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CLASS-XII

BIOLOGY

CHAPTER # 15

HOMEOSTASIS

2023-24

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HOMEOSTASIS (Botany & Zoology)

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The mechanism, in which the internal environmental conditions of a cell or an organism are maintained properly by means of self-regulatory processes, is called Homeostasis.

The external environment or conditions, in which an organism lives, may fluctuate continuously. The components of external environment are temperature, water, acidity etc. Similarly, tissue fluid and sap is the internal environment of animals and plants respectively.

In order to maintain the internal environment, the organism resists, manages or adjusts it by its own internal fluctuations. The chemical composition of tissue fluid must be kept constant. Thus, maintenance of the internal environment constant is termed as Homeostasis. Homeostasis is necessary for the cells to perform their vital activities.

ASPECTS OF HOMEOSTASIS:-

There are three aspects of homeostasis.

1. **Osmoregulation:-**
   It is the mechanism of regulation of solute balance, gain or loss of water, generally between the organism and its environment.
2. **Excretion:-**
   It is the mechanism of removal of nitrogenous waste like NH_3, Urea and Uric acid from the body.
3. **Thermoregulation:-**
   It is the mechanism to maintain the internal temperature within a tolerable range.

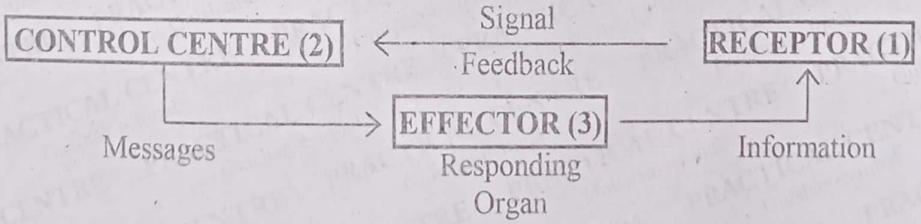
The important aspects of internal environment that must be kept constant are:

Feedback System:

There are a number of Physiological processes functioning in the body to maintain homeostasis. Homeostasis requires check and balance.

The check and balance mechanism is called *feedback system*. Usually, hormones control this feedback system but it is ultimately controlled by the nervous system.

When any change in the internal environment takes place, it is detected by the receptors and immediately reported to the control centre (Brain) which decides about the appropriate response and sends its instructions to the effector, which plays its role and brings the substance back to normal. The feedback may be negative or positive.



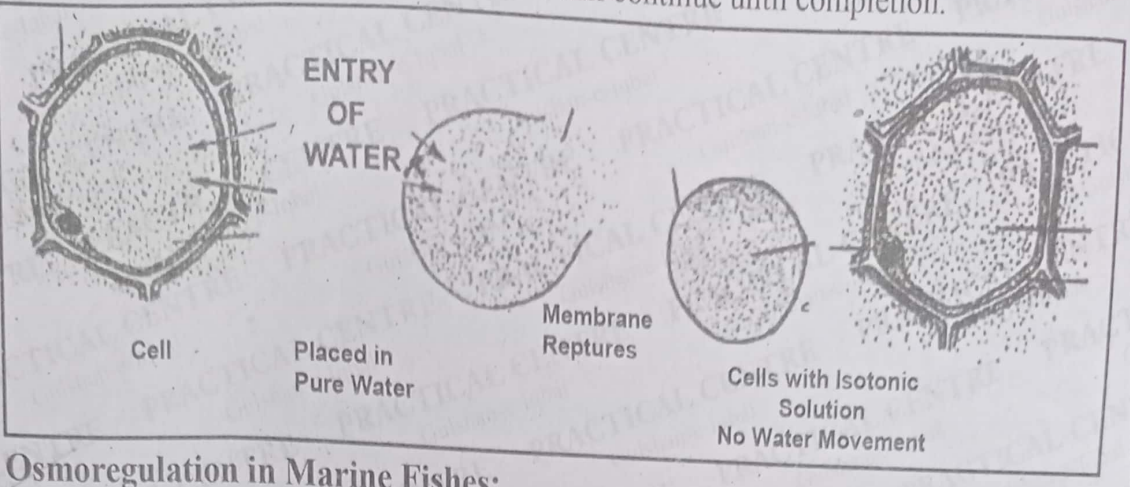
Negative Feedback:

Negative feedback refers to the opposite effect produced in relation to any change in body fluids. For example, when we take sugar, the level of glucose is raised in the blood. It triggers the mechanism, which decreases the level of glucose back to normal.

Positive Feedback:

Positive feedback refers to similar effects produced which leads to the

enhancement of change. For example, once childbirth process begins, each succeeding event makes it more likely that the process will continue until completion.



Osmoregulation in Marine Fishes:

The osmoregulation problem in marine fishes and animals is opposite to that of the fresh water animals.

These animals have lower solute concentration in their body as compared to external water (sea water). A salt-water fish loses water by osmosis through its body but compensates it by drinking sea water and pumping excess salts ions such as Na^+ and Cl^- out through gills. It also saves water and disposes some salts by producing small amount of urine with same solute concentration.

Osmoregulation in Cartilagenous Fishes:

The cartilaginous fishes i.e. shark and rays maintains relatively slightly hypertonic osmotic pressure of body fluids than their surrounding by storing high concentration of urea in their bodies. Thus they do not face problem of water loss. Excess salts are removed by special salt glands in their rectum.

Osmoregulation in Terrestrial Animals:

Land animals are not surrounded by water, therefore they cannot exchange it with the environment by osmosis. Terrestrial animals gain water by drinking and eating moist food as they constantly lose it through breathing and by disposal of waste. However, dehydration is a major problem of terrestrial animals. Arthropods and vertebrates became the most successful animals because they develop a number of adaptations to maintain their osmoregulation which are as follows.

Waterproof External Covering:

To prevent water loss through external surface, vertebrates like reptiles, birds and mammals have waterproof keratinized epidermis. Similarly, the arthropods have developed waterproof cuticle.

In terrestrial arthropods, spiracles are the only opening for exchange of gases.

Storing and Excretion of Solid Wastes:

Reptiles, birds and insects excrete uric acid as nitrogenous waste, which is insoluble in water and it is stored temporarily in cloaca where water is reabsorbed from it before its removal from the body in semi-solid form.

The embryo develops inside the egg which is covered by the shell that prevents water loss.

Use of Metabolic Water:

Some mammals like kangaroo, rat etc. make use of water, produced during the breakdown of body fat.

