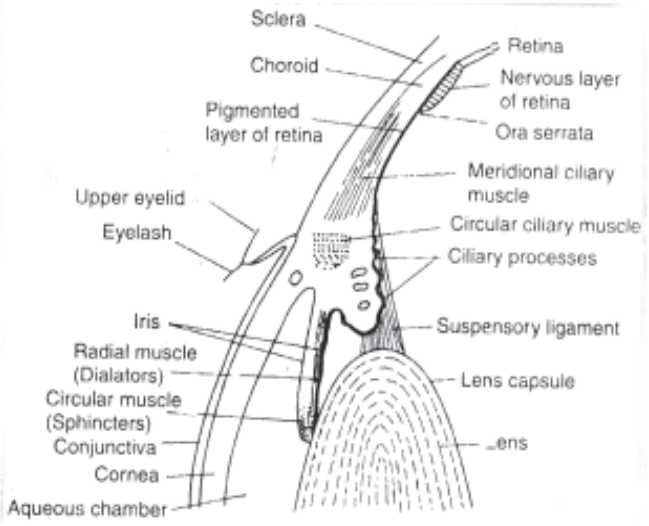


Fig. 51: Radial section of the ciliary part of eye

attachment of eye muscles. It has 2 layers – Sclera and Cornea. A small part called white of the eye is visible from front. The cornea is slightly bulged forward. It remains covered externally by a thin, transparent membrane, the conjunctiva.

2. Vascular Coat – It is composed of posterior choroid, anterior ciliary body and iris. Choroid is dark brown in colour, which absorb light rays and prevents its reflection. The ciliary body consists of circular and meridional muscles. The ciliary processes secrete aqueous humour. The iris contains 2 sets of smooth muscles – circular and radial muscles. These muscles regulate the amount of light by attering the size of the pupil.

3. Nervous Coat – This is the retina. The receptor cells are called rods and cones. This layer is followed by bipolar nerve cells. The next layer is ganglion cells. The nerve fibres of all parts of retina converge to leave through a blind spot. This is the place where neither rods nor cones are present and no image is formed. A small, oval, yellowish area lies exactly opposite to the centre of the cornea called macula lutea or yellow spot. Fovea centralis is the central point of yellow spot, where the vision is most distinct.

The lens is a transparent, biconvex, elastic structure just behind the iris. The lens divide the eyeball into two chambers – anterior watery like aqueous humour and posterior jelly-like Vitreous humour.

Function of Eye

1. Image formation and vision
2. The eye works on the principle of a camera
3. Control of the intensity of light by the iris and pupil
4. Colour vision is possible due to cones
5. Stereo scopic vision
6. Acts as photochemical receptors

EARS

Mammals possess a pair of ears on the sides of the head. The ear performs two sensory functions like equilibrium and hearing. Ear consists of three parts. External ear, Middle ear and Internal ear.

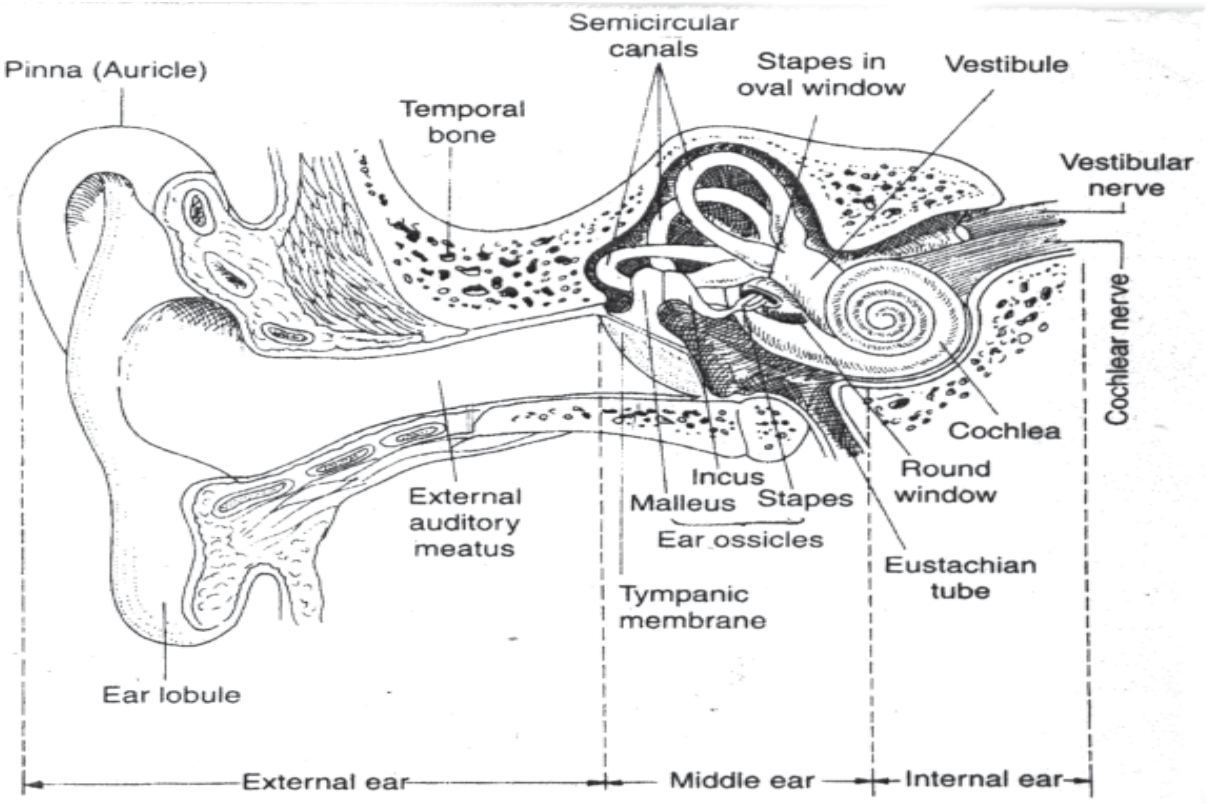


Fig. 52: Structure of the ear

External ear : It consist of pinna, external auditory meatus and tympanic membrane.

The pinna is a sensitive structure, which helps to concentrate and direct the vibrations into the ear. External auditory meatus is a tubular passage, which is lined by epithelium bearing hairs and was glands. The tympanic membrane is a thin, tightly stretched membrane. It separates middle ear from external ear.

Middle ear : This part contains three small bones or ossicles. The cavity is connected with pharynx through Eustachian tube, which serves to equalize air pressure in both sides of tympamic membrane. The malleus is attached to the tympanic membrane in one side and to the incus on the other side. The incus is connected with stapes, which is attached with oval membrane called fenestra ovalis. The other round membrane fenestra rotundus also joins tympanic cavity.

Internal ear : The internal ear is called labyrinth, which is divided to bony Latoyrinth and membranous Labyrinth. These are filled with fluid like perilymph and endolymph respectively. Membranous is called Stato – acoustic organ, which consists of utriculus, sacculus, semi-circular canals and cochlea, which consists of utriculus, sacculus, semi-ciurcular canals and cochlea. A special group of sensory cells, called macula are present in both utriculus and succulus.

Functions :

1. Hearing – sound waves are collected by pinna and directed in ward through external auditory meatus, tympanic membrane, ear ossicles and fenestra ovalis, fenestra rotundus to the cochlea for sound receptions and finally for hearing.

2. Equilibrium : Cristae and maculae are organs of balance and posture. Maculae balances against gravitational force and keep the body static.

QUESTIONS

Choose the correct answer form the choices given under each bit :

1. Which is the largest part of the brain ?
   (i) Cerebrum (ii) Medulla oblongata
   (iii) Cerebellum (iv) Corpora quadrigemina
2. Third ventricle lies in :
   (i) Mid brain (ii) Medulla oblongata
   (iii) Diencephalon (iv) Cerebrum
3. The branched tree like structure present in the cerebellum is :
   (i) Arbor vitae (ii) Arboreal
   (iii) Archenteron (iv) Areole
4. Which part of the brain controls emotions like lover, anger and pleasure?
   (i) Medulla oblongata (ii) Hypothalamus
   (iii) Cerebrum (iv) Cerebellum
5. Which of the following is a purely motor curve ?
   (i) Facial (ii) Vagus
   (iii) Trochlear (iv) Trigeminal
6. Which of the following depresses the heart beat ?
   (i) Pericardial (ii) Spinal accessory
   (iii) Trigeminal (iv) Vagus
7. Which one of these is not a reflex action ?
   (i) Salivation (ii) Blinking of eyes
   (iii) Flexion of fore arm (iv) Secretion of sweat
8. Nerve impulse is a process, which is biochemically :
   (i) Electrical (ii) Chemical
   (iii) Electro-chemical (iv) Physical

9. Which ion produces action potential in a nerve ?

(i) K^+ (ii) Cl^-

(iii) Na^+ (iv) Ca^{++}

10. The smallest bone in human body is :

(i) Malleus (ii) Incus

(iii) Stapes (iv) Columella

2. Answer in one or a few words:

(i) Where does like third ventricle ?

(ii) In which part of brain, corpora quadrigemina present ?

(iii) Name the membrane covering the brain and spinal cord ?

(iv) Which is the largest cranial nerve ?

(v) Name the cavity within the spinal cord

(vi) How many spinal nerves are there in man ?

(vii) What is called a junction between a nerve and a muscle ?

3. Fill in the blanks :

(i) The brain is encased in a bony covering called _____

(ii) The junction of two neurons is called _____

(iii) The spinal nerve is a _____ nerve.

(iv) The spot at the back of the eye where rods and cones are absent is called the _____

(v) Temperature regulation of the body is done by _____

(vi) The structure and functional unit of the nervous system is _____

(vii) The cerebrospinal fluid is secreted _____

(viii) The visual sensory cells are of 2 types, namely _____ and _____

(ix) The conduction of a nerve impulse along a myelinated nerve fibre is known as _____ conduction.

(x) The sensory part of cochlea is known as _____

4. Differentiate between :

(i) Axon and Dendron

(ii) Medullated and Non-medullated nerve fibres

(iii) Aqueous humour and Vitreous humour

(iv) Depolarization and Repolarisation

(v) Cerebrum and Cerebellum

(vi) Corpus callosum and Corpus Striatum

Long Answer – type questions

1. Describe the structure of human brain and write the functions of each part.
2. Describe the mechanism of conduction of nerve impulse
3. Give an account of the mechanism of generation and propagation of a nerve impulse

◆◆◆

UNIT - X

CHEMICAL COORDINATION AND REGULATION

Co-ordination is affected by chemicals called hormones secreted from the endocrine glands. These glands have no ducts. The word 'hormone' was introduced by starling in 1905. Huxley called hormones as chemical messengers. The gland with duct is called exocrine gland, which secrets enzyme.

Properties of Hormones

1. Each hormone acts upon definite organs
2. They have high biological activity
3. They act at a different organ (target organ) from the site of production
4. They do not initiate a reaction but can influence its rate.
5. These have slow and long lasting effect.
6. The hormones are non-antigenic effect.
7. They may accelerate or inhibit specific physiological processes
8. They are effective in very low concentration.

HUMAN ENDOCRINE SYSTEM

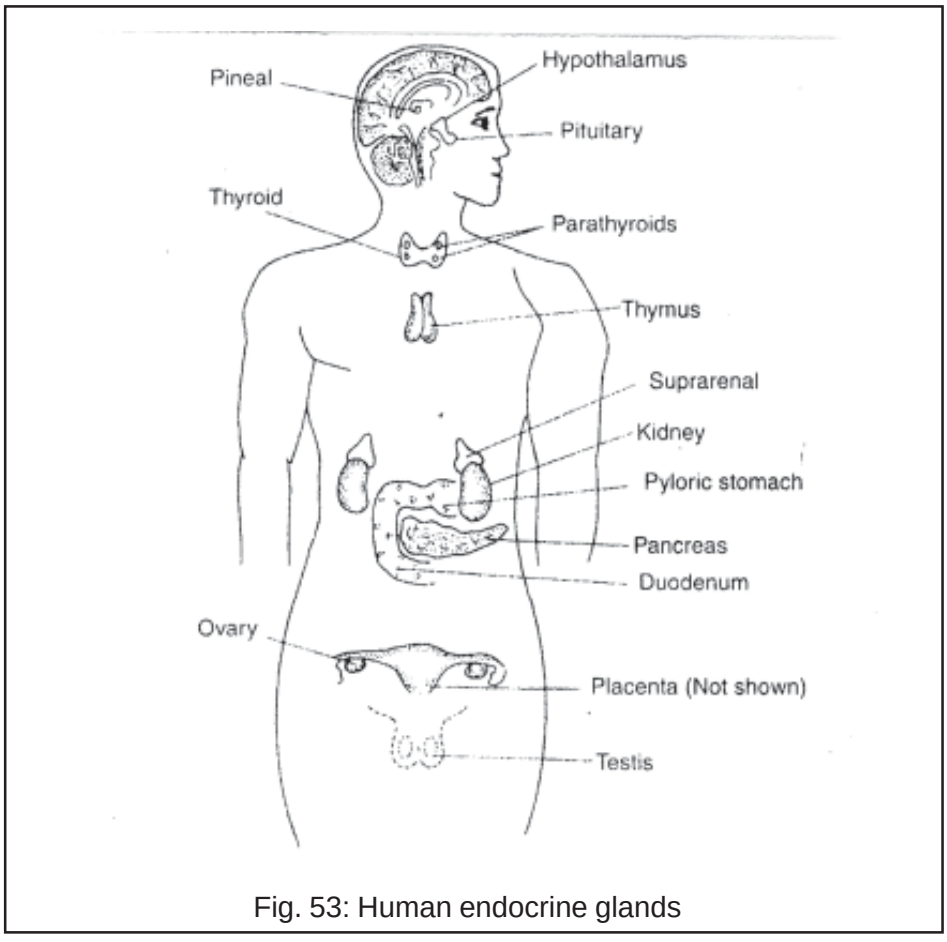


Fig. 53: Human endocrine glands

Pituitary gland

It is small-sized, 10 mm in diameter, weighs about 0.5 gm. The pituitary gland (hypophysis) is attached to hypothalamus by a short infundibular stalk.

STRUCTURE - The term pituitary was given by Vesalius. It has two components – adenohypophysis and neurohypophysis, the adenohypophysis arises from the roof of the buccal cavity in the form of an outgrowth called Rathke's pouch. The neurophypophysis originates as a down growth from the surface of the hypothalamus.

1. Adenohypophysis – This is differentiated into three parts :

(a) Pars distalis is largest part.

(b) Pars tuberalis is smaller than distalise

(c) Pars intermedia is poorly developed in human being.

The Pars distalis and Pars tuberalis form intermediate forms intermediate lobe and Pituitary gland.

2. Neurohypopysis – It is the posterior lobe. It is further differentiated into three parts :

(a) Pars nervosa or neural tube

(b) Infundibular stem

(c) Median eminence is not prominently developed.

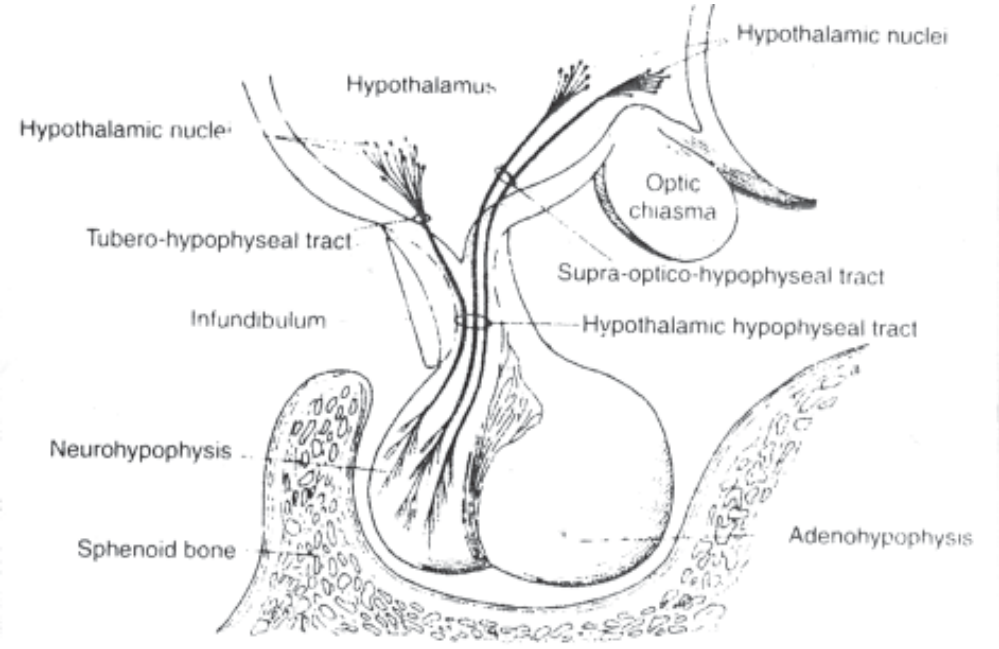


Fig. 54: Showing location of pituitary gland

HORMONES OF ADENOHYPOPHYSIS

1. Growth hormone (GH) or Somatoropic hormones (STH)

This hormone is a protein and composed of 20 amino acids.

Functions – This hormone is more effective in presence of the thyroxine. The main functions are:

(a) STH increases the growth of bones and cartilages

(b) GH promotes protein synthesis

(c) It stimulate lipolysis to release more energy
(d) GH shows diabetogenic effect

2. Thyroid Stimulating hormone (TSH)

It is also called thyrotropin. It shows the following functions :

(a) TSH controls the development and maintenance of thyroid gland.

(b) It promotes accumulation of iodine in the form of iodide.

(c) It increases the secretion of thyroxine (T_4) and (T_3) – tridothyronine.

3. Adrenocorticotropic hormone (ACTH)

It is also called Corticotropin. It is a polypeptide hormone of about 39 amino acids.

Functions: -

(a) ACTH stimulates cortex of adrenals to release adrenocorticoids

(b) The secretion of ACTH is regulated by corticotrophin releasing factor.

4. Gonadotropic Hormones (GTH)

These regulate the developemt bond functions of the gonads.

The gonadotropins are of 2 types :

(i) Follicle Stimulating hormones (FSH)
   (a) It stimulates the development and maturation of Graafian follicles upto ovulation and secrets the hormone, estrogens.
   (b) In male, FSH stimulates the development of seminiferous tubules and sperm formation.
   (ii) Luteinizing hormone (LH) – This hormone is effective in both male and female.
   (a) In females, it causes ovulation. It maintains corpus luteum. After fertilization, it secrets progesterone.
   (b) In males, it stimulates the Leydig cells to secrete testosterone.
5. Leutotropic hormone:
   It is known as lactogenic / mammotropic / prolactin hormone.
   (a) It stimulates the breasts to secrete milk, called lactation.
   (b) Prolactin induces paternalism.

6. Melanocyte Stimulating Hormone (MSH)
It is released by the intermediate lobe of the pituitary gland.
   (a) It appears to be functional only in cold blooded animal.
   (b) It makes the skin darker or lighter from the attack of enemies.

HORMONES OF NEUROHYPOPHYSIS

There are two hormones:
1. Antidiuretic Hormone (Vasopresin) – ADH

(a) It promotes reabsorption of water and helps in osmoregulation. Hyposecretion of ADH results in diabetes insipidus.
(b) ADH causes the contraction of involuntary muscles of blood vessels and raises the blood pressure.

2. Oxytocin (Birth Hormone)

(a) It is produces contraction of uterine muscles to facilitate the movement of sperms into fallopian tube after coitus.
(b) The powerful contraction of pregnant uterus helps during parturition
(c) It plays an important role in lactation.

HYPOTHALAMUS

Hypothalamus develops from the ectoderm of the embryo. It lies below the diencephalon. Hypophysial is connected to pituitary gland by an infundibular stalk or hypophysial stalk.

Hormones – The hypothalamus secrete neurohormones or releasing hormones as follows:

(i) Thyrotropin Releasing Hormone (TRH) – It stimulates the adenohypophysis to secrete its thyroid stimulating hormone (TSH)
(ii) Somatotropin Releasing Hormone (SRH) – It stimulates the adenohypophysis to release the growth hormone (GH).
(iii) Growth inhibiting Hormone (GIH) – It inhibits the secretion of growth hormone (GH) from the adenohypophysis.
(iv) Prolactin Releasing Hormone (PRH) – It stimulates the secretion of prolactin from adenohypophysis.
(v) Prolactin Inhibiting Hormone (PIH) – It inhibits the secretion of prolactin from adenohypophysis.
(vi) Melanocyte releasing Hormone (MRH) – It stimulates the intermediate lobe of pituitary gland to secrete its melonocyte releasing hormone (MRH).
(vii) Melanocyte Inhibiting Hormone (MIH) – It inhibits the secretion of melanocyte stimulating hormone from intermediate lobe of pituitary gland.
(viii) Adrenocorticotropin Releasing Hormone (ARH) – It stimulates adenohypophysis to secrete ACTH.
(ix) Gonadotropin Releasing Hormone (GRH) – It stimulates the adenohypophysis to secrete FSH, LH and ICSH.

THYROID GLAND

The thyroid gland is the largest endocrine gland located below the larynx. It is bilobed and are connected by isthmus. It measure 3-7 cms in length and weighs about 25 gms. It is larger in females than men.

Hormones

The thyroid gland secretes three hormones such as thyroxine, tri-iodothyronin and calcitonin.