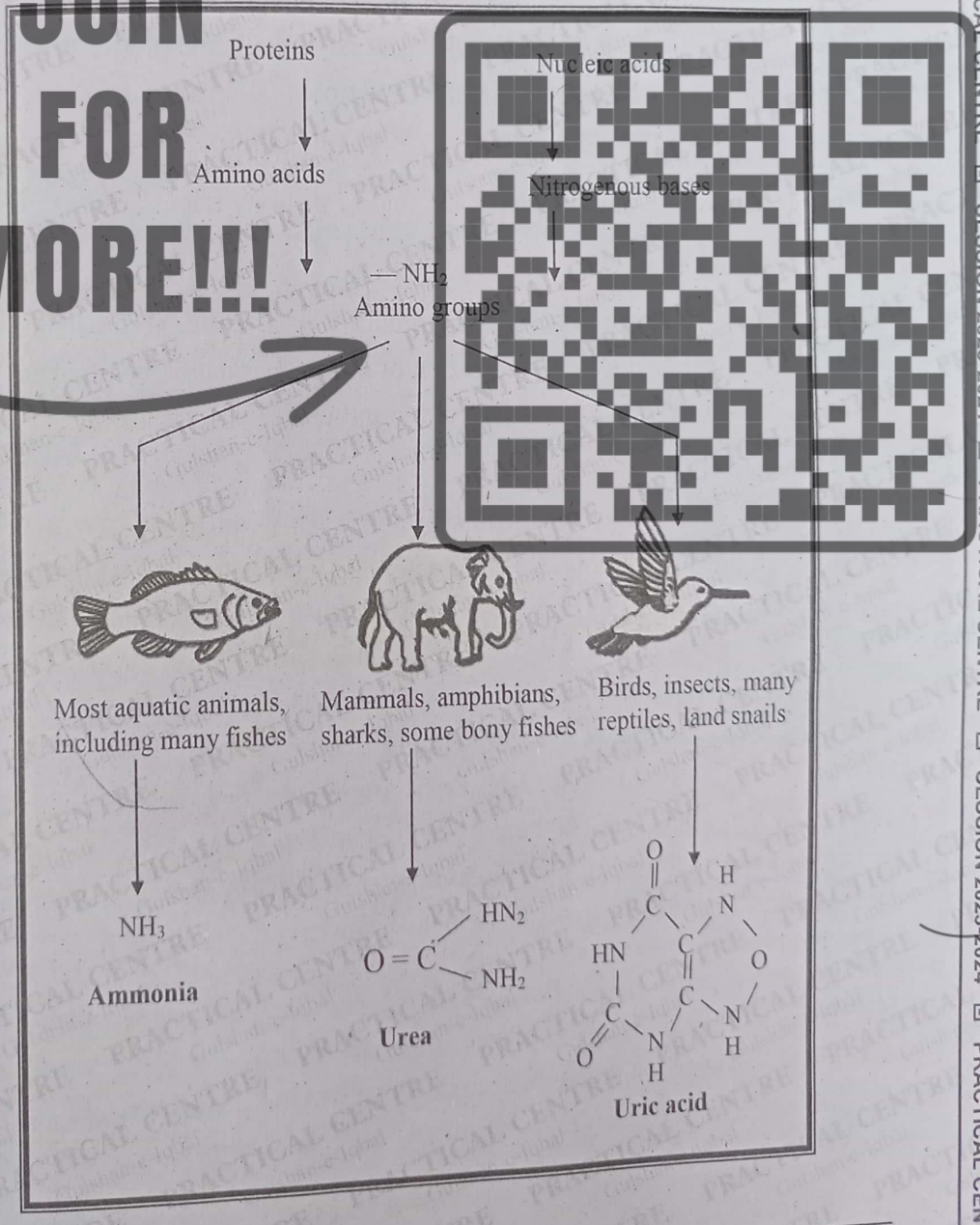
Storing the Waste:

Mammals do retain some urea in their kidneys, where it helps in re-absorption of water.

EXCRETION IN ANIMALS: (ZOOLOGY)

It is the elimination of waste metabolities water, salts and nitrogenous waste. Disposal of waste is an important step of homeostasis for water and solute balance. In different groups of animals, different nitrogenous substances such as ammonia, urea, uric acid, creatinine or trimethylamineoxide and hypoxanthine, etc are produced. These substances are produced where there is catabolism of protein or nucleic acid.

Excess of these substances can cause convulsions, coma, or death. Here, only three of them are discussed:



EXCRETORY PRODUCTS AND THEIR CORRELATION WITH HABITAT OF ANIMALS: (ZOOLOGY)

Ammonia (NH_3):

These are small gaseous molecules and are highly soluble in water and can diffuse very rapidly across the plasma membrane, even when dissolved in water. This NH_3 is highly toxic. Its toxicity can be reduced when diluted with large quantity of water. Excretion of ammonia is advantageous, as it does not require energy for removal. However, its removal requires a lot of water for its dilution.

This type of removal is associated with aquatic animals, particularly freshwater animals. For the removal of NH_3 in soft-bodied animals, the entire body surface is involved.

Urea ($CO(NH_2)_2$):

Urea is relatively less soluble in water and about 100,000 less toxic than ammonia. Therefore it can be tolerated by an animal in much more concentrated form.

Terrestrial animals such as mammals, which cannot afford loss of water during the excretion of nitrogenous wastes, switched over from ammonia to urea.

Conversion of ammonia to urea requires ATP. Urea is produced in the liver. In addition to mammals, most amphibians, shark and some bony fishes also secrete Urea.

Uric Acid ($C_5O_3N_4H_4$):

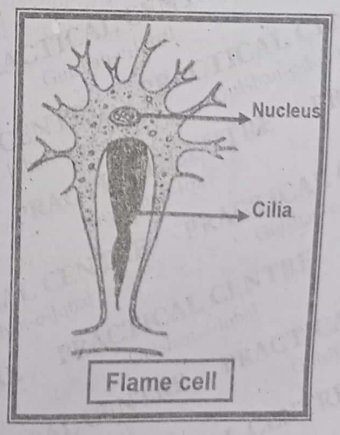
It is slightly soluble in water. It is produced as a colloidal substance. Further absorption of water results in its crystallization of urates. Formation of uric acid requires ATP. The suspension of uric acid is discharged either in the form of thick paste or as solid pellets.

Uric acid is excreted by terrestrial animals such as birds, reptiles, insects and gastropods, which need to minimize loss of water and have egg enclosed in shell.

EXCRETION IN DIFFERENT ANIMALS: (ZOOLOGY)

Excretion in Hydra:

In hydra, nitrogenous waste is ammonia. Hydra has no excretory organ. So, ammonia is removed from the cells of endoderm in gastro- vascular cavity from where it is expelled out through mouth. While ammonia from ectoderm is removed directly in water which is present outside the body.



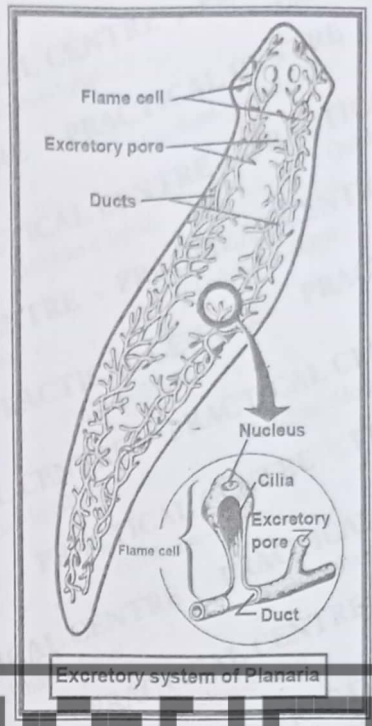
Excretion in Planaria:

Planarians are the animals where the excretory system becomes noticeable.

The excretory product in planaria is ammonia.

Excretory Organs:

The excretory system consists of a series of branching tubes, the outer ends of which open in flame cells while excretory tubules also open outside through pores.



Excretory system of Planaria

Flame Cells:

Each flame cell is a cytoplasmic body, which is hollow inside and bears a tuft of cilia which beat like flickering flame. The flame cells are bathed in body fluid.

Mechanism:

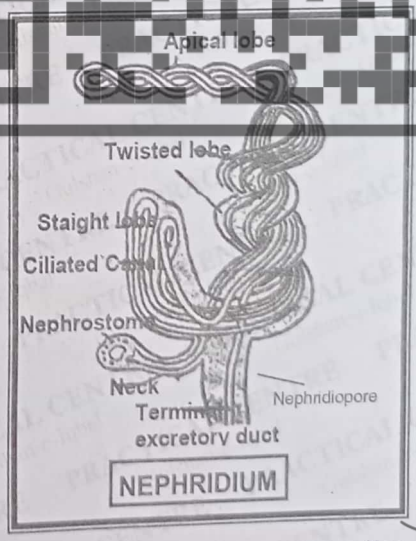
The soluble product, ammonia alongwith water, diffuses from the surrounding cells into the lumen of flame cells. The beating action of cilia propels this solution into excretory canal from where they are excreted out through excretory pores. During the movement of excretory fluid, the water is reabsorbed, if required by the animal and urine is passed out in the form of hypotonic solution. Flame cells function as osmoregulator. Most of the wastes are removed from the body surface or excreted in gut from where they are removed from the mouth along with undigested food. Some flatworms use their flame cells as excretory organs.