1. Tetraiodothyronine (Thyroxine) T_4 and Triodothyronine, T_3

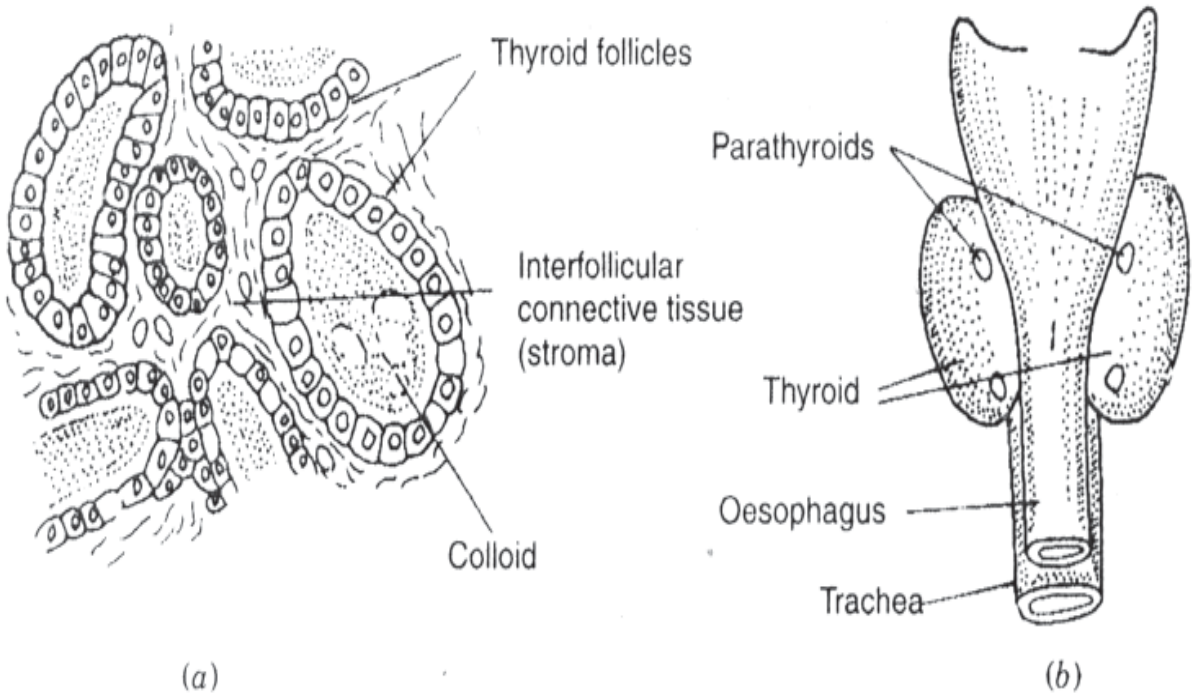


Fig. 55: Histology and location of adrenal gland

These are synthesized in the thyroid follicles. Dietary iodine is converted into iodide and absorbed in the blood from where it is actively transported into the gland.

Functions:

(i) Thyroxine affects general metabolism
(ii) It also facilitates the action of other hormones.
(iii) They promote the development and growth of body, growth and maturation of bones, behavior, reproduction and cellular physiology.
(iv) It is directly involved in the metamorphosis of frog's tadpole.
(v) Thyroxine also affects the urine formation.

2. Calcitonin (TCT)

This hormone is secreted by parafollicular cells of the thyroid gland.

Functions:

(i) It regulates calcium balance in the body along with parthyroid hormone.
(ii) It lowers the blood calcium but increases the calcification of bones

PARATHYROID GLAND

There are four oval parathyroids, partially or completely embedded in the dorsal surface of thyroid gland. Each is oval shaped, small sized, approximately 5 x 5 x 3 mms and about 0.5 gm in weight and yellow coloured. It synthesizes parathormone. Secretion of parathormone is accelerated when calcium level in blood falls, and is retarded when calcium level in blood rises.

Functions :

(i) It regulates the amount of calcium and phosphate molecules in the blood.
(ii) Calcium is the key element for nerve impulse conduction, heart beat, blood, coagulation, bone formation etc.,
(iii) It promotes absorption of calcium from food in the intestine.
(iv) It accelerates elimination of phosphate in the urine.
(v) Parathormone regulates osteoclasts.

PINEAL GLAND

It is a small, grayish red, hollow and conical gland situated on the dorsal wall of of diencephalon. Due to its location, it is also called epiphysis cerebri. In humans, it is 5 to 8 mm long and 9 mm wide. It starts to degenerate around the age of seven and in the adult, it is largely fibrous tissue.
Functions:

1. The gland secrets a hormone, melatonin. It causes the skin to turn into a light colour.

2. In mammals, melatonin acts upon gonads, delaying sexual maturation of immature animals.

3. Melatonin inhibits the ovarian activities and also regulates menstruation cycle.

ADRENAL GLAND

The adrenal gland originate from two embryonic sources – the medulla is derived from ectoderm and the cortex derived from mesoderm. These are paired endocrine glands, located, superior to the kidneys, hence called suprarenals. It is structurally and functionally divided into outer adrenal cortex and inner adrenal medulla.
Hormones of Adrenal Cortex

All hormones secreted by adrenal cortex are steroids derived from cholesterd.
(a) Minerallocorticoids
These are salt retaining hormone called aldosterone.
(i) It helps to retaintion of sodium and water and excretion of K+ ions.
(ii) The Na+ - K+ balance controls the transmission of action potential.
(iii) Low content NaCl stimulates Renin – angiotensin pathway.

(b) Glucocorticoids
This hormone is concerned with normal metabolism and resistance to stress.
(i) It influences gluconeogenesis
(ii) These have anti-inflammatory and anti-allergic properties

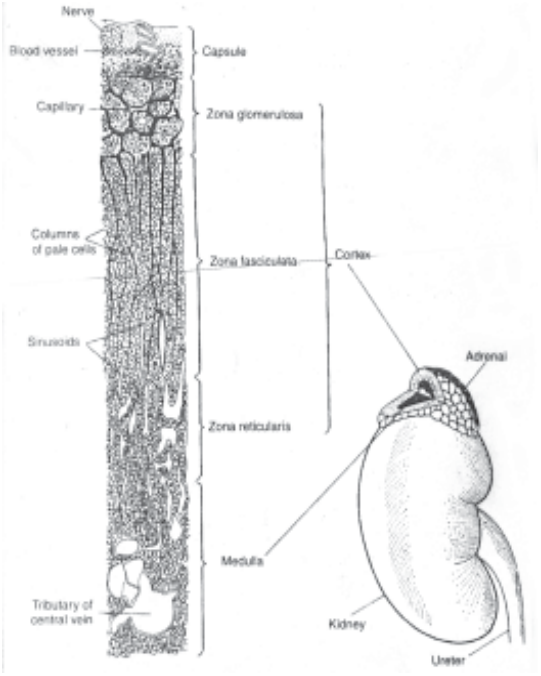


Fig. 56 (a) T.S.through the thyroid of a mammal
(b) thyroids and parathyroids in man (dorsal view)

(c) Sex corticoids
(i) It includes androgens.
(ii) It stimulates the development of secondary sexual character in males.
(iii) Female sex hormone, oestrogens maintain growth of public and auxiliary hairs.

Hormones of Adrenal Medulla

It secrets two hormones like epinephrine or adrenaline and nonepinephrin or non-adrenaline.

Functions :
(i) It increases heart beat and blood pressure.
(ii) It dilates the vessels of skeletal muscles, heart, liver, brain etc.,
(iii) It relaxes smooth muscles of trachea and bronchi, thus increasing the rate of breathing.
(iv) It contracts the arrector pilli muscles of skin raising the hairs.
(v) It retards salivary secretion, causing the dry mouth.
(vi) It dilates the pupils and also causes hyperglycemic effect by increasing blood glucose level.

Adrenaline is also called emergency hormone and hormone of triple F, i.e. adrenaline contributes to fright, fight and flight reactions which occurs in conditions of emergency.

PANCREAS

Pancreas is endodernoal in Origin. Its average length is 12 to 15 cms and weighs about 50 – 70 gms. It's glandular cells are exocrine in function. There are patches of endocrine cells called Islets of Langerhans. There are 3 types of cells :

(a) α – Cells (alpha cells) – A cells

(b) β – Cells (beta cells) – B cells

(c) – Cells (gamma cells) D cells

The alpha cells secrete glucagon hormone – Beta cells secrete insulin, where as gamma cells secrete somatostatin.

Functions : (Insulin)

(i) Insulin increases the permeability of cell membrane to glucose.

(ii) The insulin facilitates synthesis of glycogen.

(iii) Insulin accelerates the phosphorylation of glucose.

(iv) It prevents the formation of glucose from proteins and fats.

(v) It prevents formation of ketone bodies.

Functions: (Glucagon)
(i) Glucagon's main function is to increase glucose level when glucose level falls below normal by glycogenolysis.
Functions : (Somatostanin)
(i) It acts as a paracrine to inhibit the secretion of glucagon and insulin.

GONADS

A. TESTES

Each testis contains numerous seminiferous tubules, where formation of sperms (spermatogenesis) take place. Groups of Leydig's cells are present, which secrete 4 types of hormones:

(i) Testosterone
(ii) Androsterone
(iii) Epiandrosterone
(iv) Dehydro – epiandrosterone

Functions of Androgens :

(i) The testosterone regulates differentiation and development of urinogenital system, accessory genital organs and external genitalia in the embryo

(ii) During childhood, testosterone is not secreted.

(iii) At puberty, the gonadotropic hormone of the pituitary stimulate the Leydig's cells to secrete testosterone.

(iv) Testosterone is responsible for the sex-urge and affinity for a female partner
(v) It controls the growth of sex glands like prostrate, seminal vesicle etc.,
(vi) It stimulates spermatogenesis
(vii) Promotes the development of male secondary sexual characters.
(viii) It exerts a feedback inhibitory effect of pituitary ICSH secretion.

OVARIES

The ovaries consists of large number of ovarian follicles at different stages of development. It secretes three hormones – (i) Estrogens (2) Progesterone and (3) Relaxin.

Functions of Estrogens

(i) Estrogen is responsible for all puberty changes like growth of uterus, development of breasts, vagina, fallopian tubes.
(ii) It controls the formation of secondary sex character like broadening of pelvis, growth of public hormones, beginning of menstrual cycle
(iii) It increases sexual desire in females.
(iv) Estrogen inhibits the growth rate with on set of puberty.
(v) Estrogen reduces the effect of FSH secretion.

Function of Progesterone

(i) Progesterone prepares the uterus for placentation.
(ii) This hormone suppresses menstrual cycle, ovulation etc.,
(iii) It enhances breast development during pregnancy.
(iv) It also causes the enlargement of birth canal by the growth of vagina and relaxation of pelvic ligaments.
(v) It maintains the foetus by forming placenta.

Function of Relaxin
Relaxin widens the pelvic girdle for easy birth of young ones.

MECHANISM OF HORMONE ACTION
The hormones act on their respective target organs. The hormones are either steroid or proteinous. Their effect in the cell is in 2 different ways:

1. The Steroid hormones act within the cell. These pass through cell membrane and bind to specific receptors molecules present in the cytoplasm forming a complex. The complex moves to the nucleus of the cell where hormone molecule binds to the chromosome and activates the gene.

2. (i) Formation of cAMP – The hormone receptor complex releases an enzyme adenyl cyclase, which combines with ATP and forms cyclic adenosine monophosphate (cAMP). The hormone – receptor complex acts as first messenger and the cAMP as second messenger.

(ii) Permeability of Membrane – The hormone – receptor complex modifies the molecular structure of the membrane and changes its permeability. For example excess of glucose causes the release of insulin, which increase the permeability of plasma membrane for transfer of blood glucose into muscle cells.

HYPO AND HYPER ACTIVITY AND RELATED DISORDERS

Hypoactivity of a gland refers to less secretion of hormone and Hyperactivity refers to more secretion of hormone than normal one.
1. Dwarfism – Less secretion of growth hormone during growing years results in dwarfism. In this case, there is an inadequate secretion of growth hormone. The body height never reaches 130 cms. in males and 120 cms in females due to retarded growth of skeletons and others etc., This is a genetic defect.

2. Acromegaly – An excess secretion of growth hormone after the closure of epiphyses, cannot lengthen the bones and height. The consequence is the elongation of jaw bones, deformity of bones of the face, hands and feet. There is thickening of the skin on the face and hands.

3. Goitre – The thyroid gland abnormality results from a deficiency of dietary iodine. In the absence of iodine, the thyroid is unable to produce sufficient T3 and T4 (thyroid hormones) and hence negative feedback mechanism of the hypothalamus and anterior pituitary is lacking. This disease is more common in hilly areas. People suffering from this, have a low metabolic rate and decreased resistance to cold.

4. Exophthalmic goiter – Hyper or excessive secretion of thyroid hormones due to over active action of the gland resulting in the enlargement of the gland. It is characterized by protrusion of eye balls. This conditions is called exopthalmic goiter.

5. Cretinism – The deficiency of thyroid hormone in infants produce cretinism. The person has slow body growth, mentally retarded and sterile dwarf called cretin. The patient have thick and dry skin, enlarged belly, gaping mouth with thick lips and protruding tongue.

6. Diabetes – Diabetes is the physiological consequence of an increase in blood glucose concentration (Hyperglycemia). The role of insulin is to facilitate the uptotake of glucose from the blood by cells. It is characterized by frequent urination, frequent feeling of thirst, increased appetite, excretion of sugar in urine, elevated blood glucose level. Diabetes is of 2 types – Type 1 (juvenile onset diabetes) and Type 2 (Maturity onset diabetes)

7. Addison's disease – it is a disease of adrenal cortex. It is caused by an inadequate secretion of both glucocorticoids and mineralocoytscoids. The symptoms are hypoglycemto, low B.P., increased melanin pigmentaticm on skin, sodium and potassium imbalance etc.,

QUESTIONS

Choose the correct answer from the choices given under each bit :

1. Which of the following glands secrete life shaving hormone ?
   (i) Thyroid (ii) Adrenal
   (iii) Pituitary (iv) Hypothalamus

2. Oxytocin helps in :
   (i) Ovulation (ii) Implantation
   (ii) Lactation (iv) Child birth

3. A molecule acting as 'second messenger' in biological system is :
   (i) C-RNA (ii) C-AMP
   (iii) ADH (iv) GH

4. An endocrine gland, which atrophies in the adult human is :
   (i) Thyroid (ii) Parathyroid
   (iii) Thymus (iv) Pineal

5. Which of the following has no specific target tissue ?
   (i) TSH (ii) STH
   (iii) ACTH (iv) FSH

6. Which hormone possesses anti – insulin effect ?

(i) Cortisd (ii) Calcitonin

(iii) Oxytocin (iv) Aldosterone

3. Answer in one or few words :

(i) Which is the hormone that regulates the height before adolescence ?

(ii) Name the homone that helps in the development of breast.

(iii) The study of glands that secrets hormone is called ?

(iv) Which is the mechanism that forms glucose from non carbohydvates ?

(v) Name the hormone that promotes early stages of gametogenesis

Fill in the blanks:

(i) The pituitary gland is constituted by adenohypophysis and _____

(ii) Posterior pituitary secreted two hormones, namely_____ and _____.

(iii) Estrogens are secreted by _____ cells of the ovary.

(iv) Blood calcium level is monitored by hormones _____ and _____

(v) _____ has been designated as emergency hormone.

4. Differentiate between :

(i) Insulin and Glucagon

(ii) Enzyme and Insulin

(iii) Anterior pituitary and Posterior pituitary

(iv) Estrogen and Progesterone

(v) Endemic goiter and Exopthalmic goiter

(vi) Adrenal cortex and Adrenal medulla

LONG TYPE QUESTIONS

1. Give an account of the structure and function of Thyroid gland.

2. Describe the structure of adenohypohpysis. Mention the functions of the hormones secreted from it.

3. Give an account of gonadian hormones.

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Class - XII
ZOOLOGY

ZOOLOGY
LESSON PLAN -2018-19
(2nd Year)

Unit	Lect No	Topic	Date of Completion	Signature
1	**Reproduction**			
		Human Reproduction		
	1	Human reproduction , what is reproduction		
	2	Male reproduction system		
	3	Male reproduction system		
	4	Female reproduction system		
	5	Female reproduction system		
	6	Gametogenesis – spermatogenesis		
	7	Oogenesis		
	8	Menstrual Cycle		
	9	Fertilisation		
	10	Embryo development up to blastocyst formation		
	11	Embryo development up to blastocyst formation		
	12	Implantation		
	13	Pregnancy and placenta formation (Elementary Idea)		
	14	Parturition (Elementary Idea)		
	15	Lactation (Elementary Idea)		
	Reproductive Health			
	16	Need for reproductive health		
	17	Prevention of sexually transmitted diseases(STD)		
	18	Birth control- need		
	19	Methods of birth control		
	20	Contraception and Medical Termination of Pregnancy (MTP)		
	21	Amniocentesis		
	22	Infertility and assisted reproductive technologies –IVF		
	23	ZIFT,GIFT (Elementary idea for general awareness)		
II	**Genetics and Evolution**			
		Sex determination		
	24	Heredity, Variation, Gene, Allele, Chromosome arrangement		
	25	Sex determination – in humans, birds, honey bee		
	26	Sex linked inheritance – Haemophilla		
	27	Colour blindness		
	28	Mendelian disorders in human- Thalasemia, Chromosomal disorders in humans – Down's syndrome		
	29	Turner's and Klinefelter's syndrome		
	Evolution			
	30	Origin of life		
	31	Biological evolution and evidences for biological evolution		

	32	Comparative anatomy		
	33	Embryological evidence		
	34	Paleontological evidence		
	35	Molecular evidence		
	36	Darwinism		
	37	Neo, Darwinism		
	38	Modern Synthetic theory of Evolution		
	39	Mechanism of evolution – Variation & Mutation		
	40	Recombination and Natural Selection with examples		
	41	Types of natural selection		
	42	Geneflow and genetic drift		
	43	Hardy- Weinberg's principle		
	44	Adaptive Radiation		
	45	Human evolution(in brief)		
III	**Biology and Human Welfare**			
	46	Pathogens, Parasites causing human diseases		
	47	Malaria		
	48	Filariasis		
	49	Ascariasis		
	50	Typhoid		
	51	Pneumonia, common cold		
	52	Amoebiasis, ring worm		
	53	Basic concepts of immunology- vaccines		
	54	Cancer		
	55	HIV		
	56	AIDS		
	57	Adolescence		
	58	Drug and alcohol abuse		
	Improvement in food production			
	59	Apiculture		
	60	Animal husbendary		
IV	**Biotechnology and its Applications**			
	61	Principles and process of Biotechnology		
	62	Genetic engineering (Recombinant DNA technology)		
	63	Application of Biotechnology in health and agriculture		
	64	Human Insulin and vaccine production		
	65	Genetically modified organisms –Bt crops		
	66	Transgenic Animals		
	67	Bio safety issues, Biopiracy and Patents		
	68	Gel Electrophoresis and Types of Blotting		
	69	Polymerase Chain Reaction		

Unit-1

MALE REPRODUCTIVE SYSTEM OF MAN

The male reproductive system consists of a pair of testes, genital ducts, a penis and accessory glands. Testes lies outside abdominal cavity in scrotum, which communicates with abdominal cavity through linguinal canals.

Testes – Covered by tunica albuginea A number of septa divides it into 250 testicular lobules each having semniferous tubules. Inside it groups of intestinal cells or cells of leydig are present which secrete male sex hormone, testosterone. By spermatogenesis sperms produced inside testes pass to rete testis. From rete testis vasa efferentia arise and join together to form vas deferens. The vas deferens joins duct of seminal vesicle to form ejaculatory duct. It open into urethra. The Urethra opens outside at the top of penis as glans covered by prepuce.

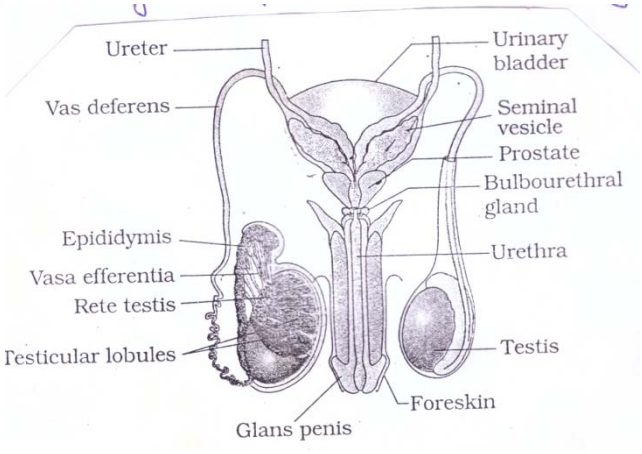


Fig.1-Male reproductive System of human being

The glands associated with male reproductive system are paired seminal vesicles unpaired prostrate glands and paired Cowper's glands.

Female reproductive system:

Human female reproductive system consists of pair of ovaries, a pair of fallopian tubes, uterus, a cervix and a vagina. Ovaries are primary

[Diagrammatic view of male reproductive system (part of testis is open to show inner details]

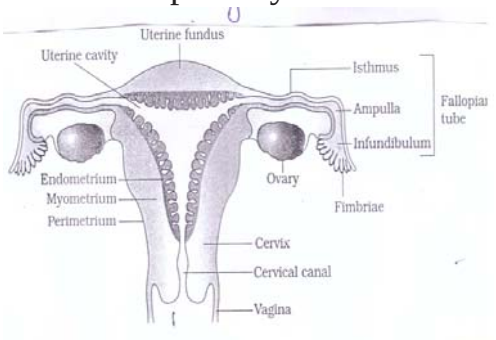


Fig.2- Female reproductive System of human being

female sex organs that produce ovum by oogenesis and hormones. It is covered by peritonium under which germinal epithelium is present. Inside ovary stroma present which is divided into outer cortex & inner medulla. Ovarian follicles develop from germinal epithelium. Mature follicle is known as Graafian follicle . After ovulation, ruptured graafian follicle becomes corpulsuteum . If egg is not fertilized corpus luteum degenerates into mass of cells called corpus albicans . Fallopian tube is divided into four segments ; infundibulum, ampulla, isthmus & interstial region. Uterus is divided into three regions – the corpus, fundus & cervix . The wall of uterus has three layers ; perimetrium, myometrium & inner endometrium . The uterus narrows to form the cervix, which opens into tubular vagina. Two types of accessory glands – glands of skene & bartholins glands associated with female reproductive system. The opening of vagina & urethra are covered by labia minora &labia majora. An erectile organ clitoris is preset.

Gametogenesis – The process by which gametes are formed in gonands is called gametogenesis.

Spermatogenesis- Formation of sperms in testis. It is completed in two steps - formation of spermatids

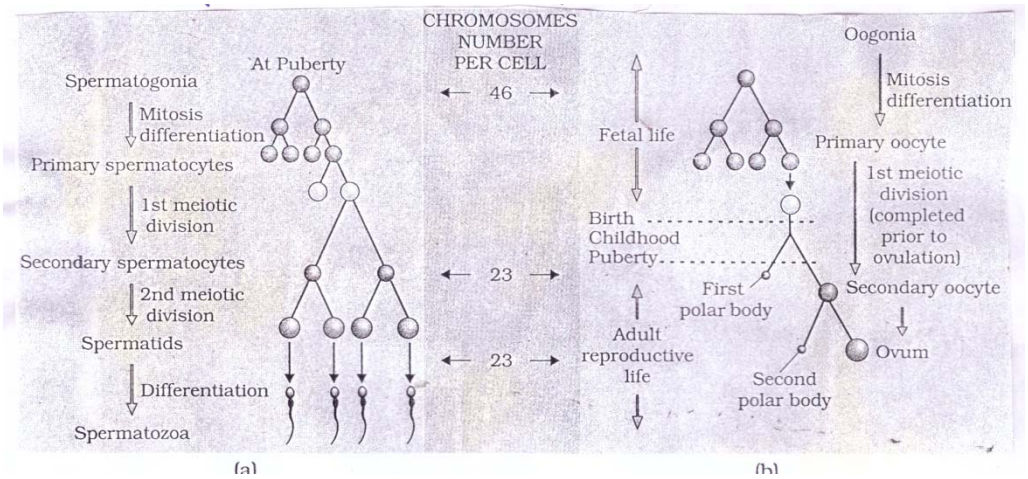


Fig.3 Schematic representation of (a) Spermatogenesis : (b) Oogenesis

and transformation of spermatids into sperm. 1st step is completed in three phases (i) Multiplication phase – Here primordial germ cell by mitosis produce spermatogonia (ii) Growth phase – spermatogonia grow into primary

spermatocyte (iii) Maturation Phase – Through meiosis primary spermatocyte form four haploid spermatid. By spermiogenesis spermatids metamorphose into motile sperm. Structure of sperm consists of head, neck, middle piece & tail .Acrosome present in sperm head.

Oogenesis – Formation of ovum inside ovary. It is completed in three phases. Multiplication phase- Germinal epitheliums divide by mitosis to form primary oocyte. It takes place in fetal life, upto puberty. Growth phase primary follicles become secondary follicles . Maturation phase- primary oocyte undergo meiotic division to form first polar body & secondary oocyte which next meiotic division form second polar body and ovum . Ovum of human is aleithal, its cytoplasm is ooplasm containing nucleus. It is surrounded by zona pellucida , corona radiata.

Menstrual cycle – The first menstrual cycle begins at puberty called menarche in girls at about 10-13 years. It consists of three phases : 1. Menstrual Phase (3-4 days) 2. Proliferative phase (10-11 days) 3. Secretory phase (13-14 days) . The cycle starts with menstrual flow (bleeding). It occurs if secondary oocyte is not fertilized. The cycle is regulated by LH & Progesterone . During proliferative phase primary follicle grow into Graafian follicle . These changes are induced by LH, FSH & estrogen. The 14^{th} day during menstrual cycle is called ovulatory phase. During secretory phase graafian follicle transform as corpus luteum. Menstrual cycle ceases around 45-50 yrs of age termed as menopause.

Fertilization- The process of fusion of a sperm and ovum resulting in the formation of zygote. The fertilizin and anti- fertilizin is secreted by secondary oocyte & sperm of same species react in a reaction known as agglutination reaction. Before fertilization sperm undergoes capacitation and acrosomal reaction. The enzymes help sperm to digest & enter the layers of ovum. Thus

fertilization membrane is formed that blocks entry of additional sperms . The nucleus of ovum condense & turns into female pronucleus. Spermatozoon becomes male pronucleus shedding middle piece of tail . The male & female pronuclei fuse to form zygote nucleus , the process called amphimixis.

Embryo development up to blastocyst formation:

The zygote undergoes cleavage to form blastomeres and develops into morula. The morula divides & transform into a blastocyst. The blastomeres of blastocyst are arranged into outer layer of trophoblast & inner layer of inncer cell mass having a cavity blastocoels.

Implementation: The trophoblast layer gets attached to endometrium & inner cell mass differentiates as embryo. After attachment, blastocyst becomes embedded in the endometrium of uterus. This is called implantation, which leads to pregnancy and Placenta formation – After implementation the chorionic villi & Utrine tissues interdigitate with each other & jointly form plancenta. Placenta is of metadiscodial, deciduous type. Placenta acts as endocrine tissue & procedure several hormones. The umbilical cord of embryo connected to placenta helps in the transport of materials between mother & foetus.

Parturition: The average duration of human pregnancy is about nine months and 10 days called gestation period. The process of delivery of foetus is called parturition. Foetal ejection reflex triggers release of oxytocin . Uterine contraction of oxytocin secretion leads to expulsion of the baby.

Sample Questions:

Q (i). Choose the correct answer

(a) Fertilization (b) Gametogenesis

(c) Spermiogenesis (d) Cleavage

(ii) In human fertilization usually occurs in the

(a) Vagina (b) Cervix

(c) Uterine Cavity (d) Fallopian tube

(iii) Delivery of human baby following pregnancy is known as

(a) Ovulation (b) Parturition

(c) Abortion (d) Conception

(iv) Placenta secretes the hormone

(a) Testosterone (b) Chorinic gonadotropin

(c) Oxytocin (d) Growth Hormone

Q2. Fill in the blanks:-

i. The swollen tip of penis is known as ----------
ii. The inner epithelial living of uterus is known as----------
iii. Corpus luteum is the main sources of estrogens----------
iv. Gonadotropins (FSH & LH) are secreted from----------
v. The menstrual cycle spans ----------days of the olation occurs on the day ----------

Q3. Differentiate between:-

i. Spermatogenesis & oogenesis
ii. Sertolicell & Leydig cell
iii. Corpus luteum & corpus albicans
iv. Spermatocytogenesis & Spermatogenesis
v. Sperm & Ovum

Q4. Long answer type:-

i. Describe the male reproductive system of human being.
ii. Describe the female reproductive system of human being.
iii. Describe the process of Spermatogenesis
iv. Give an illustrated account of oogenesis
vi. Give an illustrated & comparative account of Spermatogenesis & oogenesis

Reproductive Health

The need for reproductive health is to address the major causes of mortality among women & children as well as delays in accessing &utilizing the healthcare issues.

Prevention of Sexually transmitted diseases

- The only way to completely prevent STDS is to abstain from all types of sexual contact. The chance is reduced by using a condom.
- People in habit of frequent sexual contact should get regular gynaecological or made genital examinations.
- The visiting person needs to disclose all facts about his/ her sexual contact to the physician.
- He/she may seek assistance of experts by calling STD hotline operated by some national organisation.

Birth Control:-

Need and Methods – Family planning is a programme aimed at limiting the size of families through prevention of conception.

Contraception is a method that prevents conception. Motivation plays a major role here. Family planning by contraceptive measures are of two types:

1. Spacing
2. Terminal methods

Spacing methods are temporary which are used to postpone birth of children . They are

i. Barrier Method
ii. Use of Intrauterine devices
iii. Chemical method
iv. Hormonal Method
v. Natural Method
vi. Medical Termination of Pregnancy (MTP)- It is carried out early during first trimester . vacuum aspiration & surgical procedures follow the treatment.

Terminal Methods of family planning is permanent methods. They are two types.

1. Vasectomy- It is a surgical method of sterilisation of males. It is done in two ways.
    i. Conventional Vasectomy
    ii. Non-Scalpel Vasectomy
2. Tubectomy – It is a surgical procedure of female sterilization. It is performed by conventional trans abdominal surgery, conventional laparoscopy

Amniocentesis: This is a medical procedure used to know genetic abnormalities of foetus & foetal abnormalities. It is performed for ascertaining the following:

- Abnormal genetic conditions such as Down syndrome
- Baby's lungs are mature enough for birth
- Evaluation of a baby for infections
- Rarely, it is used to decrease the volume of amniotic fluid . Two types of amniocentesis are classed to diagnose two types of fatal abnormalities
    1. Genetic amniocentesis
    2. Maturity amniocentesis

Amniocentesis and stem cells – Recent studies have discovered that amniotic cells can be a rich sources of multipotent mesenchymal hematopoietic , neural , epithelial and endothelial stem cells.

Infertility:

Infertility refers to an inability to conceive after having regular unprotected sexual intercourse causes of infertility in women are

- Ovulation disorders
- Problems in the uterus of fallopian tubes
- Medications

Causes of infertility in men are –

- Low sperm count
- No sperm
- Low sperm motility
- Abnormal sperm

Treatment option for infertility:

Fertility treatment for men

- Erectile dysfunction or premature ejaculation
- Blockage of ejaculatory duct
- Retrograde ejaculation
- Surgery for epididymal blockage

Fertility treatment for women –

- Ovulation disorders
- Surgical Procedure - Fallopian tube surgery
  - Laparoscopic surgery

Assisted Reproductive Technology

Several methods have been practiced for conception and giving birth to healthy babies, which are collectively classed under Assisted reproductive Technology (ART) .

These are following –

1. Intrauterine insemination (IUI)
2. In vitro fertilization (IVF)
3. Donation of sperms or eggs
4. Assisted hatching
5. Electrical stimulation to induce ejaculation
6. Surgical sperm aspiration

IVF-

IVF is a process, by which an egg is fertilized by a sperm outside the body, under controlled laboratory conditions. There are five fundamental steps in the IVF Practiced.

- Step 1 – Stimulation
- Step 2- Egg retrieval
- Step 3- Insemination of fertilization
- Step 4- Embryo Culture
- Step 5 – Embryo Transfer

IVF is done to help a woman pregnant. It is used to treat many causes of infertility.

Zygote Intra – fallopian Transfer (ZIFT):

ZIFT is an infertility treatment used, when a blockage in the fallopian tubes prevents the migration of sperms to the egg.

Gamete Intra fallopian Transfer (GIFT):

GIFT is an assisted reproductive technology to counter infertility. The technique allows fertilization to take place in the woman's uterus. The zygote then implants & women becomes pregnant.

Sample Questions:

Q1. Choose the correct answer

(i) The method of directly injecting a sperm into an ovum is assisted by reproductive technology called

(a) GIFT (b) ZIFT

(c) ICSI (d) ET

(ii) Which is not a spacing method of family planning

(a) Natural Method (b) Terminal Method

(c) Chemical Method (d) Hormonal Method

(iii) Intrauterine devices are not made up of

(a) Plastic (b) Metal

(c) Rubber (d) Plastic& metal

(iv) Which is not a common type of STD?

(a) Genital Wards (b) Syphilis

(c) Cancer (d) Gonorrhoea

(v) The correct surgical procedure as contraceptive method is

(a) Ovariectomy (b) Hysterectomy

(c) Vasectomy (d) Castration

Q.2 Fill in the blanks :

i. The sterilisation procedure in males is called ---------- and in females is called---------

ii. The method of preserving sperm in frozen conditions is called ----------

iii. The monthly release of eggs is called ----------

iv. The ejaculatory duct obstruction in males is confirmed by ----------

v. Fertility treatment with donor eggs is usually done using----------

Unit-II

SEX DETERMINATION

Sex determination system is a biological system that determines the development of sexual characters in an organism. Biologically, sex is an aggregate of those morphological, physiological and behavioural characters, which differentiate male from female. Sex determination occurs in three steps : chromosomal sex determination by sex chromosomes, gonadal sex determination by the differentiation of the gonads and phenotypic sex determination by sex hormones secreted from the gonads.

Sex Chromosome

The sex chromosomes are designed as X and Y or Z and W. These chromosomes are morphologically different from each other. These chromosomes are mainly responsible for determination of sex of organisms. The other chromosomes are known as autosomes or A, which are responsible for somatic characters.

In spite of differences in shape and size, the homologous part of Y chromosome pairs with X chromosome during meiosis. The non homologous part of Y chromosome carries only Y-linked genes or holoandric genes. The Y-chromosome carries a gene ‘sry’ (Sex determining region Y) that codes for a protein called testis determining factor (TDF). TDF is required for the development and differentiation of the testis and its duct system and its absence leads to the development of ovaries.

Geneticists believed that a compensation mechanism might be operating for making the dose of genes on X chromosome equal in both male and female sexes. Mary F. Lyon established that the compensation is achieved by the inactivation of one of the two X chromosomes in the females. He termed it as dosage compensation. The inactivated X chromosome is termed as barr body.

Several genetically controlled sex determination mechanism have been discovered. These are :

1. Chromosomal mechanism
2. Haploid –disploid mechanism
3. Genic balance theory
4. Single gene effect

Chromosomal Mechanism of Sex determination

Many varieties of chromosomal sex determination mechanisms have been described in the animal kingdom. These are :

1. XX-XY mechanism
2. XX-XO mechanism
3. ZZ-ZW mechanism
4. ZZ-ZO mechanism
5. Haploidy- Diploidy Mechanism

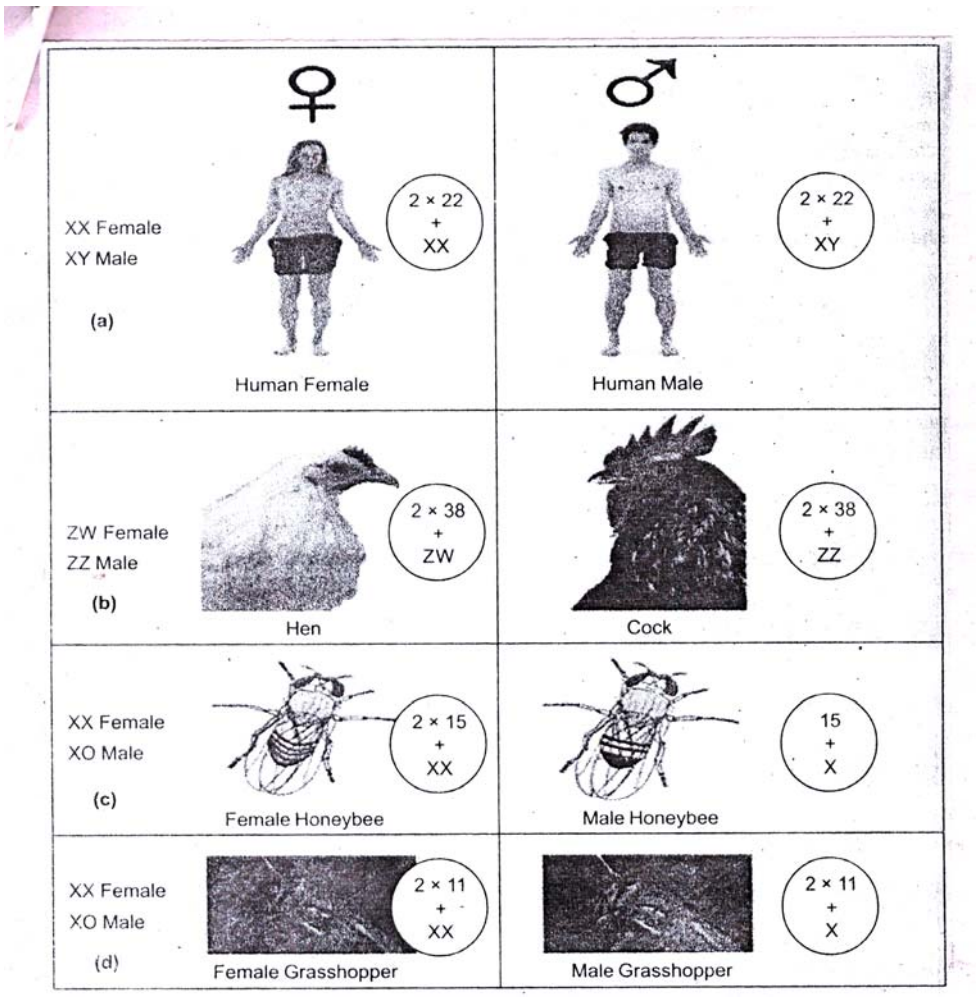


Fig.4 Different types of chromosomal sex determination mechanisms.

6.2.1 XX-XY type or lygaeus mechanism :

Wilson and Stevens first studied it in the milk weed bug, Lygaeus turcicus and hence this mechanism is identified with his name. The female is homogametic (XX) and the male is heterogametic (XY). (e.g., Human and Drosophila).

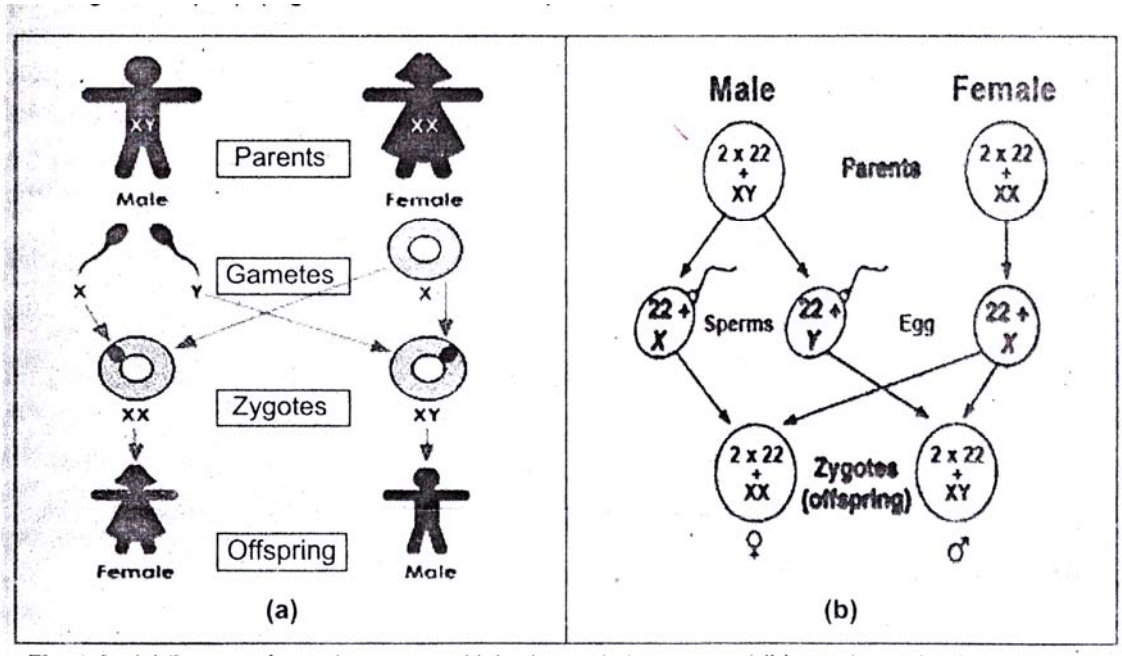


Fig.5 (a) Pattern of sex chromosomal inheritance in human, and (b) sex determination in human.

The female produces one type of egg. i.e. with only 'X' and male produces two types of sperms i.e. with 'X' or 'Y'. Fertilization of female gamete with any one of the male gametes will determine the sex of the offspring. Fig.5(a) & (b)] explains the mechanism.

6.2.2 XX-XO mechanism:

In this mechanism, only the X chromosome is present, the Y being absent.

The female is homogametic (XX) and the male is heterogametic (XO) (Fig.6.4). Maleness is determined by a single X chromosome. O denotes the absence of a Y chromosome.
(e.g., Grasshopper and Bug).

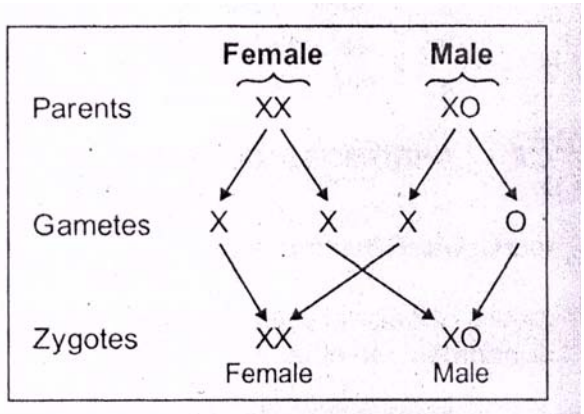


Fig.: 6 XX-XO mechanism of sex determination in grasshopper.

6.2.3 ZW-ZZ mechanism :

In this mechanism, the female is heterogametic (ZW) while the male is homogametic (ZZ). The inheritance of Z and W chromosomes occur in a simple mendelian fashion (Fig.7). (e.g.,Birds).

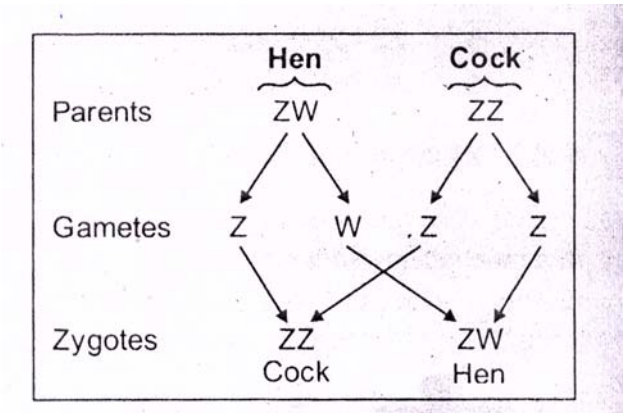


Fig. 7 Sex chromosomal inheritance in fowl.

6.2.4 ZZ-ZO mechanism :

In Lepidoptera (e.g., moths and butterflies), the male is homogametic with two Z chromosomes (ZZ), while the female is heterogametic with one each of Z and W (ZW). However, some females have ZO complement indicating that W is not essential for femaleness.

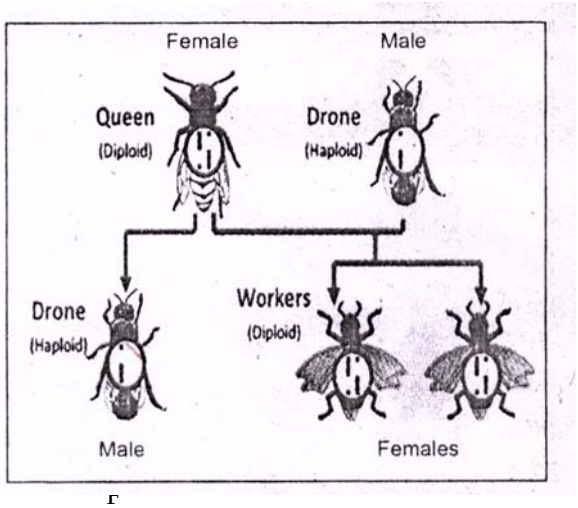


Fig.8 Haplo-diploidy mechanism of the sex determination in honey bee

6.2.5 Haplo-diploidy mechanism :

The female is diploid and male is haploid. Haploid male is produced when the egg is not fertilized (Fig.8). This type of development is termed as **parthenogenesis.** However, fertilized eggs develp as females. (e.g, Honeybee, Wasp and Ant).

GENIC BALANCE MECHANISM :

Unlike the human and other animals, autosomes play an important role in addition to the sex chromosomes in the sex determination process in *Drosophila melanogaster.* C.B. Bridges proposed the genic balance theory of sex determination based on the ratio of the number of X chromosomes and sets of autosomes. According to him, the female determining genes are located on the X chromosome, while the male determining genes on autosomes. Table 1 describes about the phenotypic sex of *Drosophila melanogaster,* based on X / A values.