EXCRETION IN EARTHWORM:

Earthworm has well-developed excretory system. The excretory and osmoregulatory organs are nephridia.

Structure:

Each nephridium is a coiled tube, open on both sides but segmental nephridia are open on one side only. Internally, the nephridia are provided with 4 canals. The canals are ciliated and glandular. The segmental nephridia open outside the skin by nephridiopores and are termed ***Ectonephric nephridia*** while septal and pharyngeal nephridia open in the alimentary canal and hence, these are known as ***Endonephric nephridia.***



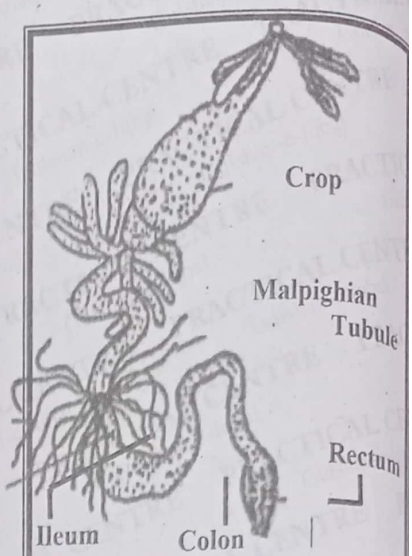
NEPHRIDIUM

Physiology:

The nephridia are supplied with blood capillaries. The nitrogenous waste matter dissolved in the blood is absorbed by nephridia, (Glandular cells), passes out through ciliated cells and is excreted out. Septal nephridia, which are provided with ciliated funnel, also absorb waste product from coelomic fluid. Salts are reabsorbed by blood capillaries. The excess amount of water is reabsorbed in long tubes.

EXCRETION IN COCKROACH:

In cockroach and other insects, the excretory organs are malpighian tubules.



Cockroach-Alimentary Canal with malpighian tubules

Physiology:

Cells of the malpighian tubules absorb the excretory waste alongwith some useful substances present in haemolymph. In the lateral part of the tubule, selective re-absorption of useful substances occurs and uric acid is discharged into the rectum. Rectum stores uric acid for the re-absorption of salt and water. So, uric acid becomes almost dry and passes out with faeces.

EXCRETION IN MAN: (ZOOLOGY)

To regulate the salt and water balance, the excretory organs of man and other mammals are:

- Liver
- Kidneys
- Skin

LIVER (An important Homeostatic Organ):

Homeostasis would not be complete without the mention of liver, which performs more functions than any other organ in the body. In addition to its role in digestion, liver supports the vital activities of the kidneys. The main Homeostasis functions of the liver are as follows.

Role of Liver in Balancing the Salts

(i) Metabolism of Carbohydrates and Lipids:

- Liver maintains the concentration of glucose in the blood. If glucose is in excess, it is converted into glycogen and stored in the liver.
- When there is shortage of glucose in the blood, the stored glycogen is converted into glucose and supplied to body.
- If glycogen is reduced, the amino acids may be converted into glucose.
- Liver removes lipids from the blood either by their oxidation or by storing these as fat.

(ii) Deamination and Urea Formation:

The body cannot store excess proteins or amino acids. So, their excess amount is immediately broken down. First, the removal of amino acid takes place. It is known as Deamination. Amino group is supplied to carbohydrate for respiration. As ammonia is toxic, so it is converted into urea, a less toxic substance by urea cycle and then released in the blood, which carries it to the kidneys for excretion. This entire cycle is known as *ornithine cycle.*

FATE OF SURPLUS AMINO ACIDS IN THE BODY

(iii) Breakdown of R.B.Cs:

RBCs are broken in the liver by. WBCs into haem and globin .Globin is broken into amino acid while iron is removed from haem. Iron and amino acids are recycled into haemoglobin.

(iv) Production of Bile:

Bile is a yellowish green alkaline fluid, which contains bile pigment (biliverdin, bilirubin) and salts, like sodium bicarbonate, sodium glycocholate, sodium taurocholate, cholesterol, phospholipids and mucous. Bile pigments are the heme part of broken haemoglobin of worn-out RBCS. Its globin is broken into its constituent amino acid and recycled into new protein molecules.

Bile salts are involved in emulsification of fats.

(v) Detoxification:

Liver can modify the structure of many drugs and poisons to make them harmless For example, Hydrogen peroxide, a by-product of many chemical pathways, is a highly toxic substance. It is broken down into Hydrogen and Oxygen by an enzyme, catalase which is present in liver cells.

(vi) Formation of Cholestrol:

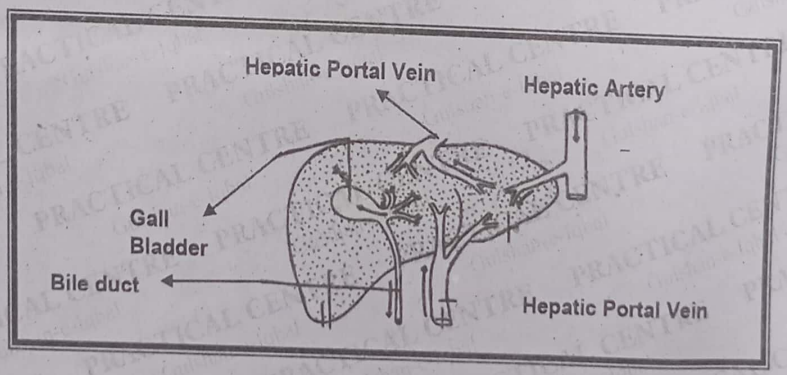
Cholesterol is chiefly synthesized in the liver and if it is in excess, is removed by bile. Its excess amount is converted into gall bladder stone, which may leads to jaundice.

(vii) Thermoregulation:

Due to its efficient blood supply and high metabolic rate, liver plays an important role in maintaining body temperature.

(viii) Storage of Vitamins:

Liver stores a number of vitamins such as A, B and D together with minerals such as Iron, Copper and Potassium.



(ix) Purification of Blood:

Many poisonous substances are produced during metabolism by disease-causing parasites, other poisons including certain drugs and alcohol are taken out from the body.

(x) Production of fibrinogen:

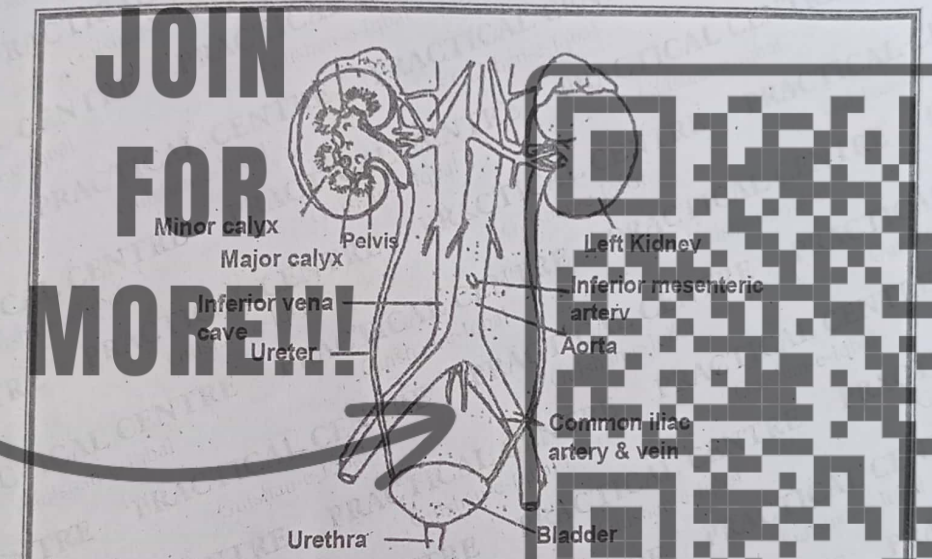
The liver manufactures an important blood protein, called fibrinogen which is vital for the clotting of blood in wounds.

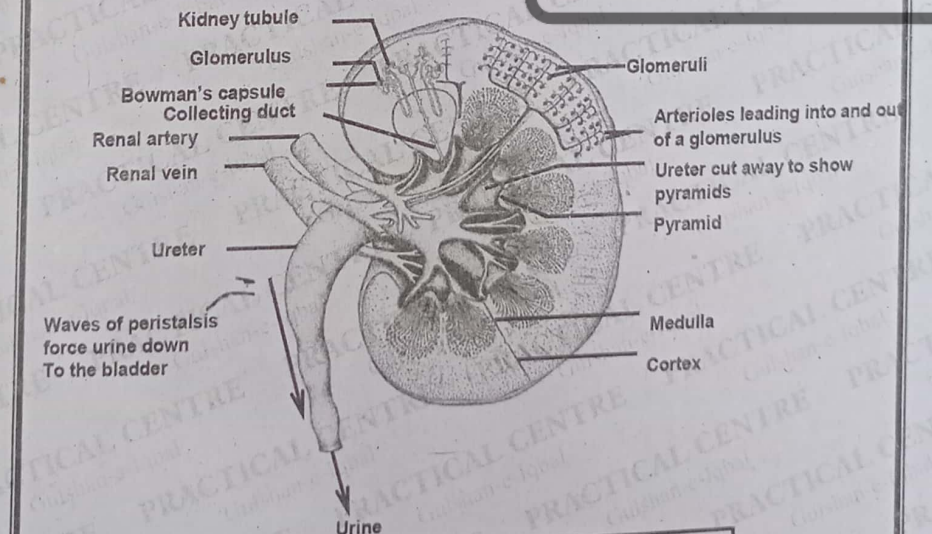
(xi) Production of heat energy:

The liver produces a great deal of heat as by-product of thousands of chemical reactions which take place within the cells.

URINARY SYSTEM IN MAN: (ZOOLOGY)

Human kidneys are two in number, each 12cm long and 6.7cm in diameter and beam-shaped. A thin tube, the ureter comes out of the concave side of each kidney and extends downward to a single large body called ***bladder.*** The bladder opens into the urethra which leads to the body surface. The bladder end of the urethra is normally held closed by means of ring of muscles (a sphincter) which controls the release of urine from the bladder.





L.S. OF HUMAN KIDNEY

KIDNEYS:

In man, there are two kidneys. Each kidney, is brown in colour and measures 6cm in width and 12cm in length. The two kidneys are situated in the lower part of the abdomen on each side of the vertebral column. Each kidney is bean seed-shaped in structure. At one side, it is convex while the other side is concave. On the concave side, there is a depression called hilus. The ureter comes out from the hilus. Hilus is also the site from where the renal artery enters and renal vein comes out.

Internal Structure of Kidney:

The internal structure of the kidney shows the following structure when cut in L.S.

Cortex:

It is the outer brownish region.

Medula:

It is the central pale yellow region.

Pyramids:

These are the cone-like structures present in medulla. Urine is dropped in the pelvis from the conical parts of pyramids.

Structure of Nephron:

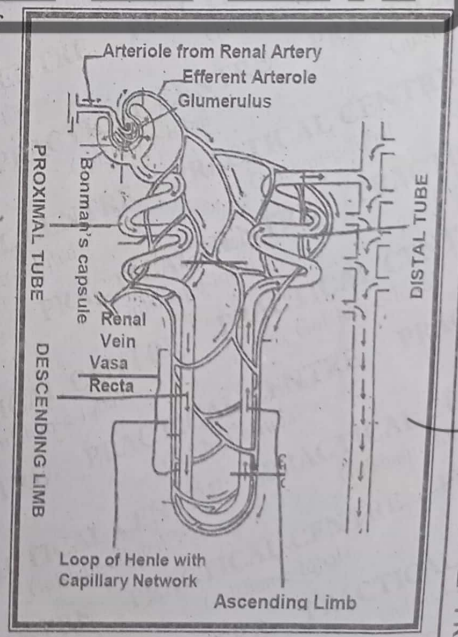
The Nephron is the structural and functional unit of kidney where filtration of urine takes place. Each nephron may be divided into two parts.

(1) Renal Capsule (Malpighian Capsule)

(2) Renal Tubules

(1) Renal Capsule (Malpighian Capsule):

It consists of a cup-shaped, double-walled Bowman's Capsule which contains a network of blood capillaries called Glomerulus. The blood vessel which enters into Bowman's capsule is known as afferent vessel which divides and redivides to form thin-walled glomerulus. This opens into efferent vessel.



(2) Renal Tube:

It is a tube-like structure which is internally lined by ciliated epithelium and glandular epithelium. It is divided into three regions.

(a) Proximal Convoluted Tubule:

It is the anteriormost convoluted part and is connected with the Bowman's capsule. This portion is meant for tubular reabsorption of the filtrates such as Glucose, Amino acid, NaCl etc.

(b) Loop of Henle:

It is U-shaped, present in the Medulla of kidney. It consists of descending and ascending limbs and is the site of reabsorption of water.

(c) Distal Convoluted Tubule:

It is a highly coiled portion of nephron, lying in the cortex. It helps in tubular secretion.

REGULATORY FUNCTIONS OF KIDNEY: (ZOOLOGY)

The kidney performs regulatory functions by (1) (2) (3) (4)

ULTRA-FILTRATION, REABSORPTION, TUBULAR SECRETION AND COUNTER-CURRENT EXCHANGE.

Ultra-Filtration:

When the blood reaches the glumerulus, it is filtered due to the following reasons:

- Diameter of Afferent arterioles is much larger than that of efferent vessels, which generates a pressure.
- Blood passing from afferent arteriole with high pressure, due to pumping of ventricle.
- Wall of Bowman's capsule is sieve-like, which permits the entire molecules except plasma protein and blood cells to pass.

So, a hydrostatic pressure is generated at the glomerulus and the plasma begins to filter but RBCs, WBCs and platelets cannot pass through the walls of glomerulus and the filtrate, which is water, urea, uric acid and some other substances, comes in the Bowman's capsule.

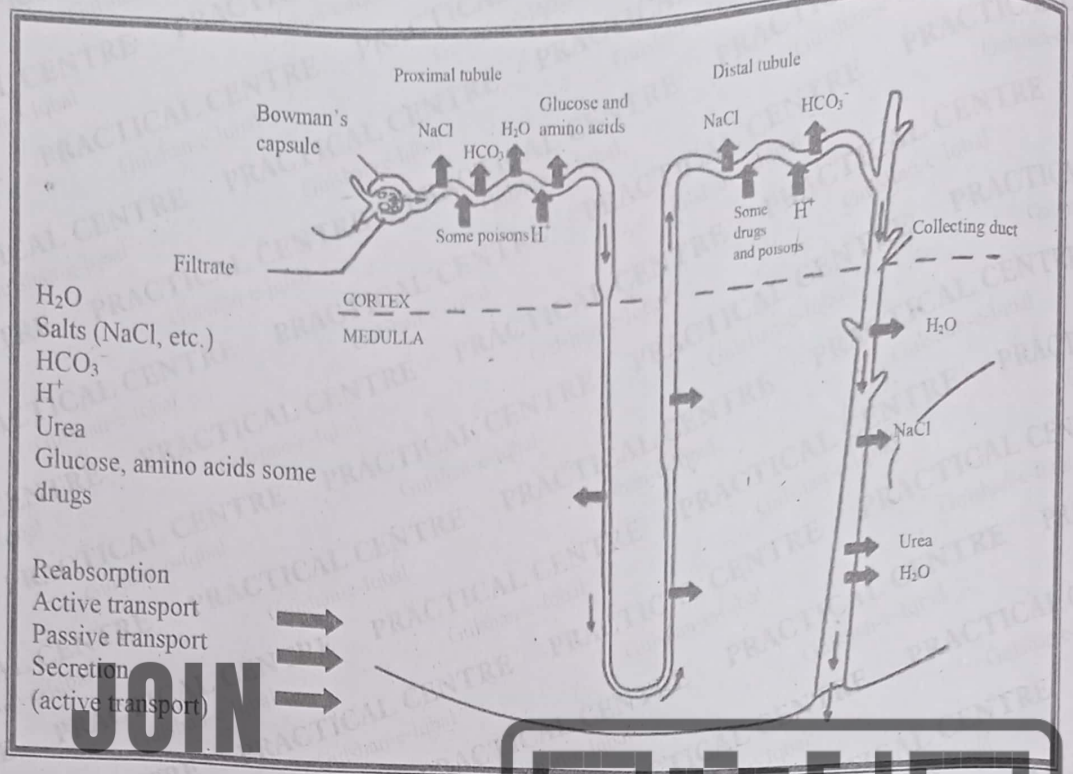
Reabsorption:

The filtrate contains some useful salts such as glucose, amino acids, water etc. The rest of the nephrons are a filtrate refinery.

When the filtrate passes down, Sodium ions are actively pumped into peritubular capillary and then Chloride ions follows passively. Due to this, Osmolarity of blood is changed and water moves passively in blood. About 60-70% salt and water are reabsorbed at the proximal convolulated. Glucose and amino acids are returned to the blood. Glucose is only re-absorbed completely because there is a plentiful supply of carrier molecules in the membrane of nephron.

Human beings produce about 1.5 litre of urine daily, depending upon the amount of liquid they drink. The full extent of reabsorption is shown below.

Urea is believed to leak from collecting duct. This creates a hypertonic environment and water is drawn out and returned to circulatory system.



Tubular Secretion:

Tubular secretion occurs at distal convolulated. Substances such as uric acid, hydrogen ions, ammonia are eliminated from distal convolulated part of nephrons. These are the molecules, which escaped during glumerulus filtration.

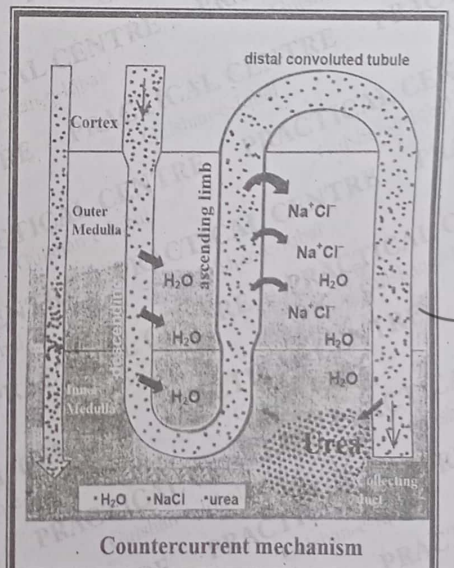
Counter Current Exchange:

It makes no difference if one drinks too much water or too little or take too much salty food or lose Na^+ by sweating. Kidneys accurately adjust how much water and sodium one's body excretes or conserves. This adjustment is about by two methods.

1. Counter-current mechanism.
2. Hormone-induced mechanism.

Counter-current Mechanism:

From the loop of nephron, the filtrate flows downward in the descending limb and the upward inascending limb. This is counter-current flow of filtrate. It allows the nephrons which are deeply penetrated in the medulla to produce concentrated urine and conserve water. First in the ascending limb of nephron, Na+ and Cl^- and some salts passively diffuse out in the tissues of medulla, hence salt concentration is reduced in tubule. But water does not come out from tubule, as this part is impermeable to water. As the salts move in medulla, here the concentration of salts is increased. Another



Countercurrent mechanism

cause of this increase in concentration is leakage of urea from collecting duct in medulla.

As concentration in medulla is increased, water moves from ascending limb to medulla. (This occurs because the decreasing number of water molecules in the descending limb encounters an increasing concentration of solute).

This ensures that water will continue to leave the descent limb and it comes in medulla because it has high concentration of salts.

Thus, the fluid, which passes from distal convolulated, to cell cortex is isotonic but as the collecting duct passes down, water diffuses out into medulla. Urea also passes out from the collecting duct to medulla, making the urine concentrated. Hence, water is conserved. This is counter-current multiplier.

The other counter-current is composed of ***Vasa recta***, the blood vessels which runs parallel to loop of henle.

Only 10% blood flows through the kidneys and passes as through ***vasa recta***. The blood flow is at very low speed and provides nourishment and O_2 to medulla cells. It also takes away the water absorbed from the filtrate, without affecting the concentration gradient of medulla.

HORMONE INDUCED MECHANISM: (ZOOLOGY)

Cells in the walls of distal tubules and collecting ducts have receptors for two hormones, ADH and aldosterone.

Effect of ADH:

When water must be conserved, the hypothalamus triggers the secretion of ADH. This hormone makes the wall of nephron more permeable to water, more water is reabsorbed and urine becomes concentrated. But when the body must lose excess water, ADH secretion is inhibited and the walls remain impermeable to water. Less water is reabsorbed and the urine remains dilute.

Aldosterone:

Aldosterone enhances the sodium re-absorption. So, less sodium is excreted when the body has too much sodium, when aldosterone secretion is inhibited, less sodium is reabsorbed and more is excreted.

Finally, when solute increases in extra cellular fluid, the hypothalamus inhibits saliva production. The brain interprets the ensuing dryness in the mouth as thirst, which is the early sign of dehydration, and one seeks fluid.

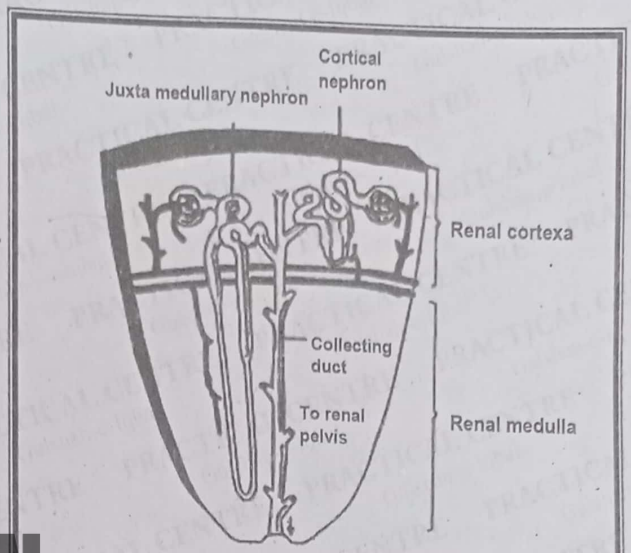
ADAPTATION OF KIDNEY FOR WATER CONSERVATION: (ZOOLOGY)

Mammal's kidneys are well adapted for the conservation of water.

The degree of concentration of urine depends on the length of loop of Henle. There are two types of nephrons in the kidney.

Juxta Medullary Nephrones:

These nephrons have longer Henle's loop for greater reabsorption of water and cause concentration in urine.