Table – 1

Sl.No.	Chromosome complement	Ratio = X/A	Sex
1.	2A + XX	2 /2=1.0	Female
2	3A + XXX 4A + XXXX	3/ 3 = 1.0 4/ 4 = 1.0	Triploid Female Tetraploid Female
3	2A + XXX	3/ 2 = 1.50	Super Female
4	3A + XX	2 /3 = 0.67	Intersex
5	2A + XY	1 /2 = 0.50	Male
6	3A + XY	1/ 3 =0.33	Super male

3.1 Gynandromorph in Drosophila as a proof of chromosomal mechanism of sex determination.

In *Drosophila,* occasionally files are obtained which a part of the body exhibits female characters, while the other part male characters. Such files are known as **gynandromorphs.** These develop due to failure of segregation (nondisjunction) of X chromosomes at cleavage. The zygote starts with 2A+2X chromosome complement. During first cleavage one of the X-chromosomes is lost in one of the blastomeres.

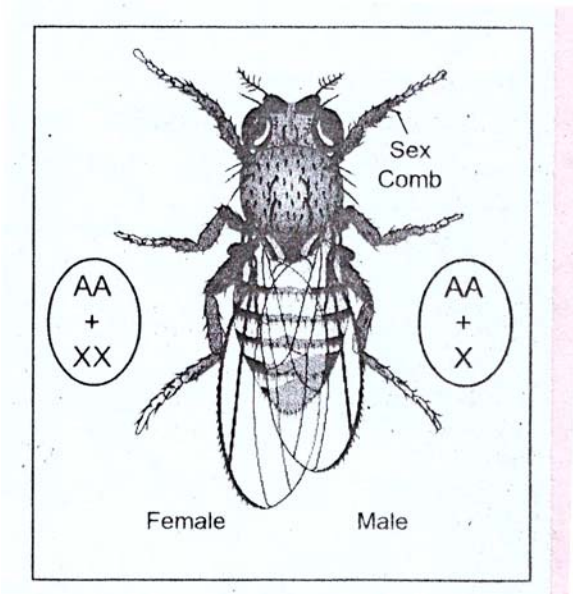


Fig:9 Gynandomorplism in Drosophila

The consequence is that, one of the blastomeres acquires 2A+2X complement, while the other 2A+X. At the end of development, the descendant blasomeres with 2A+XX complement differentiate as female phenotype, while those with 2A+X differentiate as male phenotype. Thus, half of the body is female while the other half is male Fig.9).

SEX – LINKED INHERITANCE

Genes are present on the autosomes control the somatic characters of the organism. But the genes present on sex chromosomes control the sex-characters. However, certain genes present in the sex chromosomes control the somatic characters. The body characters whose genes are located on the sex chromosomes are called sex-linked characters.

Salient features of Sex-linked inheritance

1. The body characters controlled by genes located on the sex chromosomes are called sex-linked characters.
2. The sex-linked characters are transmitted along with the sex of the animal.
3. The sex-linked genes are located on X or Y or both X and Y chromosomes.
4. Most of the sex-linked genes are located on the X chromosomes and their alleles are absent from Y chromosomes.
5. Most of the sex-linked characters are recessive.
6. They are more common in men than women.
7. They follow criss-cross inheritance, i.e. the sex-linked character is transmitted from the father to the grandson through his daughter.

Types of Sex-Linked inheritance

The sex-linked inheritance was first discovered by MORGAN in 1910 in *Drosophila melanogaster*. There are five types of sex-linked inheritance. They are as follows :

1. X-Linked inheritance
2. Y-Linked inheritance
3. XY-Linked inheritance
4. Completely sex-Linked inheritance
5. Incompletely sex-linked inheritance

1. **X-Linked inheritance –** Certain sex-linked gene are only present on X chromosomes and their alleles are absent from Y chromosome. These genes are called X-linked genes and their mode of inheritance is called X-linked inheritance, e.g. Colour blindness and Haemophilia.

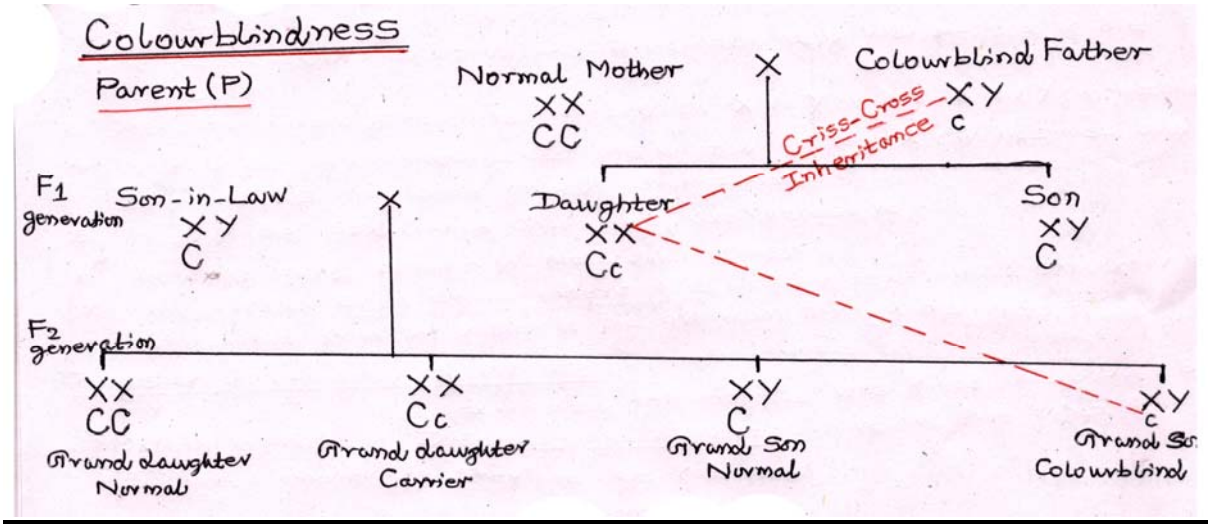
2. **Y-Linked inheritance-** The sex-linked genes located on Y-chromosome only are called Y-Linked genes. The Linked genes also called holoandric genes. These genes are transmitted from father to son, e.g. Hypertrichosis.

3. **XY Linked inheritance –** Certain linked genes are located on both X and Y chromosomes. They are called XY linked genes and their mode of inheritance is called XY Linked inheritance, e.g. Xeroderma Pigmentosa, Nephritis and Retinitis pigmentosa.
4. **Completely Sex-Linked inheritance –** The X and Y chromosome are not similar. The X chromosome is larger and straight but Y chromosome is small and curved. The lower part of X chromosome is similar to that of Y chromosome. These two parts are called homologous regions. The other part of X and Y chromosomes are not similar and are called non-homologous regions.

The genes located on non homologous regions inherit together because crossing over does not occur in these regions. So, the genes located on non homologous region are called completely sex linked genes, e.g. Haemophilia and Colourblindness

5. Incompletely sex linked genes – The genes located on the homologous region of sex chromosome do not inherit together because crossing over may occur in these regions. So, these genes are called incompletely sex-linked genes, e.g Retinitis Pigmentosa, Nephritis.

Colour blindness



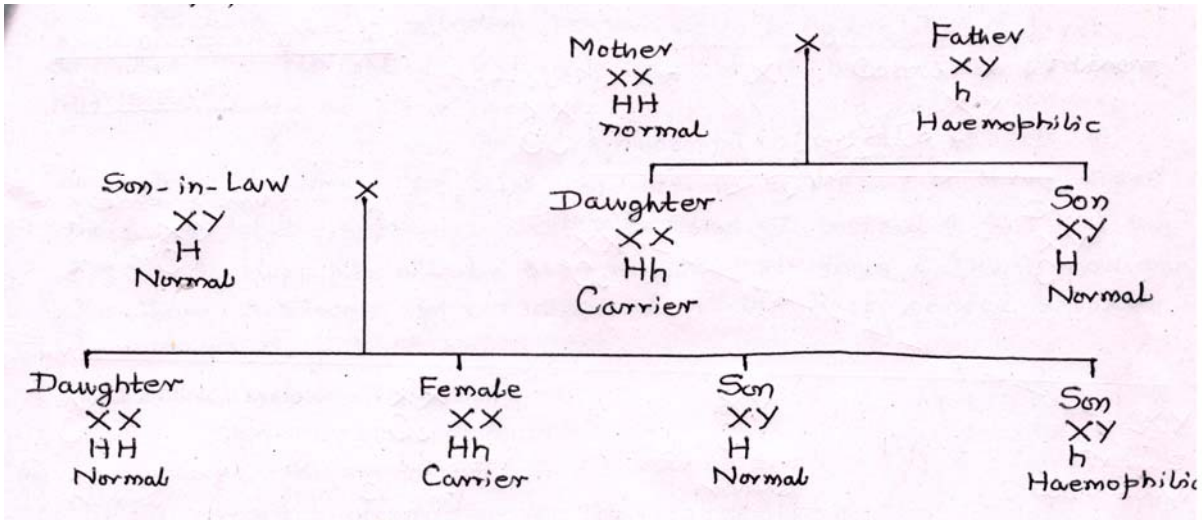
Inheritance of Colourblindness

1. Colourblindness is a sex-linked character discover by WILSON in 1911.
2. The affected person cannot distinguish red colour and green colour.
3. The red blindness and green blindness are called protonopia and deutronopia respectively.
4. Colourblindness is a recessive character.
5. Colourblindness follows criss-cross inheritance as this character is transmitted from father to the grandson through the daughter.
6. This character is common in men but rare in women.
7. It is caused by recessive genes represented by cc. The normal persons contain the genes CC or Cc or C alone (in man). The recessive genes prevent the proper development of colour sensitive cells in the retina.

Haemophilia

1. It is a hereditary blood disease discovered by JOHN COTTO in 1803.
2. This disease is characterised by delayed blood clotting. This is due to the absence of a factor in the blood called antihaemophilic globulin, which plays an important role in blood clotting. So, haemophilia is called bleeder's disease.
3. Haemophilia is a sex-linked recessive character and the genes are located on X chromosome.

4. It is caused by a recessive genes represented by hh and the normal condition is due to dominant gene H.
5. This is also common in male, but very rarely found female.
6. It follows criss-cross inheritance. It is transmitted from the father to the grandson through daughter.
7. Generally haemophilic patients will die before reaching reproductive stage, if they are exposed to severe bleeding.



MENDELIAN DISORDERS IN HUMANS

Normal genes encode normal proteins, which regulate normal physiological functions of the body. When a gene undergoes mutation, it encodes an abnormal protein, which fails to regulate the body functions. In this situation, the abnormal body functions express some abnormal phenotypic characters. The expression of these characters has been referred to as a genetic disorders or syndromes.

(a) Thalassemia -

Thalassemia is an inherited blood disorder, in which the body makes an abnormal form of haemoglobin. There are three forms of thalassemia : α - thalassemia, β-thalassemia and thalassemia minor. α-thalassemia is again of 2 types – haemoglobin H disease and Hydrops Fertalis, which is very much of severe form and it occurs when

all the four globin molecules are mutated. Most babies of this disease are either stillborn or die shortly after birth. Haemoglobin H occurs, when three out of four globin molecules are mutated. β-thalassemia is expressed when the body cannot produce β-globin. It is again of 2 types – thalassemia major (Cooley's anaemia) and thalassemia intermedia. The first type occurs when two β-globin genes are mutated or absent. It is more severe than thalassemia intermedia.

Symptoms, Diagnosis and Treatment

The symptoms are feeling of tiredness, pale skin with severe anaemia, enlarge spleen, yellowish skin and dark urine. The disease is diagnosed by blood test and genetic analysis. The treatment are blood transfusion and bone marrow transplantation.

(b) Down Syndrome

This was previously known as mongolism due to short stature of the affected person. John Langdon Down first described the clinical symptoms in 1866. In this honour, the syndrome has been named as Down syndrome.

It is caused by a chromosomal aberration, known as aneuploidy (trisomy). The 21^{st} chromosome is present in three doses. Thus the total chromosome number becomes 47, instead of 46. Here the zygote develops into a baby expressing the symptoms of Down's syndrome. The Down syndrome was recognized as the first genetic disorder in humans by J.Lejeune in 1959.

6.8.2.2Clinical symptoms :

- Short stature with an epicanthal fold.
- Broad head with round face.
- Wide nostril, open mouth and large tongue with distinct furrow.
- Stubby hands with simian crease on the palm.
- Hyperflexible joints.
- Mental retardation.

6.8.2.3Diagnosis, Treatment and Prevention :

Prenatal screening of the pregnant women in undertaken by ultrasonography and aminiocentesis sampling to make sure about the contraction of this disorder. There is no treatment available as yet. However, counseling through education support and creation of sheltered work environment works encouragingly. Life expectany is 50-60 years.

6.8.3 Turner Syndrome :

Turner syndrome is a condition, in which a female is missing one of the two X chromosomes, such that the complement becomes 45, XO [Fig.10(a)and(b)]. This condition is associated with many abnormal phenotypes, first described by H.H. Turner in 1938. It occurs in about 1 per 2500 live female births. More than 90% of the women bearing fetus affected by Truner syndrome abort spontaneously. An approximate frequency estimate in the human population is 1/5000.

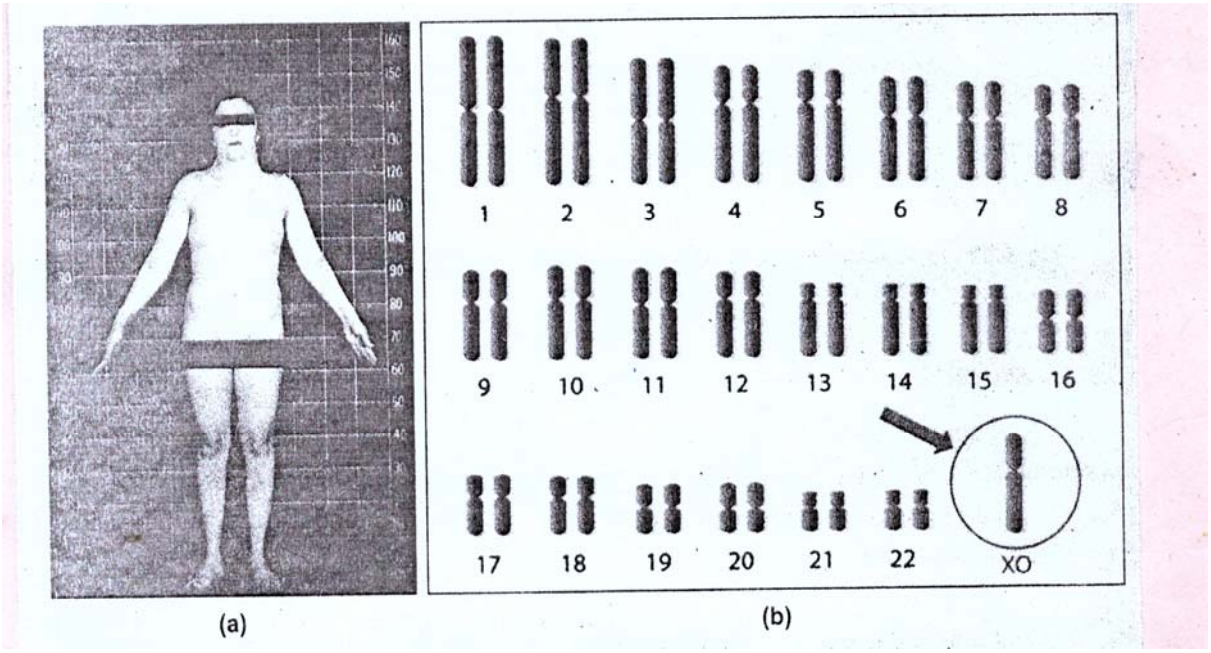


Fig.10(a) A female with Turner syndrome phenotypes, (b) Turner syndrome chromosome complement (the arrow shows one X chromosome, there being no Y chromosome)

6.8.3.1Ganetic Basis :

It is caused by a chromosomal aberration, known as **aneuploidy (monosomy).** In the female, one out of two X chromosomes is missing. Thus, the chromosomal number is 45 instead of normal 46 [Fig.10(b)]. It is the result of primary non disjunction, which may occur in one of the two meiotic divisions of the maturation phase of gametogenesis. The consequence is the formation of an egg with two X chromosomes and another with no X chromosome. If the later one is fertilizsed by a normal sperm bearing an X chromosome, the complement becomes 45, X and Turner syndrome expresses.

6.8.3.2Clinical Symptoms (Fig.10(a)]:

- Short stature with low-set ears
- Webbed neck
- Shield-like chest
- Swollen hands and feet
- Virtually no ovaries
- Limited secondary sexual characters

6.8.3.3Diagnosis, Treatment and Prevention :

Diagnosis is done by physical examination and genetic analysis Turner syndrome affected subjects undergo hormonal therapy. Growth hormone injection in early childhood may increase the height by few inches. Estrogen replacement therapy is undertaken at puberty to start the breast development. Estrogen and progesterone are administered together, a little later to initiate the monthly cycle. Turner syndrome affected persons have a shorter life expectancy.

6.8.4 Klinefelter Syndrome :

Klinefelter syndrome is an abnormal genetic condition, caused by the presence of an extra X chromosome in addition to the usual male sex chromosome complement of XY [Fig.]. Thus the diploid chromosome number becomes 47 with XXY sex

chromosome complement. This condition was first described by H.F. Klinefelter in 1942. It is estimated to occur in 1 in 500 live male births.

6.8.4.1Genetic Basis :

The condition is due to the presence of an extra X chromosome in the male. The XXY condition presumably arises at fertilization of an exceptional egg (XX) by a Y-sperm or an X-egg by an exceptional XY sperm. The exceptional eggs and sperms are the outcome of primary nondisjuction of X and Y chromosomes during maturation phase of gametogenesis. Studies in

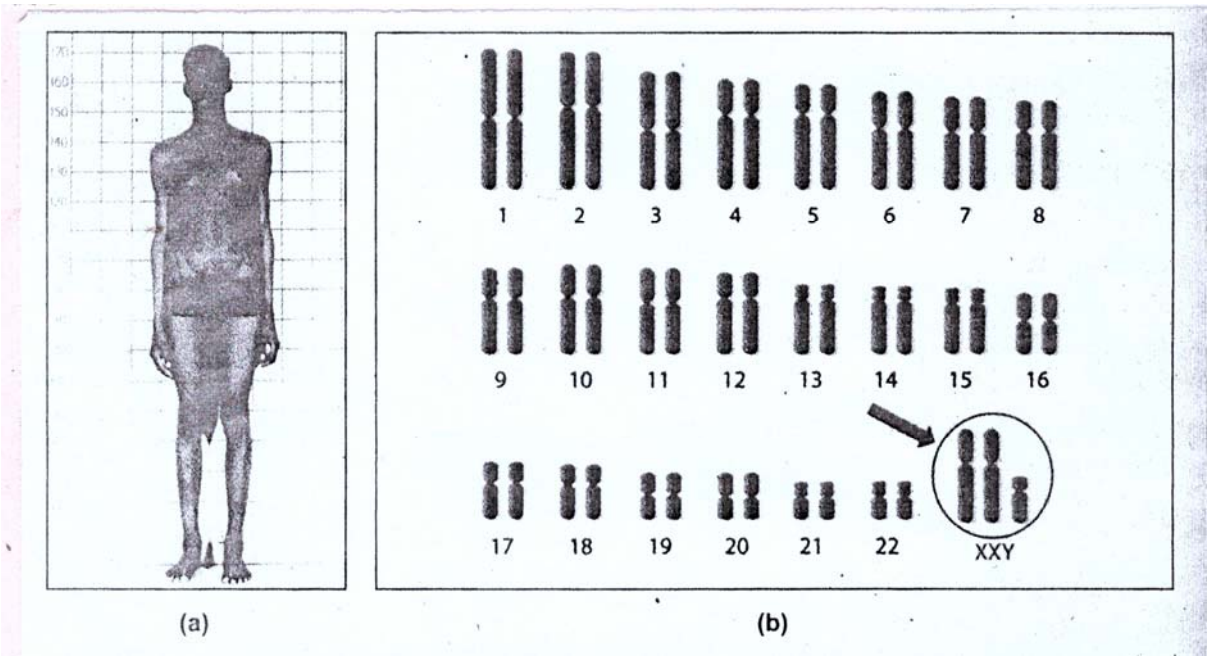


Fig.11 A male showing Klinefelter syndrome phenotypes and (b) Chromosome complement (the arrow shows the presence of an additional X chromosome).

Turner syndrome and Klinefelter syndrome indicate that, the Y chromosome is essential for the expression of maleness. The usual karyotype is 47, XXY, while more complex karyotypes, such as XXXY, XXXXY, XXXXXY, XXYY, XXXXYY are also associated with Klinefelter syndrome. The frequency of occurrence is 1 in 500 male births.

The syndrome is diagnosed by a chromosome complement examination. There is no treatment option. It can be prevented through education and genetic counseling by a trained clinical geneticist.

QUESTIONS

1. Choose the correct answer :

(i) Genes located in Y chromosome are :

(a) Mutant genes (c) Holandric genes

(b) Autosomal genes (d) Sex-linked genes

(ii) A colourblind person cannot distinguish :

(a) All colours (c) Green colour

(b) Red colour (d) Red-green colour

(iii) Sex-linked genes are :

(a) Dominant (c) Lethal

(b) Recessive (d) Not inherited

(iv) A Down Syndrome will be :

(a) 45 + XX (c) 44 + XXY

(b) 44 + XY (d) 22 + XY

(v) No. of Barr bodies present in Turner's Syndrome is :

(a) 0 (c) 2

(b) 1 (d) 3

(vi) In Genic balance theory, when the sex-ratio is 1, which type of sex is expressed ?

(a) Intersex (c) Male

(b) Super male (d) Female

(vii) A cross of F_1 with the recessive parent is known as :

(a) Back cross (c) Hybrid cross

(b) Test cross (d) Double cross

(viii) Which one is a sex-linked order ?

(a) Hypoglycaemia (c) Nightblindness

(b) Cancer (d) Colour blindness

(ix) Which type of chromosomal basis of sex determination is found in birds ?

(a) XX-XY (c) ZW-ZZ

(b) XX-XO (d) ZZ-ZO

(x) which gene is present in the Y-chromosome that codes for the protein TDF ?

(a) Cry (c) Sry

(b) Try (d) Tra

2. Answer the following in one or two words :

(i) What is ‘Criss-Cross’ inheritance ?