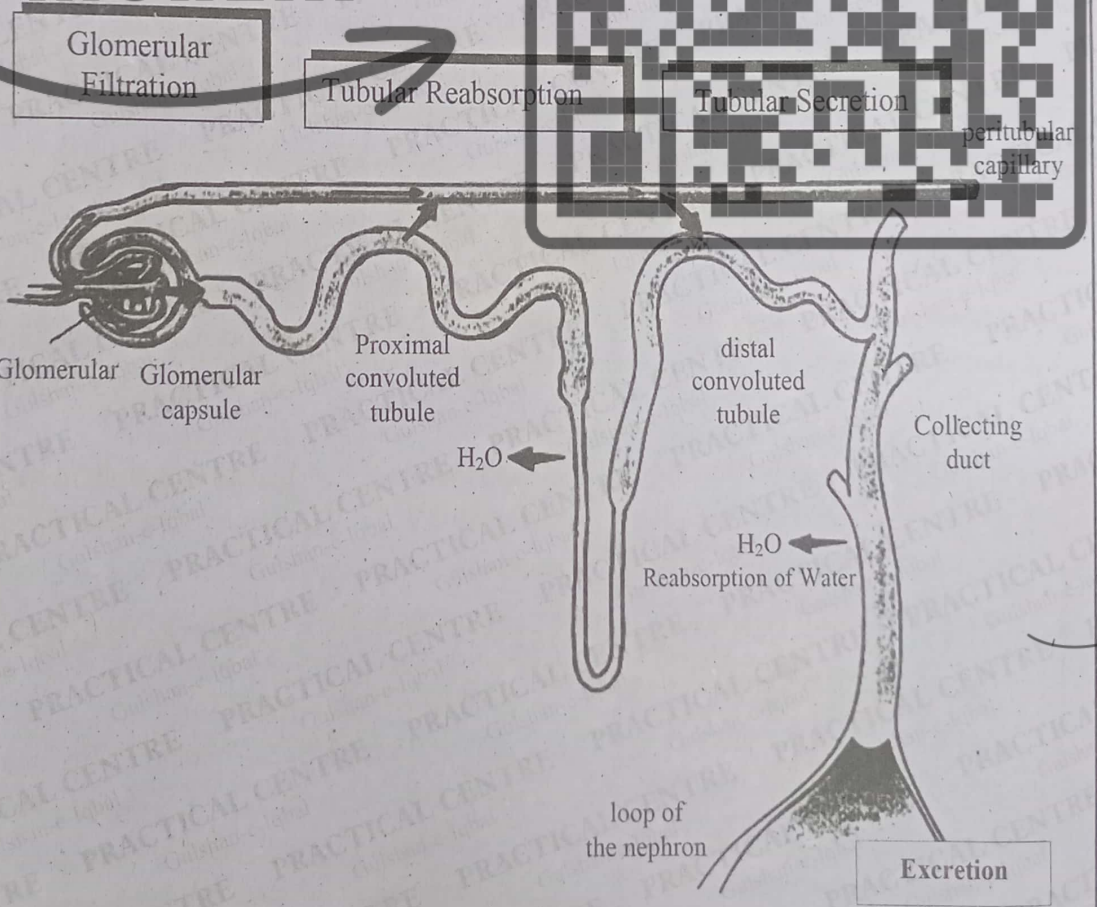
Cortical And Juxta-Medullary Nephrons

Corticalnephrons:

These nephrons have smaller loop of Henle and cause dilution of urine.

Composition of Urine:

Urine contains 95% water and 5% solid waste. The analysis of urine composition is helpful in diagnosing various disorders, infection and diseases of the kidney.



t 95%
solids 5 %

Nitrogcno
1. 0
Urea 3.00 grams (s>o0 ml ofu rine)
Ceatinine l-2 gramis
Ammo ni a 1-2 grams
Jic acid l gram

[lons(Salts

Fsiive lons	Negative lons
Sodium	Chlorides
Po tassium	Sulphates
Magmesium	Phosphates
Aluminium	
Calcium	

KDNEY PROBLEMS;(Z00LOcY

Kidney Stones:

Stony materials found in the kidney and this causes urinary obstruction and is gmerally complicated by infection

The stone is formed due to hypercalcimia ie. when there is high level of oxalates. 0xalates are present in green vegetables and tomatoes and are cause of hyperoxluria.

The ncidence ofcalcium oxalate type stoneis 70%.The incitnce ofoterbps or sonesie.by calcium phosphate and urc asid is 15%and 10%rspectitely. These slis ae precipitated outduring urine formation and accumulate laterto fom stone.

Lithotripsy and Surgery:

The kidney's stone can be removed mostly by urgery, but presenly, lithotipsy cm be used or the removal of stone In lihotipsy technique, sone peseit in kidhey, utrorgall bladder tbe is broken with shock waes wichism adhmnetliestmolog) ln his process,shock waves are focused on stone from outside the body and when the stone is broken in small fragments, they are passed through urine

Renal Failure:

which are either [illegible] in nature, may destroy the nephrons particularly its glomerulus part. As a result,the nitogenous wastes starts accumulating in blood which leads to sympotoms such as nausea,vomiting,loss of appetite and weakness.In severe cases, it may lead to coma and death.

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DIALYSIS:

In chronic renal failure, the function of the kidney is lost. It cannot remove waste products. So, to remove the waste, the blood of patient is treated through dialysis. There are 2 main types of dialysis.

1) Haemodialysis:

Haemo-dialysis means cleaning the blood. In this process, blood is circulated through a machine, which contains a dialyzer, also called artificial kidney. Dialyzer has two spaces separated by thin membrane. Blood passes from one side of membrane and dialysis fluid on the other side. The waste and excess water pass from the blood through membrane into the dialysis fluid.

2) Peritoneal Dialysis:

This method involves the following: the abdomen has peritoneal cavity lined by a thin epithelial membrane called peritoneum. This peritoneal cavity is filled with a dialysis fluid that enters the body through a catheter. Excess water and wastes pass through the peritoneum into the dialysis fluid. This process is repeated several times a day and requires an abdominal incision, which is done in hospital. Dialysis is used after kidney failure and is done again and again until a matching donor's kidney is transplanted.

3) Kidney Transplant:

Dialysis may be used as a temporary measure. In high degree of renal failure, dialysis is useless. A matching kidney is transplanted from a donor. It is a surgical procedure and successful in 80% cases.

THERMOREGULATION: (ZOOLOGY)

The maintenance of internal temperature within a range that allows cells to function efficiently is called thermoregulation. The normal temperature range for active life is 10°C to 35°C for most of the organisms. The temperature influences directly upon the membrane properties and cell metabolism.

Thermoregulation in Animals:

Animals obtain heat energy from two sources i.e. from external source or internal source.

External source is solar radiation or indirect radiation etc while internal source is metabolic activities of cells.

CLASSIFICATION OF ANIMAL ON THE BASIS OF TEMPERATURE:

There are two types of animals, according to their thermal characteristic.

(i) Poikilotherms

(ii) Homeotherms

Poikilotherms (Cold-blooded Animals):

(Having variable temperature)

Poikilotherms are those animals whose body temperature changes according to their environment. Invertebrates, fishes, amphibians and reptiles are cold-blooded animals.

Homeotherms (Warm-blooded Animals):

(Having constant temperature)

Homeotherms are those animals whose body temperature remains constant and does not change according to their environment. Mammals and birds are homeotherms.

However, both the terms are discarded because poikilotherms maintain their body temperature while homeotherms change their body temperature. So, ectotherm and endotherm have replaced these terms.

Ectotherm:

Ectotherm animals are those that absorb heat from their environment because they produce low metabolic heat. Invertebrates, fishes, reptiles and amphibians are ectotherms.

Endotherm:

Endotherm animals are those that generate their own heat. Birds, some fishes, and some flying insects are included in this group.

Heterotherms:

Heterotherms are those animals who generate heat of various degrees and cannot regulate their body temperature within a narrow range. Bats, humming birds are included in this category.

Mechanisms of Thermoregulation in Animals:

Temperature influences the metabolic activities of animals. Aquatic animals have stable environment while Terrestrial animals feel the fluctuation of temperature over a 24 hours period. To adapt and tolerate the temperature fluctuations, animals show many structural physiological and behavioural responses.

Physiological Adaptions:

- There is slight change in blood circulation.
- Change in the rate of metabolism.
- Cooling occurs when sweat evaporates from skin surface.
- Activation of certain muscles.
- Energy is lost from the body as latent heat, which reduces the body temperature

Behavioural Adaptations:

- Animals can increase or decrease heat by changing their location.
- They bask (enjoy by sitting in sun) on warm rocks in winter.

- Animals find wet cool areas or burrows in summer.
- Animals migrate to comfortable climates.
- Some animals open their mouths to reduce heat e.g. birds.

Structural Adaptations:

- Lungs are modified for panting.
- Sweat glands are present in mammals and not in birds.

THERMOREGLATION IN MAN:

Mammals, including man, maintain their high body temperature within a narrow range of about 36-38°c or 98.6°F. So, there are ways in the body to control overheating or overcooling.

Overheating:

Vigorous activities, disease, absorption of radiation from the sun and many other factors bring about overheating. Overheating produces two marked effects on skin. i.e. Vasodilation and Sweating.

Vasodilation:

Due to overheating, blood vessels are dilated, more blood flows through them, the capillaries which lie just beneath the epidermis and when overheated blood flows very close to the body surface, the blood rapidly loses heat and the body is cooled.

Relaxation of Hair Erector Muscles:

The hair erector muscles are attached with hairs, Whenever heat is lost from the body, the hair erector muscles relax and hairs lower down and offer least possible obstruction to heat loss by radiation and convection.

Sweating:

Due to overheating, sweating occurs and when it evaporates from the body, cooling occurs. Moreover, evoporating liquid carries away body heat.

Metabolic Rate:

Metabolic rate of the body is decreased and hence body generates less heat.

Behavioral Mechanism:

- We move to cooler location.
- We use thin clothes or dresses made up of good cotton because it is a conductor of heat.

MECHANISM OF THERMOREGULATION IN COLD TEMPERATURE:

The following changes occur when there is overcooling.

Decrease in Sweat Production:

The heat loss is mininised by evaporation.(i.e. sweating does not occur)

Vasocontraction:

The arterioles contract which supply less blood towards skin and heat loss is prevented.

Metabolism:

The rate of metabolism is increased by secretion of adrenaline in the short term and thyroxin in the long term.

Contraction of Hair Erector Muscles:

Due to cooling, the hair erector muscles contract and hairs become errect and form a film over the skin forming an insulation.

Shivering:

In cold conditions, shivering occurs which generates heat in muscles.

Brown Fat:

Some mammals posses brown fat which is a special tissue found in between neck and shoulders and this tissue produces heat rapidly.

Subcutaneous Fat Accumulation:

In mammals, fat is stored in adipose tissues below the skin which is bad conductor of heat, so heat is conserved. This mechanism is very important in polar bear and aquatic mammals like seal, whale and walrus.

Behavioral Mechanism:

- Organisms move to warmer location.
- Animals come closer to each other.
- Human beings wear thick clothes or woollen clothes because wool is bad conductor of heat.

Role of Brain in Temperature Regulation:

Hypothalamus is a part of brain which has thermoregulatory centre and its acts as the thermostat of the body. The set point of this thermostat is 37°C.

Any change in temperature below or above 37°C is detected by hypothalamus.

In case of increase in temperature above the set point, hypothalamus and other parts of the nervous system detect and sends signals to the system that increases the blood flow to the skin and causes sweat glands activation and sweat is evaporated for cooling.

In cold temperature, the cold receptor sends the impulse to hypothalamus and it signals to inhibit the heat loss mechanism and activates the heat-producing mechanism.

This includes constriction of superficial blood vessels and stimulates shivering and non-shivering mechanism.

Fever (Pyrexia):

When the body temperature is above normal temperature i.e. 37°C or 98.6°F, it is called fever.

Fever is caused due to bacterial or, viral infection. Fever is caused by pyrogens, which are released by macrophage (Leucocytes). This fever inhibits the growth of pathogenic micro-organisms.

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CLASS-XII

BIOLOGY

CHAPTER # 16

SUPPORT AND MOVEMENT

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SUPPORT AND MOVEMENT

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Support: The support may be define as the stability provided to the body by means of skeleton as known as support.

MOVEMENT:

The movement is the change in position of a living organism from one place to another place. **OR** The displacement covered by a living organism from one point to another point called movement. **OR**

The movement is a displacement from one point to another, and occurs at all levels of the organization called movement.

LOCOMOTION: It is the type of movement of an organism in search of food, to escape from predators, find a mate, distribute offspring, avoid dangerous condition, maintain position and avoid unnecessary products called locomotion.

In terrestrial animal, the need for support is more essential as because the air does not provide it, like that of water.

STRUCTURE NECESSARY FOR LOCOMOTION IN ANIMALS:

Three structures are necessary for locomotion in higher animals.

1. **SKELETON:**

   It provides support to the body and maintains the shape of organism.

2. **MUSCULAR SYSTEM:**

   It provides movements in different part of the body.

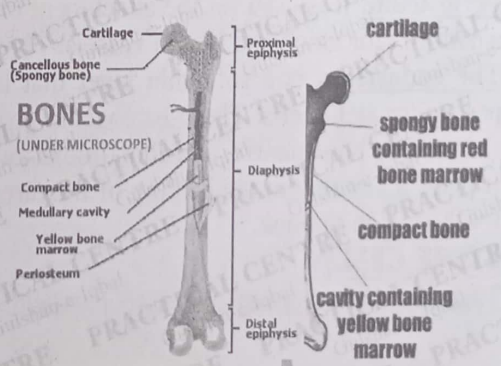
3. **THE NERVOUS SYSTEM:**

   The system which control and coordinate the Skeletal & Muscular system.

HUMAN SKELETON

SKELETON:

The skeleton is the hard part or hard plates of the body which provides a definite shape to the body, provide support and surface area for the attachment of muscles, it store salts and minerals, produce a hormones hold osteocalcin and also produce blood, it also protect the vital organs of the body like brain, heart, lungs and livers and it help in locomotion or movement called skeleton.



BONE

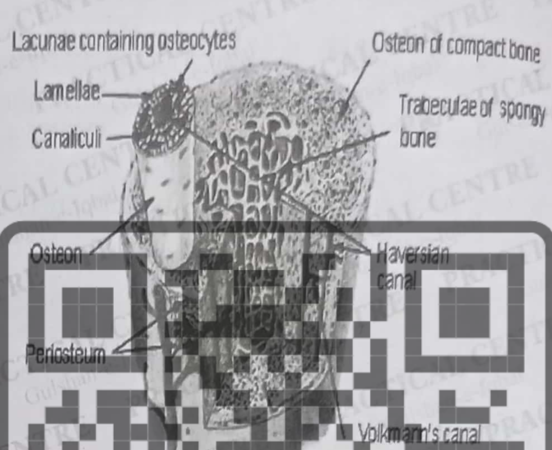
- It is the form of connective tissue which composed of different cells.
- The skeletal bones are different in their shapes and size but they are similar in

their structure, formation, and function.

- The major piece of bones consists of an **extracellular matrix,**
- The extracellular matrix of bone is woven from flexible strands of **collagen fibers** and hardened by crystals of **calcium phosphates 10 to 20% water and osteoblast.**
- The process is known as ossification or calcification; which takes place in the presence of vitamin 'D' which is necessary for calcium absorption from the blood and milk.
- The major part of a childes diet contains a good source of calcium and other minerals.

DISTINCT REGION OF BONE:

A long bone has three distinct regions:



<u>**Epiphysis:**</u> The terminal regions of bone are **epiphysis.** They are **cancellous or spongy** parts of the bone. Each part has small weight-bearing cross-linked regions called **trabeculae.**

The epiphysis is filled with red bone marrow, which produces **20%** of blood cells that form about **20%** of the total mass of the skeleton.