(ii) What is Barr body ?

(iii) What are holoandric genes ?

(iv) What is ‘Gynandromorph’ ?

(v) What is the other name of Bleeder’s disease ?

(vi) Name any two X-linked disease of human beings?

3. Differentiate between :

(i) Autosome and allosome

(ii) Supermale and Super female

(iii) X-chromosome and Y-chromosome

(iv) Down Syndrome and Klinefetter’s Syndrome

(v) Phenotype and Genotype

Long Type Questions

4. Describe the chromosomal theory of sex determination.

5. Give an account of Genic balance theory.

6. What is sex-linked inheritance ? Discuss the phenomenon with reference to Haemophilia or Colourblindness.

Unit-III

ORIGIN OF LIFE

The big bang theory explains the creation of present universe as the consequence of a single huge explosion that happened about 13.7 billion years ago.

Theories of origin of life :

Several theories have been proposed on the origin of life. These are theory of special creation, theory of catastrophism and cosmozoic theory of panspernaia which have been discarded due to lack of logical explanations.

Theory of abiogenesis was strengthened by A.I. oparin and J.B.S. Haldane.

Chemical Evolution :

i) The primitive earth was anaerobic

ii) Early Molecules :

Free molecular oxygen was not present for which primary atmosphere was reducing in nature.

iii) Simple Organic Molecule :

Stanley miller and Harold Urey conducted an experiment by heating ammonia, methane, hydrogen and water vapour at 800^0C in a glass apparatus. This experiment demonstrated that more complex organic compounds were formed from simpler inorganic precursors.

iv) Complex Organic Molecules :

These are polysaccharides, fats, proteins, nucleotides and later nucleic acids.

v) Molecular aggregates and cell like structures :

The sea water rich in soluble organic matter was termed as primordial soup. These colloidal particles were termed as coacervates by oparin. The first cell like structure are termed as protobionts which would have contained various macromolecules.

Biological Evolution :

After creation of living matter from the pre-biotic soup, evolution of living forms occurred in following manner.

i) Prokaryotes ; They are first chemoheterotrophs.

ii) Later photoautotrophs evolved possessing chlorophyll.

iii) Evolution of eukaryotes occurred in form of two distinct forms, plants and animals.

Evidences of Biological Evolution :

To establish the authenticity of evolutionary process scientists have documented many evidences which are :-

1. Palaeontology
2. Comparative anatomy
3. Embryology
4. Molecular biology

1. Evidences from Palaeontology :

Leonardo da vinci is known as father of Palaeontology which deals with study of fossils.

Fossils :- It is any remain or impression of entire body of parts of an animal or plant that has been preserved in the sedimentary rock deposit of earth's crust. Fossil records of horse, elephant camel and man explain gradual evolution of these species. Fossil of Archaeopteryx is an example of connecting link that explains evolutions of birds from reptiles. A living fossil example Latimeria closely resembles features of recorded fossil which is a living species.

Evidences from Comparative Anatomy :

Comparison of morphological and anatomical features or organs of different groups throws light on the occurance of organic evolution.

Homologous organs and Homology :

The organs which have same fundamental structured and embryological origin, but appear different externally and carry out different functions are called homologous organs. Homologous organs exhibited by forelimbs of frog, ichthyosaur bind, whale, horse and human have pentadactyl limb plan. Through adaptive radiation all mammals have originated from an ancestral terrestrial mammal.

Analogous organs and Analogy :

The analogous organs appear similar externally. Carry out similar functions but have different embryological origin. It indicates different ancestry also called convergent evolution. The wings of an insect, pterosaur, a bird and a bat are considered as analogous organs.

Vestigial Organs :

They are considered as remnants of well developed and useful structures present in their ancestors but now reduced and do not perform any function. Vestigial organs inhuman body are vermiform appendix, plica semilunaris, Coccyx, nipples in male, wisdom teeth and tonsils.

Connecting Links :

These are transitional organisms possessing characters of two different groups indicating evolution of one from the other. Examples are Euglena, Peripatus, Archaeopteryx.

Atavism :

The process of reappearance of some ancestral characters in the present day organisms is known as atavism. Examples in human are moving ear pinna, elongated canine teeth, long and dense hair on body.

Evidences from Embryology :

The similarities in the process of embryonic development of various groups of animals and their embryos provide evidences in support of organic evolution. From the study of comparative embryology following conclusions are derived.

1. **Common Pattern of Development :**

   In the process of sexual reproduction, all multicellular animals produce a diploid zygote which undergoes cleavage to form morula. Morula forms blastula which develop into gastrula.

2. **Similarity in early embryos of vertebrates :**

   A comparative study of early embryos of different vertebrates, such as fish, salamander, lizard, monkey and human provides striking similarities in the early embryos. Such similarities in early embryos suggest that all these animals have a common ancestry.

3. **Recapitulation in Embryos :**

   Ernst Haeckel stated that embryos of higher animals repeated the adult stages of their ancestors. This is also called ontogeny recapitulates phylogeny.

Evidences from Biochemistry, Physiology and Molecular Biology :

The following points clearly explain a close relationship among living organisms and their evolution through a common ancestor.

a) Universal hereditary material:- DNA is the genetic material in all organisms.
b) RNAs :- Different types of ribonucleic acids in diverse organisms are similar in their structure and function.
c) Nucleotides :- All the constituents of nucleotides are structurally similar in diverse groups of organisms.
d) Central Dogma :- Transcription and translation is known as central dogma which is universal.

e) Protein structure :- Some proteins in diverse organisms are similar in their amino acid sequences and carry out similar functions.
f) Serum Proteins :- By precipitin test closeness among different species is established.
g) Blood groups :- The presence of blood group antigens is an evidence establishing relationship of human with great apes.
h) Hormones :- Hormones show similarity in their structures and function in different animals.
i) Nitrogenous wastes :- Most of aqnatic animals excrete ammonia while land animals urea except insect, reptiles and birds which excrete uric acid.

Darwinism :-

The mechanism of origin of new species was explained by British naturalist Charles Robert Darwin. Darwin published a book entitled origin of species. The propositions of Darwin's theory of natural selection are as follows :

1. Prodigality of reproduction (Over production) :- organisms have an inherent tendency to reproduce and increase their number rapidly.
2. Limiting factors :- There are some limiting factors like food supply, diseases, harsh physical conditions put a check on anormous number, growth of living beings.
3. Struggle for existence :- Three types of struggle like intra-specific, inter-specific and environmental struggle are faced by organism.
4. Variations and Heredity :- Darwin believed that variations are continuous and he had no idea about discontinuous variations. Heritable variations are raw materials for evolution.
5. Survival of the fittest and Natural selection :- Nature plays a decisive role in selecting the fit organisms. Natural selection is based on selecting the fit ones that adapt better with environment and produce offspring in large number.
6. Origin of New Species :- Organisms possessing favourable heritable variations go on accumulating new characters which after a long period of time offsprings become distinct from ancestor and a new species originates.

Criticism to Darwin :-

A few objections are discussed below :-

i) Darwin did not explain used and disuse of organs.

ii) He did not distinguish between somatic and germinal variations.

iii) His natural selection was based on mistaken concept of artificial selection.

iv) He did not recognize large fluctuating variations.

v) Natural selection did not explain arrival of fittest.

vi) The theory of Pangenesis was not accepted.

Modern Synthetic Theory of Evolution :

This theory is a collective explanation of the fundamental mechanism of evolution. Homologous recombination, mutation, natural selection, isolation, genetic drift and migration are the bases for the mechanism of evolution. The proposer of the theory are, Sewall Wright, R.A. Fishcher, J.B.S. Haldane, Jullian Huxley, Ernst Meyer, T.Dobzhansky.

Mechanism of Evolution :

Variations :- There are two causes of origin of genetic variation.

1. Genetic recombination – Homologous combinations between genes present on paternal and maternal chromosomes during gametogenesis is known as genetic recombination. These may occur at three levels
   i) Production of new gene combinations
   ii) Independent assortment of chromosomes
   iii) Random fusion of male and female gametes. Examples in human, 70×10^{12} combinations can be formed.
2. **Mutation :-** Hugo de Vries proposed the mutation theory. These are sudden, heritable and discontinuous variations. A gene mutation involving only one nucleotide is called point mutation and more than one base pair is called gross mutation. Accumulation of mutations in a population brings about a large scale

change in a species in long run. A classical example of point mutation is sickle cell anemia.

Natural Selection :-

Natural selection can occur with or without environmental change. The natural selection has been operating is established by a change in the morphology (Pigmentation) of the peppered moth in Manchester city when industrial revolution was picking up. The phenomenon has been termed as industrial melanism. Another example is pesticide resistance by mosquitoes.

Types of natural selection :- Three types are observed.

1. Directional selection
2. Stablizing selection
3. Disruptive selection

Gene Flow and Genetic Drift :

The process of allele transfer from one population to another is called gene flow. Random breeding among individuals and migration changes the frequencies of some genes.

Genetic Drift :- It refers to a random change in gene frequency in the population. If the population size is small, there will be a random fluctuation in the gene frequencies due to chance done. This chance fixation of genotype is known as genetic drift.

Hardy-Weinberg's Principle :

Hardy-Weinberg law of genetic equilibrium proposes that evolution is a population character.

Punnnett square for Handy – Weinberg genetic equilibrium

		Female	
		A(P)	A(q)
Male	A(P)	$AA(P^2)$	Aa(pq)
	A(q)	Aa(pq)	$Aa(q^2)$

Adaptive Radiation :

It is the diversification of organism of a population into a number of new groups with adaptive characters suiting their need for survival. This has been termed as divergent evolution. The pentadactyl limb pattern seen in terrestrial mammal has been modified to perform different functions. It is logical to say that all mammals have originated from an ancestral terrestrial mammal through adaptive modifications of basic pentadactyl limb plan.

Human Evolution :

Two early primate species, Dryopithecus and Ramapithecus were surviving some 15-20 million years ago in Miocene Epoch. While the former was more ape-like, the later was more human-like fossils recovered from Ethiopia and Tanzania suggest that man-like primates, Australopithecus lived in East African grasslands about 3 million years ago. *Homo habilis* more closer to humans evolved later.

Homo erectus originated about 1.9 million years ago. This was the first hominid to have migrated from Africa to Asia and Europe.

Archaic Homosapiens evolved in Middle Paleolithic period. *Homo sapiens* Netherlands were living primarily in east and Central Asia. Ultimately *Homo sapiens* sapiens, the modern man evolved during 75,000 to 20,000 years ago in ice age.

Sample questions

Q. Multiple choice questions: Choose the correct Answer.

i) Who proposed the chemical origin of life ?

a) A.L. Oparin – JBS Haldane

b) Louis Pasteur – A.L. Oparin

c) Francesco Redi – JBS Haldane

d) Spallazani - Louis Pastur

ii) Analogous organs have :

a) Different origin and similar function

b) Similar origin and similar function

c) Similar origin and different function

d) Different origin and different function

iii) Who is known as Father of Modern Paleontology ?

a) Leonardo da Vinci c) Ernst Haeckel

b) Karl Ernst Von Baer d) Georgen Cuvier

Q.2. Fill in the blanks with appropriate words.

i) The concept of chemical evolution was proposed by J.B.S. Haldane and a Russian scientist _____.

ii) The mutation theory was proposed by _____.

iii) Natural selection in action was demonstrated by _____moth.

iv) Peripats is connective link between _____ and _____.

v) Sudden reappearance of some ancestral characters in the present organisms is called as _____.

Q.3. Answer each within 50 Words.

i) What do you mean by chemical evolution.

ii) Write three criticism on Darwinism.

iii) Describe homology in early embryonic development.

iv) Explain genetic drift.

Q.4. Long answer questions.

i) Discuss the evidences of organic evolution from comparative anatomy and morphology.

ii) Describe Darwin’s theory of natural selection and origin of species and discuss about criticisms.

Unit-IV

BIOLOGY AND HUMAN WELFARE

A. Health and Diseases

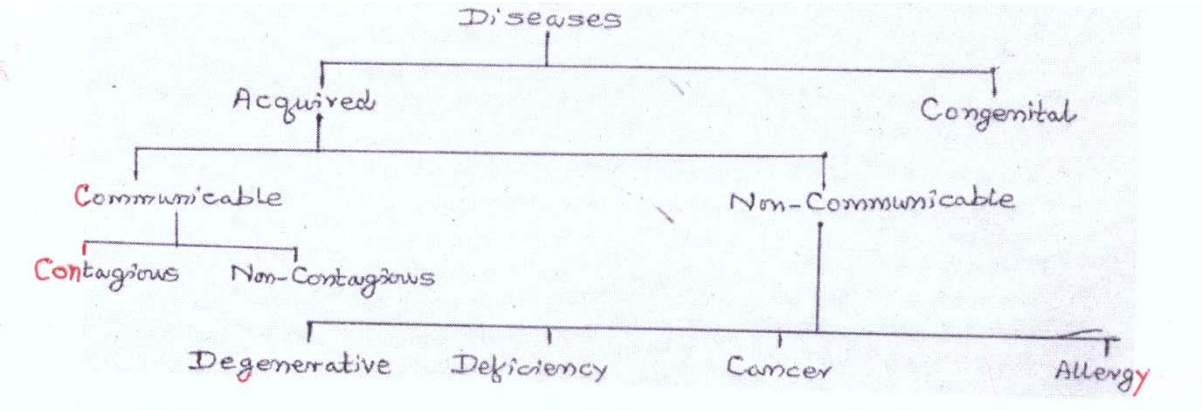
Health is Wealth. A good health is maintained by balanced diet, good routine habit, a sense of good hygiene, Physical exercise and mental well being. State of good health is disturbed by several agents including pathogens. These organisms enter into the body and interfere with and destabilized the normal physiological functions of body.

Pathogens – A Pathogens is an infectious agent that causes a diseases or illness to its host. It disturbs the normal physiology of the organism. Typically, the term pathogen is used to describe infectious agents such as viruses, bacteria, Fungi, Prion and Parasites of various forms. A pathogens may be described in terms of its ability to produce toxins, enter tissues, colonize and share nutrients and its ability to induce immune suppression in the host. Many classes of Pathogens are mentioned below:

1. Viruses – adenovirus, picorna virus, retrovirus , Papova Virus, Polyoma Virus etc.
2. Bacteria – Mycobacterium, Streptococcus, Shigella and Salmonella
3. Fungi – Saprophytic Pathogenic Fungi
4. Prions – Protein Pathogen that do not contain nucleic acid.
5. Parasites – Protozoan parasites and helminth parasites

Parasites causing Human Diseases

A diseases is defined as the condition of the body or a part of the body in which normal body functions are disrupted leading to abnormal in an organ or system.



1. **Acquired diseases** – This Occurs after birth. These may be communicable or non- communicable.

(a) **Communicable** – These are infections and spread from infected persons to healthy persons through pathogens. These may be contagious or non-contagious. Contagious diseases are transmitted through contact e.g. Syphilis, Chicken Pox, Meassles and Leprosy etc. Non-Contagious diseases are transmitted through agencies like water, air, food and Vector Organism.

(b)**Non- Communicable Diseases –** It does not spread from person to person. These are four types

I. Degenerative Diseases – These occur due to degenerative changes in some vital organs, e.g Cardiovascular diseases, Brain diseases, Arthritis etc.

II. Deficiency Diseases – These are caused due to deficiencies in food or hormone , e.g Kwashiokor (Protein Deficiency), Pellagra(Vitamin-B5), Goitre(Iodine Deficiency), Diabetes mellitus (Insulin deficiency).

III. Cancer – These are caused by several physical and chemical agents called carcinogens.

IV. Allergy – These are caused by several allergies (foreign substances) e.g Asthma, Hay fever.

2. Congenital diseases - These are inherited genetic disorders, e.g – Color Blindness,

Haemophilia, Down's Syndrome etc.

MALARIA

Malaria is caused by protozoam parasite, Plasmodium , which is transmitted by a vector , female anopheles mosquito. The Parasite was first discovered by Charles Laveran (1880). Sir Ronald Ross first observed oocysts of Plasmodium in female anopheles.

Symptoms:

a) Cold Stage or Rigor Stage – Fever comes with rigor and sensation of extreme cold, which lasts for 15 minutes to 1 hour.
b) Hot stage- Temperature of body increases to 106^0 F, which lasts for 2 to 6 hours with fever
c) Sweating Stage – Fever comes down with profuse sweating, which lasts for 2 to 4 hours.

Life Cycle:

Malaria Parasite is a digenetic Parasite – asexual cycle takes place in humans(primary host) and Sexual cycle is the intermediate host, female anopheles mosquito.

Human Cycle –

Sporozoite is the infective stage of Malaria Parasite. The Sporozoite is injected into the body of a healthy person by bite of an infected mosquito. It forms the hepatic schizonts in the liver cells and then burst from merozoites . The process continues for many cycles and a stage comes when the Parasites enter the R.B.C . The cycle in which liver schizogony takes place are referred to as pre- and exo – erythrocytic schizogony.

The next cycle is erythrocytic schizogony , where the merozoites enter the R.B.C and pass through the stages of trophozoite and schizont. The trophozoite feeds on hemoglobin. The byproduct from the feeding process is a

toxic substance, known as haemozoin . RBC merozoites and haemozoin granules are liberated into the blood plasma. After sometime male and female gametocytes develop. Then these enter into female anopheles for further development.

Mosquito Cycle - The Mosquito cycle begins while the gametocytes are ingested by the vector mosquito when sucking blood from infected persons. The male gametocyte undergoes a process of exflagellation forming 4-8 thread like microgametes. The female gametocyte undergoes the process of maturation and becomes macrogamete. The fusion of gametes form zygote and is called as Ookinete. This cycle is referred to as gamogony . The ookinete penetrate wall as through the stomach wall and encysts as an oocyst.

Then starts the sporogony cycle , where the oocyst grows and divides to form numerous sporozoites, which migrate into the salivary glands of the vector making vector infected. When infected mosquito bites a healthy person, sporozoites enter blood with saliva. Thus, life cycle completed in two hosts.

Treatment

Drugs like Chloroquin, Primaquin, Quinine , Mefloguine are recommended.

Parasite	Types of Malaria	Incubation Period	Recurrence of Fever
P.vivax	Benign tertian	10 days	48 hours
P.malariae	Quartan	28 days	78 hours
P.ovale	Mild tertian	15 days	48 hours
P.falciparum	Pernicious, Cerebral, Subtertian, aestivo, Tropical malaria	12 days	48 hours

TABLE. 2. A COMPARISON OF HUMAN INFECTING SPECIES OF PLASMODIUM

Prevention and Control

1. Use of mosquito , bed nets and screening of houses
2. Destruction of mosquito larvae by larvicides and larvivorous fishes like Gambusia .
3. Use of domestic space sprays including aerosol.

FILARIASIS

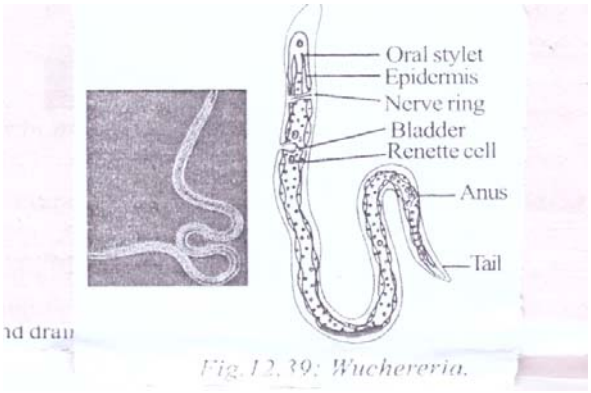


Fig.12. Filaria is caused by Wuchereria bancrofti , a nematode parasite

1. It is a nematode parasite causing elephantiasis in man.
2. It is commonly known as filarial worm.
3. It is a digenic parasite. Man is the primary host and the Culex Mosquito is secondary host.
4. It lives in the lymph nodes and lymph vessels of man.
5. The sexes are separate and it exhibits Sexual dimorphism. The male is smaller than the female. The male has a curved posterior end and a pair of spicules.
6. The male and the female are found coiled together.
7. It is viviparous, giving birth to larvae.
8. The larvae is called microfilaria. It has a stylet.
9. The microfilaria passes from the lymph vessels into the blood vessels.
10. The larva comes to the peripheral blood vessels in the night.
11. When the Culex mosquito bites a man containing the larva, the larva enters the of mosquito.

12. In the gut, the larva moults twice and becomes another larva called filariform lava.
13. The filariform larva penetrates the gut and migrates to the muscles of the mosquito. Then it reaches the mouth parts.
14. When the mosquito bites another man, the larva enters the blood of the man.
15. From the blood it goes to the lymph vessels and lymph nodes.
16. It causes the obstruction of the free flow of lymph. As a result , the lymph glands and lymph vessels of the affected parts(usually legs, arms, scrotum and mammae) are enlarged. This condition is known as elephantiasis. It is usually accompanied by fever, headache and mental depression.
17. It can be prevented by killing the vectors (mosquitoes). Mosquitoes are killed by spraying insecticides. The **compounds of antinomy and arsenic** are satisfactory for the treatment of elephantiasis. **Heterazan** is another drug.

Symptoms of Filariasis

- The incubation period is 5-18 months.
- Lymphopharyngitis
- Fever
- Elephantiasis of genitals, legs and arms
- Considerable disability
- Reversible lymphoderma
- Eosinophilia

Fig. 13: Elephantiasis in one leg of patient suffering from filariasis

Control Measures

1. Treatment of all people in endemic areas with **diethylcarbamazine** capable of killing larvae and some adults.

2. Consumption of salt mixed with diethylcarbamazine to prevent infestations.
3. Killing of mosquito larvae by spraying insecticides to reduce vectors.
4. Use of Mosquito nets, propellants and other to escape from mosquito bites.
5. Setting up of underground drainage system to avoid mosquito breeding.

ASCARIASIS

Ascariasis is the most common human nematode parasite. It is the infection of the intestinal tract by the adult nematode positive, *Ascaris lumbricoides* . Children are infected more often than adults.

Symptoms

This disease does not have no symptoms. But depending on severity and part of the body infected may have a little symptom. If the person has a heavy infection, a large number of worms may be present and may cause severe abdominal pain, fatigue, vomiting and weight loss.

Epidemiology

Ascaris lives in the lumen of small intestine and lays rhabditiform eggs. It penetrates the intestinal wall and reaches mesenteric blood vessels. Then it reaches liver through the hepatic portal vein and the post caval vein. From the heart, it is carried to the lungs through pulmonary arteries. In the Lungs , it enters the alveoli, where it lives for some days and grows. From alveoli, it passes through the bronchus into the trachea and then to the throat. It then moves into the oesophagus , finally reaching the small intestine. Then it moults and becomes adult.

Pathogenesis

Ascaris causes a diseases called ascariasis. When Ascaris shares the food of man, it causes weakness, anemia and eosinophilia . When it enters the appendix , it causes appendicitis, when damages liver causes hepatitis and damages lungs causes pneumonia.

Prevention

1. Human faces should be safely disposed underground.
2. Fruits and vegetables should be thoroughly washed
3. Hands should be properly washed before eating.
4. Finger nails should be regularly cut.

Treatment

1. A mixture of the oil of chenopodium and tetrachloroethylene is an effective drug for Ascaris eradication.
2. Piperazine citrate
3. Tetramisole
4. Dithiazanine
5. Hetrazan etc.

Enteric Fever –Typhoid and Paratyphoid

Genus Salmonella parasitize the intestine of man leading ***to enteric fever, gastroenteritis and septicemia.***

Salmonella typhi is the causative agent of typhoid fever in man.

Salmonella paratyphi A, B and C cause paratyphoid fever in man.

These are Gram negative rods, about 1-3 m x 0.4 -8m in size. These are aerobic and facultatively anaerobic. They grow well in 37^0C over range of pH6-8. These are killed at 60^0C in 15 minutes.

Boiling, chlorination and pasteurization of milk kill these bacilli. In polluted waters and soil , they live for several weeks.

Ingestion of 10 bacilli may produce an infection. They enter the body through lymphoidal tissue of the pharynx. After reaching the gut, they attach themselves to the epithelial cells of the intestinal villi and penetrate inside. Since they are virulent, they survive and enter the mesenteric lymph nodes and multiply. From there they enter the blood stream. Further multiplication occurs in liver, gall bladder, spleen, bone marrow, lymph nodes, lungs and kidneys. After the incubation period of 11days, these bacilli come from gall bladder enter the ileum. It causes inflammation, necrosis, typhoid and ulcers. This infection may lead to intestinal perforations and hemorrhage.

The normal symptoms of typhoid are headache, fever, malaise, anorexia, coated tongue and abdominal discomfort with either constipation or diarrhoea. Symptoms of paratyphoid fever is also similar to typhoid but milder.

Epidemiology: It is worldwide in distribution. Several countries have eradicated typhoid fever due to the improvement of sanitation and protected water supply.

The source of infection is the patient or carrier. Convalescent carrier sheds typhoid bacilli in faeces after clinical cure upto a period of 3 months. Temporary carriers shed the bacilli up to one year. Chronic carriers shed the bacilli up to one year . Chronic carriers shed the bacilli for more than a year. Along with faecal carriers, Urinary carriers are also present.

Prophylaxis: Typhoid fever may be endemic or epidemic. It is a water borne, food borne or milk borne disease. Typhoid fever can be effectively controlled prophylactic method.

Treatment: Streptomycin, tetracycline, amphicillin , amoxicillin and furozolidine are used in antibacterial therapy for thyroid. Elimination of carriers by these drugs is not so effective.

9.2.2 Pneumonia:

Pneumonia is a lung infection accompanied by cough, fever and difficulty in breathing. Following infection, there may be inflammation in the air sacs and

fluid may accumulate. For most people, pneumonia can be treated at home. It often clears up in 2 to 3 weeks. But older adults, babies and people with other diseases may become seriously ill. They may need intensive care in the hospital. More than 10 million cases have been documented every year in India.

Pneumonia may be contracted in the daily life, such as at school or work. This is called community- associated pneumonia. The disease may also be contracted, while in a hospital or nursing home. This is called healthcare – associated pneumonia.

9.2.2.1 Causes of Pneumonia:

Pathogens like bacteria and viruses usually cause pneumonia. It usually starts when someone breaths the pathogens into the lungs. One may be more likely to be infected following a cold or flu. These illnesses make it difficult for the lungs to fight infection, so it is easier to contract pneumonia. Having a long-term or chronic, diseases like asthma, heart diseases, cancer or diabetes also makes one likely to get pneumonia.

9.2.2.2 Symptoms:

1. Cough-One is likely to secrete much mucus (sputum) from the lungs. Accumulating mucus causes irritation leading to severe coughing. Mucus may be rusty or green or tinged with blood.
2. Fever
3. Fast breathing and feeling of breathlessness.
4. Severing as though there is a chilled ambience.
5. Chest pain that often feels when one coughs or breaths.
6. Fast heart beat.
7. Feeling extremely tired and weak
8. Nausea and vomiting.
9. Diarrhoea

9.2.2.3 Diagnosis:

Primarily, a physical examination is conducted. If necessary, a patient undergo chest x-ray and a blood test. This is sufficient to diagnose pneumonia. In an extreme, the mucus from the lungs may be pathologically examined to find out if causative pathogens are present.

9.2.2.4 Treatment:

In pneumonia is diagnosed to be caused by bacteria, antibiotics are prescribed. These almost always cure pneumonia caused by bacteria. One needs to take the full course of the prescribed antibiotics. Plenty of rest, sleep and intake of rehydration drink are required. Smoking is totally prohibited.

Pneumonia caused by a virus usually is not treated with antibiotics. Sometimes antibiotics may be used to prevent complications. But more often rest and treating cough with conventional medicines work

9.2.2.5 Prevention:

People of 65 years of age or more, having smoking habit and with cardiovascular and lung problems need to have a pneumococcal vaccine. The vaccine does not keep pneumonia away. However, if pneumonia occurs, complications may not occur.

9.2.3 Common Cold/ Rhinitis:

It is one of the most common infectious diseases of human, which is caused by some 200 types of Rhino viruses and a small bacterium, *Dialister pneumosintes* . The pathogens do not reach the lungs. They infect nose and upper respiratory passage causing inflammation of mucus membranes. There is inflammation of the nasal tract, nasal congestion, flow of mucus, sneezing , sore throat, hoarseness, cough, tireness, headache and slow fever. Some persons also

suffer from allergic rhinitis. Common cold spreads through oozing droplets from talking and sneezing, direct contact, hand shake and using common articles like pen, pencil, books, cups , door handles , computer key boards, computer mouse etc. It cures automatically after3-7 days. Medicines are taken to reduce severity of nasal tradition and clearing the nasal tract.

AMOEBIASIS

Amoebiasis or Amoebic dysentery is caused by *Entamoeba histolytica*. It is an endoparasite and lives inside the intestine of man . The fully grown and mature *Entamoeba* is called trophozoite.

Lifecycle

Entamoeba completes its lifecycle in only one host. Hence, it is monogenic parasite.

Binary Fission

The trophozoite undergoes a sexual reproduction by binary fission. The nucleus divides into two daughter nucleus by mitosis. This is followed by the division of the cytoplasm. Most of the daughter amoebae feed and grow up to trophozoites and others undergo a process called encystment.

Encystment

The *Entamoeba* looses it pseudopodium and becomes spherical. The process of formation of cyst is called encystment. The cyst contains one nucleus . Soon, the nucleus divides twice and forms a tetra nucleate cyst.

Excystment

The tetra nucleate cyst enters the intestine of another man through contaminated food and water. Here the cyst wall ruptures and the tetranucleate. Amoeba comes out. The Amoeba then undergoes multiple fission to form eight

daughter trophozoites . It causes ulcer, blood vessels are damaged and blood oozes into the intestine.

Prevention

1. Before every meal, the hands should be properly washed and cleaned.
2. Drinking Water should be well boiled.
3. Food stuffs and water should be protected from house flies and other insects.
4. Vegetables and other food stuffs should be properly cooked.

Treatment

Amoebiasis is a curable disease . It can be treated with the following drugs.

1. Emetine
2. Chloroguine
3. Diodoguinine
4. Tetramycin
5. Aureomycin
6. Ertthromycin

Ringworms -

Ringworms are pathogenic microscopic fungi called dermatophytes . They cause superficial skin infections known as tinea. They grow on the parts of the skin , hair, nails etc. The children are more susceptible to catching ringworms than adults.

Symptoms

1. Tinea barbae – infects bearded area of the face and neck.
2. Tinea capitis – Ringworm of scalp, commonly affects children
3. Tinea corporis – Ringworm of the general skin of the body
4. Tinea Manws – Ringworm in the hands , particularly palms and fingers.

Treatments

It is necessary to apply antifungal medicines. Ringworm can be treated tropically with external applicants or systematically with oral medications. Clotrimazole, Ketokonazole, Econazole compounds may be used for treatment. Oral medications are essential for penetrating into deeper areas of injection.

BASIC CONCEPTS OF IMUNOLOGY

Immunity is defined as the resistance to infection. This is carried out by the process of recognition and disposal of non-self or foreign material that enters the body. The non-self is the life threatening infectious micro organisms or it may be tissue grafts.

Immunity is broadly classified into two types , namely ***Innate immunity and acquired immunity.***

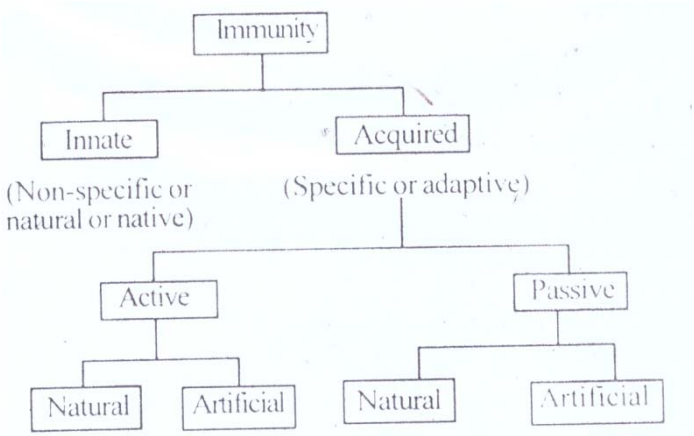


Fig 2.1 : Classification of immunity

1. Innate Immunity

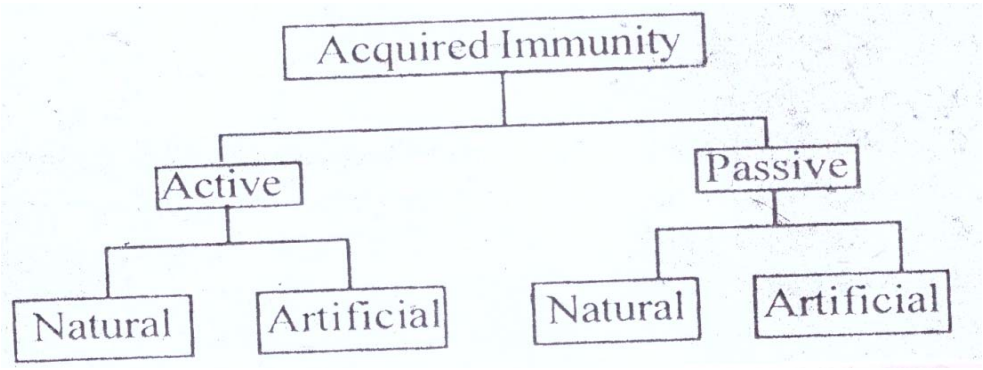
All living organisms are naturally gifted with the resistance to certain infections from birth and this natural defense mechanism is known as ***innate immunity or native immunity or natural immunity***.

2. Acquired Immunity

The resistance developed by man during his life is known as acquired immunity or adaptive immunity.

This is distinct from innate immunity in that it is due to specific antibodies or sensitized lymphocytes produced in response to specific antigens. Hence, this immunity is also known as ***specific immunity.***

This acquired specific immunity is of two types namely ***active and passive***. Both active and passive immunity may be natural or artificial.



VACCINES

A Vaccine can be defined as a preparation of bacterial, viral or other pathogenic agents or their isolated agents, which is administered with the objective of stimulating a recipients protective immunity. Thus a vaccine is basically an antigen or its component that induces acquired immunity in the host, producing T- and B-Lymphocytes.

Types of Vaccines

1. **Natural Live Vaccines-** This includes natural non-pathogenic organisms, e.g Cow pox virus vaccines, Simian and bovine retrovirus vaccines, currently these are not in use.
2. **Live attenuated vaccines -** Attenuation refers to the weakening of a pathogenic bacterium or virus by making it less virulent. Micro-Organisms are attenuated or weakened , so that they do not cause diseases , e.g BCG(Bacillus Calmette- Guerin). Attenuated vaccines are also used for polio , yellow fever and measles.
3. **Inactivated Vaccines-** This vaccine is also inactivated. The inactivation of pathogen is done by modifying it chemically by formaldehyde treatment or physically by heat treatment, e.g Salk Polio vaccine, whooping cough vaccine . The greatest advantage of inactivation or killed pathogen of a vaccine is that there is no longer of mutation or reversion to the pathogenic form.
4. **Toxoid Vaccine –**Diptheria and Tetanus bacilli (bacterial pathogen)produce exotoxins that induce several characteristic symptoms associated with these diseases. These exotoxins are isolated and chemically modified, so that their toxicity is lost. The non-toxic immunogenic derivatives of exotoxins are commonly used as vaccines e.g diphtheria and tetanus vaccines.

5. **Polysaccharide Vaccine –** The capsular polysaccharide of bacteria act as excellent vaccines because it resists immune action, e.g Haemophilus influenza, Streptococcus Pneumonia
6. **Live vector Vaccine –** The desired gene encoding for the target antigen of the virulent pathogen is joined to a suitable vector (attenuated bacteria or virus) and then transformed vector is inoculated into an individual, where the vector slowly replicates and serves as a source of said antigen, e.g. small pox virus, adenovirus are viral vectors, where as bacterial vectors are Salmonella typhii, Vibro cholera etc.
7. **Recombinant antigen vaccines –** A gene coding antigenic proteins can be introduced and expressed in yeast, bacterial or even mammalian cells using recombinant DNA technology. These cells are them cultured in the Laboratory and the protein produced is harvested.
8. **DNA Vaccines –** This vaccine represents a recent type of vaccine in which there is a deliberate introduction of DNA plasmid, into the muscle cells of recipient. The plasmid contains a protein coding gene, which acts as an antigen. This antigen is expressed in the cell leading to both humoral and cell – mediated immune responses.

CANCER

Multignant tumours are called cancerous, which have undergone migration from its source of origin (metastasis) . The tumour is an independent, autonomous, uncontrolled growth of a tissue containing a mass of abnormal cells.

Types of Cancer

1. Carcinoma – Malignant growth of epithelial cells.
2. Sarcoma - A malignant tumour arising from mesenchymal tissues, connective tissues and endothelial cells.
3. Lymphoma- Tumour arising from lymphoid tissue
4. Leukemia- Tumour of W.B.C

Factors / Agents causing Cancer

1. **Physical Agents –** Ultraviolet rays, ionizing radiation, solar radiation
2. **Chemical Agents –** Various metals like Nickel, Beryllium, Arsenic and Chromium, Asbestos, Hormones, Aflatoxin etc.
3. **Nutritional Agents –** Deficiency of proteins, vitamins and minerals , Alcohol and different contaminants
4. **Biological Agents-** Caused by viruses, e.g Hepatitis B
5. **Mechanical factors –** Severe frictions, trauma, irritation causes cancer.
6. **Other Factors –** Host and Environmental factors. Host factors are age, sex, marital, race, customs, habitats and socio-economic status; environment factors are variation, air pollution , diet drugs and social environment.

Genetic Basis of Cancer

Cancers have a genetic basis and are caused by genetic transformations of cells. The genes are of two types – Oncogenes and tumor- suppressor genes. Oncogenes encode oncoproteins that promotes the loss of growth control and the transformation of a cell to a malignant state. Onco viruses are the source of

oncogenes. Tumor suppressor genes or anti- oncogenes encode proteins that refrain abnormal cell growth and prevent cells from becoming malignant.

Diagnosis

a. Fine needle Aspiration Cytology (FNAC)
b. Biopsy of tissues
c. PAP test done for cervix cancer
d. X-rays, CT scans , MRI scans detect cancers of internal organs.
e. Mammography for detection of breast cancer.
f. Abnormal count of WBC in Leukemia.
g. Monoclonal antibodies along with radio-isotopes can detect prostrate cancer and thyroid cancer.

HIV and AIDS

AIDS- AIDS is an epidemic viral disease of human population. It is called acquired immune deficiency syndrome . AIDS is caused by the infection of an RNA virus on lymphocytes. As a result the T-helper cells are depressed. This leads to the suppression of the immune system. Hence the name immune deficiency.

As the immune system is depressed, the individual is susceptible to infection and a series of diseases develops until his death. As the initial infection of virus, paves way for the development of a complex of diseases . It is called a **Syndrome.**

AIDS was first discovered by an RNA virus called human immune deficiency virus abbreviated as ***HIV.***

AIDS is caused by an RNA virus called human immune deficiency virus abbreviated as HIV. It is a class of retrovirus . It was discovered by Luc Montagnier in 1983.

Formerly the HIV was named as LAV(Lymphadenopathy associated virus) and IDAV (Immune deficiency associated virus). This virus is also called HTLV -3(Human T-Cell leukemia virus -3).

The human immune deficiency virus (HIV) is an RNA Virus. HIV belongs to retroviruses.

It utilizes reverse transcriptase to convert RNA to DNA . It is spherical in shape. The virus consists of an outer coat called capsid and an inner core .

The capsid is a glycoprotein

The core contains two strands of RNA Protein and the enzyme reverse transcriptase.

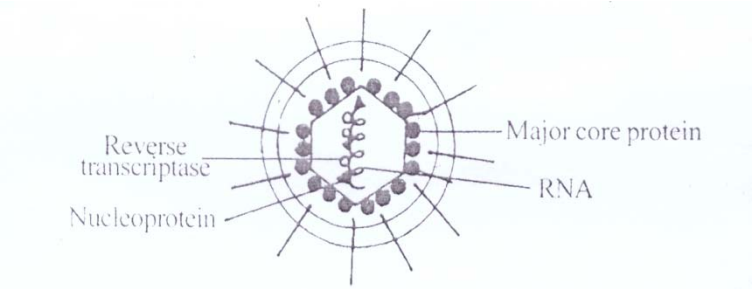


Fig.15 Structure of HIV

Infection and Life Cycle

The HIV infects T helper cells. Macrophages and mono-cytes. The virus enters the nucleus of the host cell. There, it uses its own reverse transcriptase and converts its RNA into DNA.

The viral DNA is integrated with the host DNA. When the host DNA replicates, the HIV DNA also replicates and produces multiple copies. The viral DNA produces mRNA and new viral particles are synthesized. They come out of cell and inflect new cells.

Transmission

HIV is transmitted in the following method

1. Sexual Contact : both homesexual and heterosexual
2. Blood Transfusion
3. Mother to foetus through the placenta

The AIDS patient show the following Symptoms

1. The AIDS patients initially show fever like that of influenza. Thus is followed by rash, headache, swelling of lymph glands, weight loss. **Lympha denopathy** and general malaise.
2. The WBC count is reduced. This condition is called **leukopenia**
3. The blood platelet count is lowered. This is called **thrombocytopenia.**

4. The T-helper cells are depressed. Hence the cell mediated immune response is also deficient.
5. As the immune system is depressed. The patient is prone to infection of various microbes and a complex of disease is produced.
6. The AIDS patients usually, develop a form of cancer called **Kaposis sarcoma.**
7. There is a serious pulmonary infection.
8. Death is caused in 2 to 3 years due to a series of various kinds of infections.

Diagnosis

AIDS is diagnosed by the following tests.

1. **Leucopenia :** The leukocyte and lymphocyte count is reduced. The lymphocyte count is below 2000per c.m.m
2. **Thrombocytopenia –** The platelet count in the blood is decreased.
3. **IgG and IgA Levels:** The levels of antibodies IgG and IgA are raised.
4. **Cell Mediated Immunity:** The cell mediated immunity is diminished . This is visualized by skin tests.

Control of AIDS

AIDS can be controlled and prevented by the following method.

1. Sexual contact with prostitutes should be avoided.
2. Syringes, needles and other materials used in the hospitals should be sterilized.
3. The HIV infected patients should be kept in scheduled places.
4. HIV free blood should be given during blood transfusion.

Treatment

AIDS can be treated by the following methods

1. **AL -721:** It is drug for AIDS prepared by an American Company. It is a mixture of 3 natural lipids made from the yolk of hen's egg. AL stands for **active lipids** and 721 represents the ratio on which the three lipids are combined. The drug can be consumed orally along with orange juice. It is believed that AL-721 removes cholesterol from the membrane around the HIV and prevents the virus from infecting lymphocytes.
2. **Prevention of Viral Replications :** The drug **azidothymidine** limits replication of virus. The drug blocks the reverse transcription.
3. **Inactivation of Reverse Transcriptase:** The HIV replication can be prevented by drugs like **Suramin** and **ribavarin .** These drugs inactivated reverse transcriptase.
4. **Stimulation of Immune System -** In AIDS cell mediated immune response is suppressed. Hence the immune system is stimulated by the injection of lymphokines **like interleukin -2(IL-2) and gamma interferon (y-IFN)**
5. **Grafting of Bone Marrow –**In AIDS patients T-helper cells are depressed. This can be rectified by transplanting bone- marrow to AIDS patients.
6. **Convergent combination Therapy:** Recently AIDS Researchers at the Massachusetts. General Hospitals have found **convergent combination therapy.**

   It is a technique to stop the deadly virus from replicating and spreading to other cells. This technique is a 3-drug combination therapy. The 3 different drugs aim at the inactivation of reverse transcriptase. – an enzyme that the virus needs for its life cycle. This technique will prolong the life of people infected with AIDS virus.

ADOLESCENCE

Adolescence is an important phase in human life between childhood and adulthood. It refers to the age between 10 to 19 years. A lot of physical, psychological and physiological changes occur and noticed in the body.

Physical Changes

The growth of the body becomes apparent in the size, height and weight as it is the period of growth and sexual maturity. Due to continued secretion of growth and sex hormones, gonads start maturing and several secondary sexual characters develop in both males and females. In males, moustaches, beard, hair growth in the body and public hair growth, change in voice and increased muscularity take place, while in females, growth of breast and public hair, widening of pelvic girdles occur.

Psychological Changes

Several noticeable changes occur in the behavior, attitude, emotion etc. They differ from view of parents; need for money for increased expenditure, bad company, tendency to drink alcohol, tobacco, stealing robbery and affinity for girls take place.

Behavioral Changes

1. Changes in eating and sleeping habits.
2. Changes in emotion and tendency to find male and female company.
3. Tendency to appear to become more handsome or beautiful.
4. Tendency to become more hostile, irritable and non- cooperative
5. Lying, cheating and often stealing money
6. Tendency to take drugs, tobacco and alcohol
7. Indulging in Criminal activities.

Alcohol Abuse

Alcoholism is a social problem for adolescents and affluent sections of the society. Several reasons may be attributed to it. It may be due to bad company, desire for excitement, out of curiosity, a desire to escape from failure or disappointments etc.

Effect

1. A high dose of alcohol is an intoxicant and affects the central nervous system as a depressant. Drowsiness affects judgment, co-ordination , alertness, responsiveness etc.
2. It damages liver and causes liver cirrhosis . It may also cause hepatitis and Liver cancer.
3. Alcohol decreases ADH Secretion, which control diuresis.
4. Alcohol has widening effect on blood vessels.
5. Excess consumption of alcohol makes a person aggressive.

Drug Abuse

Drug is a chemical, which is used for the treatment of disease under the supervision of a physician. But their prolonged uses make the person drug addict and it causes various addictive disorders. Several types of drugs are there:

1. **Sedatives and Tranquilizers** – These depress the activities of the CNS. They lower tension and anxiety and larger doses induce sleep, e.g benzodiazepines and barbiturates.
2. **Stimulants –** These causes stimulation or excitement of CNS, affect the release of adrenalin from the adrenal gland and makes a person alert, active, wakeful and reduce appetite. Caffeine contained in tea, coffee and cocoa belongs to this category.
3. **Hallucinogens -** These drugs change a person's thoughts, feelings and perceptions, causes hallucinogens, LSD (Lysergic acid diethyl amide) e.g Bhang, Ganja, Charas etc.

4. **Opiate Narcotics –** These drugs suppress pain, reduce anxiety and tension e.g Opium, Morphine, Codeine.

Withdrawal Symptoms, Treatment

Each drug shows a set of withdrawal symptoms when it is withdrawn. Withdrawal symptoms of alcohol addiction shows hallucinogens, fits tremors etc. Treatment is done by using diazepam, Vitamin B, apomorphine etc. Antioxidants may be used to reduce alcohol dependence.

Deaddication centers are established where both outdoor and indoor facilities for counseling and treatment are available. Pharmacotherapy, psychological treatment and supportive care by friends and family members help in preventing the relapse. Care must be taken to see that the supply of drugs is stopped**.**

****

QUESTIONS

Group-A

1. Select the correct answer

(i) Which one is not a bacterial Disease?

(a) Tuberculosis (b) Typhoid

(c) AIDS (d) Cholera

(ii) Amoebiasis is caused by :

(a) Plasmodium vivax (b) Entamoeba gingivalis

(c) Trypanosuma gambiense (d) Entamoeba histolytica

(iii) Malaria is transmitted by

(a) Male Anopheles (b) Female Anopheles

(c) Female Culex (d) Female Aedes

(iv)AIDS Virus has :

(a) Double standard DNA (b) Single standard DNA

(c) Single standard RNA (d) Double standard RNA

(v) Against which foreign organism (antigen), antibiotic is effective?

(a) Virus (b) Bacteria

(c) Fungal Infection (d) Protozoam

2. Fill in the Blanks :

i. The immunity, present right from birth is known as ----------

ii. Toxoid is an example of ----------immunity

iii. Antiviral substances are ----------

iv. The spread of cancerous cells to distant sites is called ----------

v. During allergic reaction ----------is secreted

Group-B

3. Short answer types questions:

i. What are the different species of Malaria Parasite?

ii. What are carcinogens?

iii. What is the cause of alcoholism?

iv. What is AIDS?

v. What kinds of physical changes are characteristics of adolescence?

vi. What are the Social and Moral implications of drug abuse?

4. Distinguish Between:

i. Filaria and Malaria

ii. Communicable and Non- Communicable diseases

iii. Benign tumour and Malignant tumour

iv. Innate Immunity and Acquired immunity

v. Vaccination and Immunization

vi. Sporogony and Schizogony

Group-C

5. What are Pathogens? Classify diseases and give a note on this?

6. What are acquired and innate immunity? Discuss the mechanical and chemical barriers of innate immunity?

7. Describe the Structure, Infection, control and prevention of AIDS?

8. Write the Symptoms, diagnosis, treatment and control of Malaria?

UNIT-V

IMPROVEMENT IN FOOD PRODUCTION

Apiculture :

Considering the commercial importance, honey bees are cultured artificially in specially designed bee hives and honey is harvested. This practice is known as bee keeping or apiculture.

Four species are of commercial importance. They are :

1. *Apis dorsata*
2. *Apis indica*
3. *Apis florae*
4. *Apis mellifera*

Social Organisation :

i) Castes of honey bee – They are three types queen, drone of worker. The queen and workers are fertilized (diploid) females, while drones are haploid males.

ii) Life cycle – Fertilization in bee is aerial. During nuptial flight by the process of swarming one of the drones copulates with virgin queen. The queen bee lays eggs. The development of egg is indirect.

Egg ⟶ larva ⟶ pupa ⟶ miniature bee ⟶ mature adult

iii) Honey comb – It consists of many hexagonal cells made from wax secreted by worker bee.

Bee Keeping :

There are two methods of apiculture : indigenous of modern.

i) Indigenous method – Two types of hives are used. Fixed hive & movable live.

ii) Modern method – Here a movable hive is constructed by a wooden box.

iii) Chemical composition of honey – Constituent of honey are Levulose, dextrose, maltose and other sugars enzymes and pigments, Ash and water.

iv) Bees wax – It is secreted by the workers and deposited in the form of flakes.

Animal Husbandry :

1. Dairy farm management – Milk is produced through a practice known as dairy farming.

   Breeds of dairy cattle – The indigenous breeds of cattle are classified into:

   i) milch breeds

   ii) dual purpose breeds

   iii) draught breeeds

(i) Indigenous Milk Breeds of Cattle – These are high milk producers. These include Sahiwal, Red Sindhi, Gir, Tharparkar and Rathi.

Dual-purpose breed cows yield average quantity of milk. Some examples are, Deoni, Hariana, Kankrej and Ongole.

(ii) Exotic Milch Breeds of Cattle : Some common exotic breeds are Holsetein – Friesian of Netherlands, Jersy of Europe and America, Red Dane of Denmark.

(iii) Cross-breed strains of cattle : Karan Swiss, Karan Fries, Frieswal, Sunandini.

Draught breed cows are poor milkers. Example are Nagpuri, Bechaur, Malvi, Khillari etc.

(iv) Milch breeds of Buffalos – These are namely Murrah, Nili-Ravi, Bhadawari, Surti, Mehsana.

(v) Milch breeds of Goats – These are Jamunapuri, Beetal, Jhakrana and Surti.

Housing :- There are two housing systems for cattle, loose housing and closed housing.

Nutrition :- In South Asian countries including India, cattle and buffaloes are fed on wheat, paddy and ragi straws. The lactating animals are given and addivitinal supplement of by product concentrates such as oil cakes, brans and pulses.

Health care: Some common diseases of dairy animals are foot and mouth disease, black quarter, tuberculosis, mastitis, pneumonia etc. several cattle vaccines have been formulated for developing immunity against diseases like foot and mouth disease.

Reproduction and Propagation:– The old method of propagation is substituted by artificial insemination. The discovery of cryopreservation has inspired using frozen semen instead of fresh semen.

Organic Dairy Farming :-This stands as an alternative to the present practice, which forbids use of synthetic chemicals.

Success story of Dairy Farming in India :- Dairy farming practice has grown to such a height due to success of the operation flood prograemme. The success of this programme is known as white revolution.

Poultry Farm Management :

Breeds of Poultry :

i) Multinational Industrial Breeds – This stock includes, white layers, brown layers, chicken broilers.

ii) Indian breeds – are Chittagong, Kadaknath, Nicobari.

Housing Management These are –

a) Free range system
b) Semi-intensive system
c) Folding unit system
d) Intensive system

Nutrition – The essential poultry nutrients are Carbohydrates, fat, protein, minerals, vitamins and water.

Animal Breeding :-

Traditional method of animal breeding are

i) Inbreeding
ii) Out breeding

Modern methods of Animal breeding are –

i) Artificial insemination
ii) In vitro Fertilization and Embryo Transfer
iii) Transgenic Animals

Sample questions

Q1. Fill in the blanks –

i) Milk yielding cattle breeds are known as _____ breeds.

ii) Foot and mouth disease is a common disease of _____.

iii) Traditional method of breeding is substituted by artificial_____.

iv) Culture of honey bee on a commercial basis is known as _____culture.

v) The characteristic flight of queen bee during fertilization is known as _____.

Q.2. Answer the following within 50 words each.

i) Name three indigenous breeds of cattle.

ii) Name three exotic breeds of cattle.

iii) What is cryopreservation ?

iv) Describe organic diary farming.

v) Enumerate castes of honey bee.

vi) Describe swarming.

Unit-VI

BIOTECHNOLOGY AND ITS APPLICATIONS

PRINCIPLES AND PROCESS OF BIOTECHNOLOGY

"Biotechnology is an application of knowledge and techniques of biochemistry, microbiology, genetics, immunology, tissue and cell culture, molecular biology, chemical engineering and computer science to living systems or parts thereof, for harvesting beneficial products and / or services of mankind".

Genetic engineering is a technique where the gene is transferred from one organism to another organism. The organism containing the new gene is called a recombinant. The DNA containing the introduced gene is called a recombinant DNA. As genetic engineering produces recombinant DNA, it is also called recombinant DNA technology.

GENE CLONING

Production of multiple copies of a desired gene is referred as Gene cloning. In this technique, a particular desired gene (DNA) is isolated from an organism and introduced into another organism using a suitable vector. The inserted desired gene (DNA) replicates independently and is transferred to progenies as a result of cell division. Thus many identical copies of desired gene are produced from a single gene. This techniques involves following five steps :

1. Preparation of the desired gene
2. Isolation of plasmid vector
3. Insertion of desired gene into vector
4. Introduction of r-DNA into host cells
5. Identification of cloned gene

1. **Preparation of the desired gene –**

The desired gene can be obtained in two ways :

a. From natural source
b. From mRNA

a. From Natural Source – The desired gene, say insulin gene, is available in mammalian pancreas. The desired gee is isolated from the cells by the following steps.
    1. The cells are washed with Sodium Chloride Solution.
    2. The cell is ruptured by homogenization.
    3. The homogenate is treated with a detergent SDS (Sodium Dodecyl Sulphate).
    4. The homogenate is centrifuged to remove cell lebris.
    5. The supernatant contains protein, RNA and DNA.
    6. The proteins are precipitated by protease and removed by centrifugation.
    7. The supernatant is treated with ribonuclease. It is centrifuged to remove RNA.
    8. The resulting solution is treated with ethanol and stirred well with a glassrod and a white fibrous ppt. is framed around the rod.
    9. The ppt. is dissolved in Ethanol-Nacl solution. It contains DNA.

2. From mRNA

The eukaryotic genes, such as human insulin gene, are synthesized from **mRNA.** The synthesis of desired gene from **mRNA** involves the following steps.

1. The cells of islets of Langerhans of human pancreas contain large amount of **mRNA** coding for insulin.
2. The **mRNA** is isolated from cells.
3. The enzyme **reverse transcriptase** and **nucleotides** are added to the **mRNA.**
4. The reverse transcriptase synthesizes a complementary **DNA**strand using **mRNA** as the template. The DNA synthesized on **mRNA** is called **cDNA (complementary DNA).**

5. **DNA polymerase** and nucleotides are added to the single stranded **cDNA**. The **DNA** polymerase catalyzes the synthesis of a second strand. Thus a double stranded **DNA** (insulin gene) is produced.

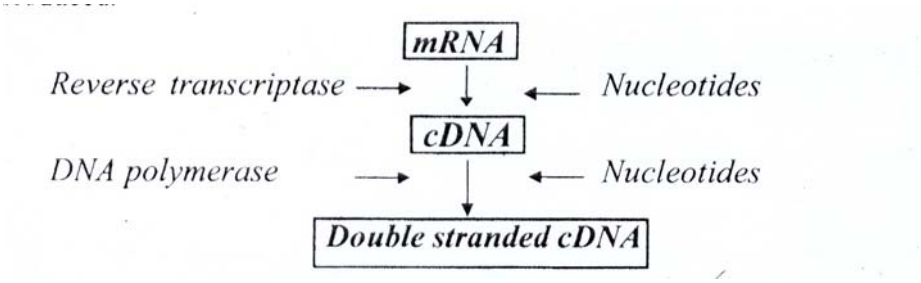


Fig.16 Steps Involved in the synthesis of cDNA from mRNA

2. Isolation of Plasmid

A plasmid is a circular double stranded DNA found in bacterial cells. The plasmid is isolated from the bacterial cell by the following steps :

1. The bacterial cell wall is ruptured by treatment with **lysozyme** and **EDTA.**
2. The cell is lysed by treatment with **sodium lauryl sarcinate (SLS).**
3. The plasmid DNA is separated from other cell components by **centrifugation.**

3. Insertion of Desired Gene into the Plasmid

After the preparation of desired gene and plasmid, the desired gene is inserted into the plasmid. It involves the following steps :

1. The plasmid is cut with a **restriction enzyme**. Restriction enzyme functions as **chemical knives** in Genetic Engineering. It recognizes specific nucleotide sequences and makes cuts.
2. The restriction enzymes make two types of cuts. Some restriction enzymes such as **EcoRI** make cuts producing **DNA** fragments with **sticky ends** or **cohesive ends**. When this enzyme is added to the plasmid, it removes a piece leaving single-stranded tails at the ends. These single stranded tails are called **sticky ends** or **cohesive ends.** The base sequence of one tail is complementary to that found in the other tail.

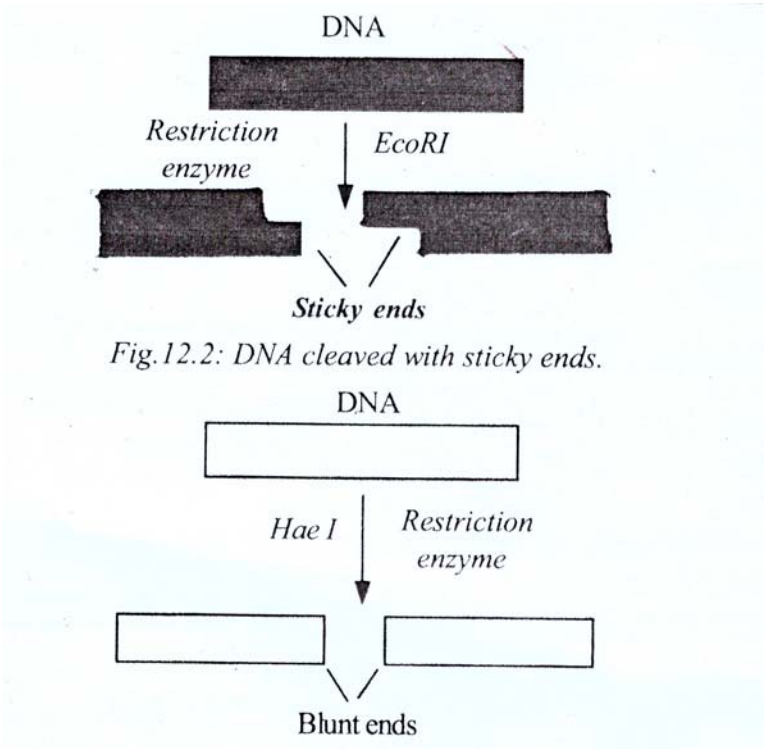


Fig.12.2: DNA cleaved with sticky ends.

Fig.17 DNA cleaved with blunt ends

Some restriction enzymes, such as **Ball,** make cuts producing DNA fragments with **blunt ends.** These enzymes cut the two strands of DNA **along the line of symmetry of the recognition site.**

3. The desired gene is also cut with the same restriction enzyme. The enzyme produces DNA fragments with sticky ends or blunt ends.
4. The cut plasmid and desired gene are mixed together. The desired gene gets inserted into the plasmid. The sticky ends of plasmid and desired gene are linked by complementary base pairing. This process is called **ligation.**
5. The enzyme **DNA ligase** is added to seal the nick found in between the plasmid and desired gene. For blunt end ligation, the enzyme **T4-DNA ligase** is used.

   The plasmid **DNA** containing the desired gene is called **recombinant DNA or rDNA.**

4. Introduction or rDNA into Host Cells

The recombinant **DNA(rDNA)** can be introduced into a bacterium, plant cell or animal cell. The cell that receives the foreign **DNA** is called **transformed cell** and this process is known as **transformation.** Transformation is a process of genetic modification in which fragments of **DNA** from one cell enter and get integrated into the **DNA** of another cell.

The **rDNA** is introduced into the host cells by any one of the following methods.

1. Transformation
2. Electroporation
3. Shot gun method
4. Microinjection
5. Liposome mediated fusion

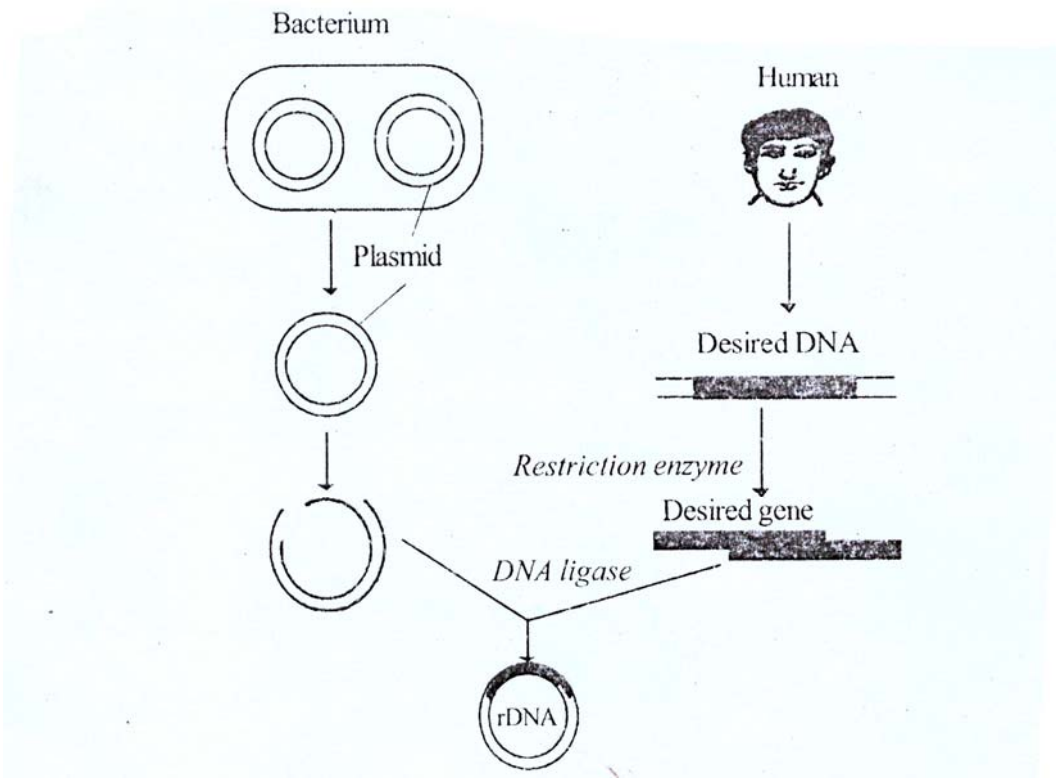


Fig. 18 Construction of recombinant DNA

1. Transformation

rDNA can be introduced into **bacterial cells** by **transformation. Transformation** is a genetic modification process where DNA fragments of one cell enter and get integrated into the DNA of another cell. As a result of transformation, the cell is genetically modified and it gets new genetic property. The genetically modified cell is called **transformant** or **transformed cell.**

Transformation easily occurs in E.coli.

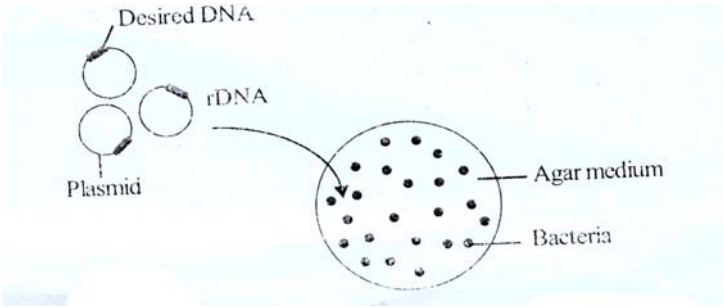


Fig.19 Transformation

The rDNA is mixed with the culture of *E.coli*. The *E.coli* take up rDNA from the medium and it is integrated with the genome of *E.coli*. Thus *E.coli* is transformed.

2. Electroporation

rDNA can be introduced into **plant cells** by electroporation. Electroporation is the introduction of rDNA into plant cells through cell wall by making the cell wall permeable with electric shock treatment.

3. Shot Gun Method

In shot gun method, rDNA can be introduced into plant cells. The rDNA coated gold particles are injected into platn cell by a **microprojectile gun.**

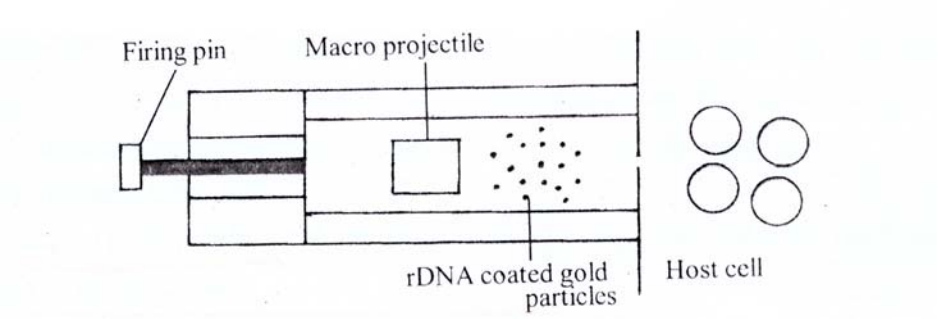


Fig. 20 Microprojectile gun

4. Microinjection

The rDNA can be introduced into plant cells, animal cells and eggs by a syringe. This method is called **microinjection.**

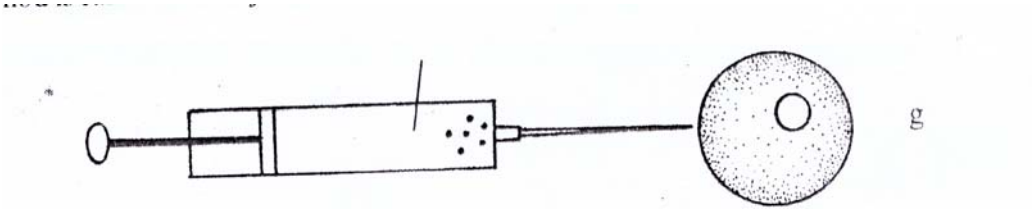


Fig. 21 Microinjection

5. Liposome Mediated Fusion

Liposomes are phospholipid vesicles. They contain many concentric layers of phospholipids.

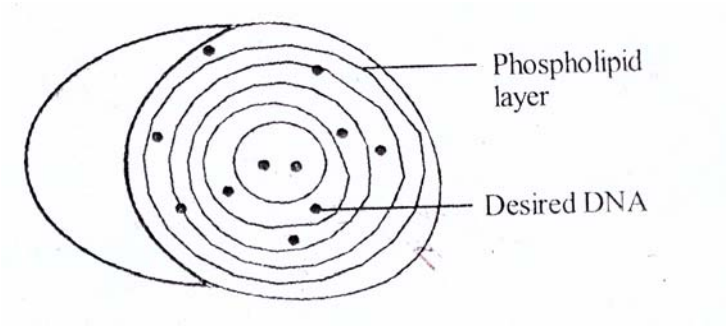


Fig. 22 Liposome

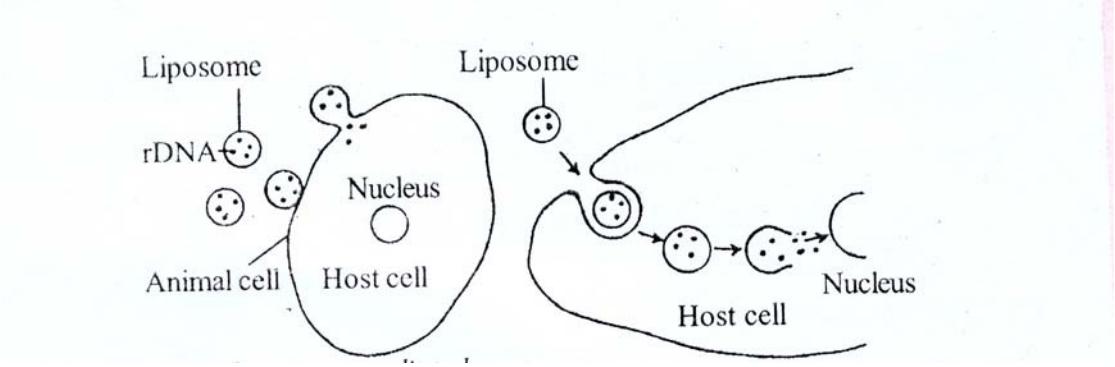


Fig.23 Liposome mediated Fusion

Fig.24 Entry of lipsome into animal cell by endocytosis

The liposomes are loaded with rDNA. The rDNA loaded liposomes bind with the animal cell membranes and unload the rDNA into the cell.

The liposome also enters the cell by endocytosis. On entering the cell, the lipsosome ruptures releasing rDNA.

5. Identification of Cloned Genes

The host cell containing the rDNA is called the **transformant.** The presence of rDNA or cloned gene in the host cell can be identified by the following methods :

1. Insertional inactivation
2. Immune chemical method
3. Colony hybridization

1. Insertional Inactivation

The inactivation of an antibiotic resistant gene in a plasmid by the insertion of a desired gene is called insertion inactivation.

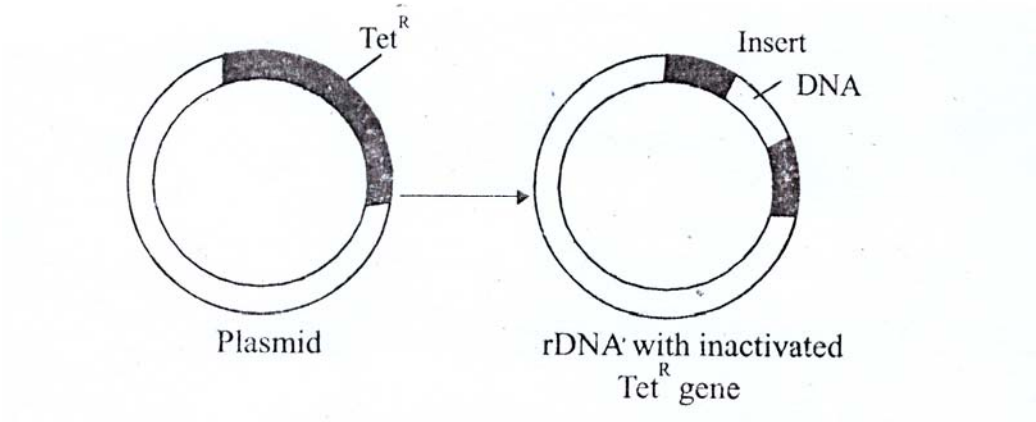


Fig.25 Insertional inactivation in a plasmid

A plasmid contains tetracycline resistant gene, called **Tet^R.** The bacterium containing this plasmid is resistant to the antibiotic tetracycline and this bacterium can grow very well in a medium containing tetracycline.

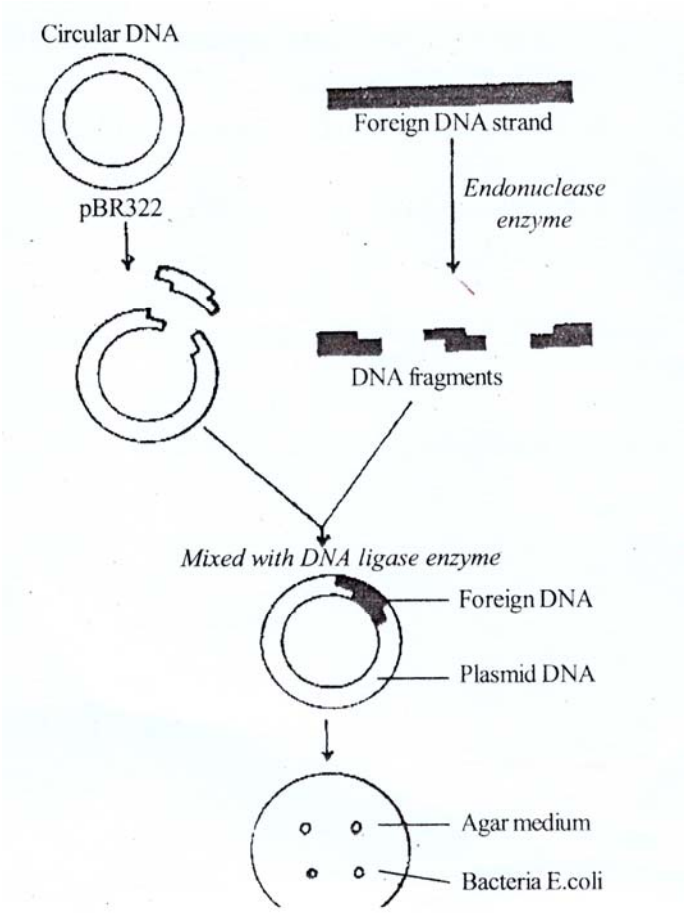


Fig. 26 : Insertion of foreign DNA in a plasmid or construction of recombinant DNA (rDNA)

When a desired gene is inserted in the middle of the **Tet^R** gene, the **Tet^R** gene is made non functional. The bacterium containing this plasmid cannot grow in a medium containing tetracycline. Thus the presence of rDNA can be identified by culturing the bacteria in a **replica plate** containing tetracycline.

2. Immunochemical Method

When the desired gene produces an antigenic protein, the rDNA can be identified by immunochemical method. The proteins produced by the recombinant cells are allowed to bind with radio labeled antibodies. The colony whichbinds with radio labeled antibodies contains rDNA.

3. Colony hybridization

In this method, the rDNA can be identified by mixing it with radio labeled complementary m-RNA. The r-DNA of transformed cell alone will base pair with mRNA.

Unit-VII

APPLICATION OF BIOTECHNOLOGY IN HEALTH AND AGRICULTURE

Biotechnology mainly deals with use of micro-organisms, plant and animal cells in culture systems for the production of beneficial products through gene manipulation techniques. Genetically engineered bacteria yield the following human health care products.

INSULIN

Insulin is a hormone secreted by beta cells of the islets of Langerhans of pancreas. The deficiency of insulin leads to diabetes in man. Diabetes is treated by injecting insulin. This treatment is called insulinotherapy. Genetects company (USA) chemically synthesized two DNA segments coding for polypeptides A and B of human insulin. The two DNAs were inserted separately into plasmids and then the rDNAs were introduced into *Ecoli* cultures. One *Ecoli* culture produced Polypeoptide-A and the other culture produced polypeptide-B.

These two polypeptides were isolated and linked with each other to make an active insulin molecule. Eli Lilly (USA) manufactures human insulin in the name humulin. Gilbert et.al made *E.coli* to produce rat insulin to treat diabetes.

Human insulin is also produced by genetically engineered yeasts.

VACCINE PRODUCTION

A vaccine is defined as an antigenic agent, which, when administered into the animal, generates and active acquired immune response. The antigenic agent varies from vaccine to vaccine. It is generally of three classes.

(i) attenuated (inactivated) whole organisms

(ii) isolated antigeni proteins, such as coat proteins of viruses

(iii) inactivated toxins.

The latter two fall under the subunit vaccine class, where a part of the organism, possessing an antigenic property, is used in the vaccine. Success have been achieved in developing some vaccines. These vaccines are termed as recombinant vaccines.

Genetic engineering is used to develop vaccines against some severed diseases such as hepatitis, AIDS etc. A gene coding for surface antigen HBs Ag was isolated from Hepatitis-B virus and cloned in *E.coli* and Yeasts. The genetically engineered microbes expresses the cloned gene and produced HBs antigen.

This antigen is isolated, pufified and used for vaccination. Such vaccines are called subunit vaccines. Sometimes genes for antigens of more than one pathogen are linked together and cloned in bacteria. Such recombinant bacteria produce multiple antigen peptides (MAPs). The MAPs are used for vaccination against more than one disease.

Recombinant Vaccine manufacturing companies

Several multinational biotech companies started commercial production of recombinant vaccines. The common brands presently available for human use are: Recombivax (Merck); Energix B (Glaxo Smithkline);Elovac (Human Biological Institute, a division of Indian Immunological Limited); Generac B (Serum institute) and Shanvac B. All these are Hepatitis B vaccines. Twinrix, manufactured by Glaxo smithkline is the only combination vaccine used against Hepatitis A and B.

GENE THERAPY

The treatment of genetic diseases by introducing proper genes into patients cells is called gene therapy. The gene used to treat a genetic disease is called remedial genes or remedial DNA or gene drug or gene medicine. Human beings suffer from many diseases due to defects in their genetic makeups. Such diseases are called genetic diseases or genetic defects.

The remedial gene is introduced into germ cells such as egg, sperm and zygote or somatic cells such as liver cells, skin cells and bone marrow cells. If it is introduced into somatic cells, the therapeutic strategy is called somatic gene therapy. If it is done in germ cell, it is called germ line gene therapy. The remedial gene may replace the function of the defective gene (gene replacement therapy) or add the copy a mutated gene (gene augment therapy), example – Thalassemia, Leukaemia.

There are several strategies of gene delivery for gene therapy. They are broadly divided into in-vivo gene therapy and ex-vivo gene therapy. In ex-vivo gene therapy, some cells are taken from the patient, cultured, genetically manipulated with the gene

medicine and reintroduced into the patient body. This is useful to treat the diseases of blood and immune system via stem cells. In the in-vivo gene therapy, the gene drug is directly introduced into cells of the patient, while they remain in the body. It is useful to cure diseases of cells that are difficult to grow for a long time in cultures. Here, the gene drug may be introduced into patients cells by allowing recombinant viruses to infect the cells or by Liposome mediated transfer or particle gum.

Gene Therapy Methods

There are two methods in gene therapy. They are :

1. Germ line gene therapy
2. Somatic cell gene therapy

1. **Germ Line gene therapy –** Treatment of genetic diseases by introducing a remedial gene into sperm, egg or zygote is known as germline gene therapy. The gene may be introduced into germ cells by using micro-injection, biolistics or liposome fusion. The introduced gene corrects the genetic disorder in the cells. It has been inherited to future generations.
2. **Somatic cell gene therapy –** Treatment of genetic diseases by introducing a remedial gene into somatic cells is called somatic cell gene therapy. The remedial gene is introduced into liver cells, spleen cells, muscle cells or blood cells. In general, somatic cell gene therapy is of four types :
   a. Embryo therapy
   b. Ex-vivo therapy
   c. In-vivo therapy
   d. Antisense therapy

GENETICALLY MODIFIED ORGANISMS (GMOs)

A Genetically Modified Organism (GMO) is one, whose genetic material has been altered by genetic engineering. Herbert Boyer and Stanley Cohen (1973) first created the GMO. Many GMOs have been created for the benefit of mankind. Genetically manipulated animals having introduced gene in their genetic makeup are called transgenic animals. The transgenic animals contain an inserted gene called transgene.

The process is very simple but it is an expensive, time consuming and expensive process. It includes many techniques like identification of a beneficial gene in a donor organism, isolation and purification of the soil gene, transfer of the gene to a recipient cell and generation of a transgenic organism from the transformed cell. Many gene transfer techniques have been described. Among these techniques, microinjection is the techniques of choice for animal cells, where as electroporation for plant cells. The transgene are either transferred alone or in conjunction with a vector or carrier DNA. Several species of animal viruses have been used as vectors for animal cells, while the Ti plasmid (Tumour inducing plasmid of *Agrobacterium tumefaciens)* is the vector of choice for plant cells.

GMOs have wide ranging applications in agriculture and animal husbandary; medicine and health care management and environmental monitoring and management.

Bt Crops – The use of modern agricultural practices and improved animal breeding techniques have helped to achieve and increase more productivity. Agricultural scientists have been using improved varieties of seeds, inorganic fertilizers and pesticides. Pesticides are used to kill a variety of organisms, which damage crop plants through infections and destroyed stored food grains following harvest. These organism are collectively called pests. There have been large scale uses of pesticides, which accumulate in the environment, causing serious environmental pollution problems. Secondly, these enter into food chains and consequently, by the process of eating and being eaten, enter into body of organisms. These are not metabolized and hence, accumulating in the living tissues dose by dose in a phenomenon called bioaccumulation.

Bacillus thuringiensis is gram positive bacterium having insectidal property. Many crop plants have been genetically modified by the Bt protein gene (cry). Monsanto of USA genetically engineered and marketed Bt cotton seeds bearing the trade name of Bollagard. Plant Genetic Systems (Later became Arentis Crop Science) is the creator of a variety of corn seeds, carrying cry gene. It was marketed in the trade name of Star Link Corn. It was withdrawn from the market because it was not suitable

for human consumption. Several other Bt plants like tobacco, coffee, cocoa, walnut, soyabean etc. have been successfully generated by using cry gene.

TRANSGENIC ANIMALS

The technology adapted for producing transgenic animals is called transgenic animal technology. It includes the general methodologies of recombinant DNA technology. They are :

- Isolation of desired gene
- Construction of rDNA
- Delivery of rDNA into host cells
- Screening of transformants
- Rearing of transformant cells into animals

The transgenic animals contain an inserted gene. The inserted gene is called transgene. Production of transgenic animals is called transgenesis.

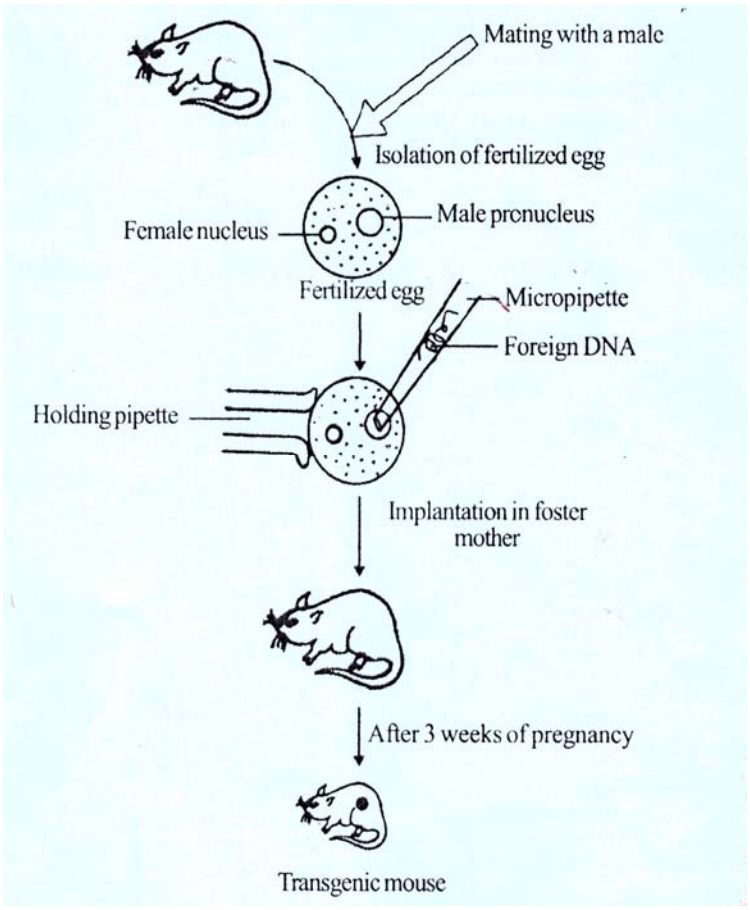


Fig.27 Transgenesis in mice using microinjection method

- A female mouse is superovulated by injecting pregnant male's serum and human chorionic gonadotropin. The mouse products about 35 eggs.
- This female mouse is mated with a male.
- Fertilized eggs are taken from the oviduct and kept in a balanced salt solution.
- The eggs are observed under the microscope to pick up eggs having male and female pronuclei, i.e. just before the fusion of male and female nuclei. The male pronucleus is larger than the female one.

BIOSAFETY ISSUES

Biosafety refers to the prevention of loss of biological integrity of biological processes and products, harvested by using living organisms. New innovations are made and applied in the manufacture of beneficial products and services of the mankind. Inspite of various developments, biotechnology was confronted with an important issue, i.e. in the safety in manufacture and/or designing and applications of these products and processes.

Biopiracy

Illegal transfer of biological resources has been termed as biopiracy. It describes a practice, in which indigenous knowledge and practice used by indigenous people of a region is used by others for profit without permission from and with little or no compensation or recognition to the indigenous people themselves. This is an illegal practice and enforceable in the court of Law.

There is a fear that during the course of bioprospecting, scientists may transfer any biological resource, which they may consider as noval. Biopiracy is understood as the theme of encroachment over the knowledge and bio-resources of indigenous communities, by individuals or organizations securing excusive monopoly control over these resources, knowledge and practices. Nobody is entitled to exploit the producer, inventor etc. as he / she is the real owner of the creation. The controversies may include.

a) Jeevani controversy
b) Neem controversy
c) Turmeric controversy
d) Basmati controversy

Patent – A patent is a set of exclusive rights granted by a sovereign state or intergovernmental organization to an inventor or assignee for a limited period of time in exchange for detailed public disclosure of an invention. An invention is a solution to a specific technological problem and is a product or a process. Patents are a form of Intellectual Property.

The capability of the brain to think something novel or innovative is called intellect. When someone invents something by using his intellect, it becames his property called intellectual property. There are several forms intellectual property – patent, design, trademark, trade secret, geographical indications and copy right.

Patent is an open letter. It is a set of legal rights, privilege and authority granted by a sovereign state to a person or as institution for a limited period of time for an invention using scientific and technical knowledge. India enacted the Patent Act in 1970. It's headquarters is at Kolkata, West Bengal. The nodal centre for Indian Biosafety Network is the Department of Biotechnolog, Govt. of India. **Patents are granted for inventions but not for discoveries.** For examples the double helical model proposed by Watson and Crick was a discovery and hence, does not qualify to be patented, while new forms of recombinant DNAs have been patented.

Pre-requisites for a patent

1. The invention must be new or innovative
2. The invention must have an inventive step.
3. The invention must have an industrial application.
4. The invention must be sufficiently explanatory before applying for a patent.

QUESTIONS

1. Choose the correct answer :

(i) DNA Ligase is commonly known as :

(a)Molecular Scissors (c) Molecular glue

(b) Molecular Marker (d) Molecular probe

(ii) Who proposed the double helical structure of DNA ?

(a)Jacob and Monod (c) Watson and Crick

(b) Sanger and Gilbert (d) Beadle and Tatum

(iii) The blotting of protein molecule to a nylon membrane is known as :

(a)Southern blotting (c) Northern blotting

(b) Western blotting (d) Eastern blotting

(iv) Exonuclease is an enzyme that :

(a)Makes internal cuts in polynucheotides

(b) Polymerizes nucleotides

(c)Joins two polynucleotide fragments

(d) Removes nucleotides from the terminal one to another

(v) Humulin is manufactured by :

(a)Pfizer (c) Eli Lily

(b) Hoechst (d) Aventis

(vi) Which enzyme is related with production of Gloden rice ?

(a)B-carotene (c) Glyphosate

(b) Luciferin (d) Bt protein

2. Answer the following in one word only :

(i) The enzyme that catalyses the replication of DNA.

(ii) The restriction endonuclease isolated from *Escherichia coli.*

(iii) The technique of separation of DNA fragments based on their molecular weight and electrical charge.

(iv) The enzyme that catalyzes the synthesis of RNA on a DNA template.

(v) Genetically engineered rice, rich in Vitamin A.

(vi) The somatic hybrid cell that produces monoclonal antibodies.

3. Fill in the blanks with appropriate words :
   (i) The word Biotechnology was coined by _____.
   (ii) The delivery of a foreign DNA fragment into the fertilized egg with a micropipette is known as _____.
   (iii) The transfer of a separated protein molecules from the gel into the nylon membrane is known as _____.
   (iv) Cohesive ends in the DNA fragments are generated by _____cutting.
   (v) The uptake of the recombinant DNA by the bacterial host cell is known as _____.
4. Differentiate between :
   (i) Ligase and Restriction endonuclease
   (ii) Southerns blotting and Northern blotting
   (iii) DNA polymerase and RNA polymerase
   (iv) Plasid and Cosmid
   (v) Ex-vivo genetherapy and In-vivo gene therapy

LONG TYPE QUESTIONS

1. Give as account of Recombinant DNA Technology.
2. Give notes on patents and biopiracy.