<u>**Diaphysis:**</u> **The middle region** of long **bone is diaphysis.** The external part of the diaphysis is known as **cortical bone.**

<u>**Cortical bone**</u> forms almost **80%** of the skeletal structure and consists of many small cylinders known as **Osteons.**

<u>**Osteon:**</u> Each osteon is made of many **lamellae,** which are concentric layers made of **an organic part collagen, and an inorganic part** called **hydroxyapatite,** which is mostly **calcium phosphate.** In the center of every osteon is a **Haversian canal.**

<u>**The Haversian canal**</u> contains the blood supply and innervations of the bone cells.

<u>**The medullary canal**</u> is located at the center of the bone. It is a hollow space lined by a honeycomb-like structure called the **spongy or cancellous bone. The medullary canal** contains the bone marrow, the site of blood cell production.

<u>**Metaphysis:**</u> A region between the terminal and the middle region is **metaphysis.**

<u>**Outer and Inner Covering of Bone:**</u>

The outer covering of bone is the **periosteum** and the inner layer is the **endosteum.**

<u>**Periosteum:**</u> It is used for the attachment of muscles and their tendons. It also provides a pathway for blood and lymph vessels.

<u>**The endosteum**</u> is a soft, thin layer that lines the inner cavity of long bones. It has progenitor stem cells. These osteogenic progenitor cells develop into osteoblast which secretes the bone matrix, and chondroblast which secrete cartilage.

It plays a key role in the healing of fractures by producing new cells that are necessary for the fusion of bone.

BONE CELLS:

There are three types of cells associated with bone.

i. **Bone-forming cells (osteoblasts):** These are progenitors that secrete matrix around themselves to form spongy bone which later becomes compact bone.

ii. **Mature bone cells (osteocytes):** Osteoblast cells when isolated from the surrounding matrix in the space called lacunae, become osteocytes. They direct osteoblasts to the site of the damage, hastening (fast healing). Osteocytes also phagocytize the bony matrix that will start the action of osteoblast.

iii. **Bone dissolving cells (osteoclasts).** These cells are responsible for breaking down the composite material in bones. They help in the demineralization and repair of bone.

STRUCTURE OF CARTILAGE

It is a type of soft flexible connective tissue surrounded by a layer called perichondrium. It is formed by chondroblasts that produce chondrocyte cells. They are abundant in lacunae in the cartilage. These cells secrete extracellular matrix, which is a gel-like mixture of protein **proteoglycan** formed by **chondroitin sulfate** and **protein** and some other **non-collagenous proteins** to develop cartilage. The matrix of cartilage also contains large no of **collagen fibers**, which are embedded in an amorphous material. These fibers provide support and strength to the cartilage. Cartilage is thin, soft, and elastic. It is found on the surfaces of joints whose bones move against each other. It also forms stiff but flexible structures like the larynx, external ear, and tip of the nose. In all vertebrates, embryonic endoskeletons are composed of cartilage, which is replaced by bones.

TYPES OF CARTILAGE:

- **HYALINE CARTILAGE:**

  It is the most abundant type in the human body. It has a smooth surface that allows tissues to slide easily.

  LOCATION: It is present in between the ribs and sternum, nose at the bone surface in many joints.

- **FIBRO CARTILAGE:**

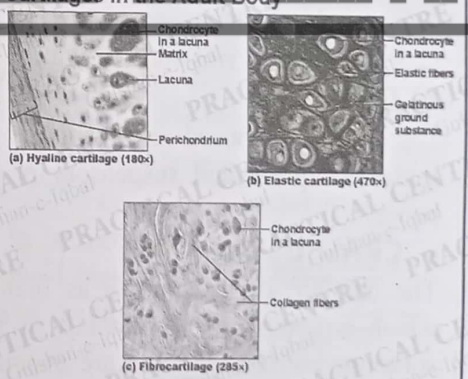
  It has matrix-containing bundles of collagen fibers. It is the hardest among other cartilages.

  LOCATION: It is present as an intervertebral disc, in the knee joint and the pectoral girdle.

- **ELASTIC CARTILAGE:**

  It is the most flexible and strong cartilage.

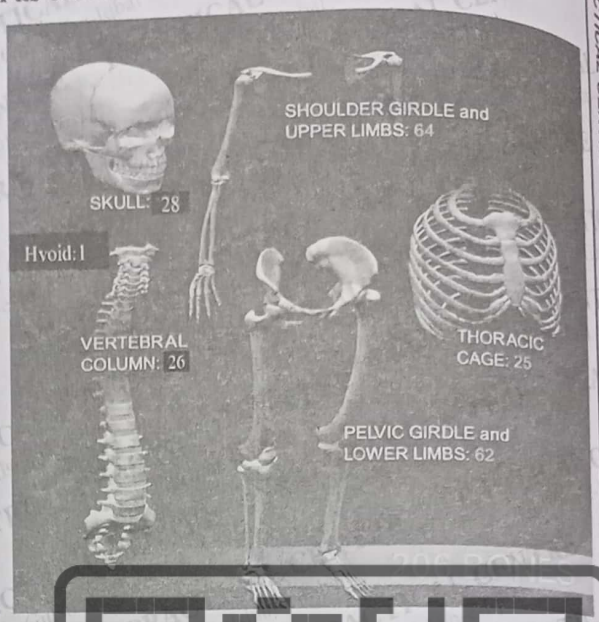
  LOCATION: It is located in the pinna of the ear, external and internal auditory tubes, epiglottis, and larynx.



ENDOSKELETON:

"The skeleton which is found inside of animal body and the muscles are attached to the outer surface of skeleton is known as endoskeleton."

The Endoskeletons support structures, that reside in the animal body. It is also found in few invertebrates such as sponges and sea squids. The endoskeletons of vertebrates are the most complex and versatile. The vertebrates are supported by endoskeleton which is composed of two types of connective tissue like bones and cartilage which are develop from mesoderm (3rd cellular/germinal layer) and it is covered by muscles.



THE HUMAN SKELETON:

- The adult human endoskeleton composed of **206 bones**,
- The 18% of total body weight composed of endoskeleton.
- The newborn baby having about **300 bones** of which many small bones get fused together in adult stage.
- The human endoskeleton can be divided into following two parts, called:

1) **Axial skeleton**
2) **Appendicular skeleton**

1. AXIAL SKELETON:

The skeleton, which is found on central axis or body axis called the Axial skeleton.
The axial skeleton consists of skull, vertebral column, ribs and sternum.

1) SKULL:

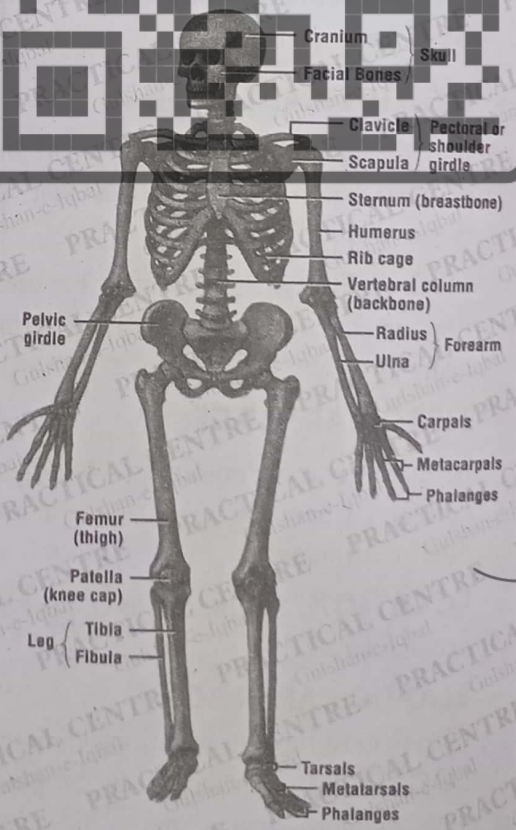
The skull composed of cranium, jaws, sensory, capsule and suspensory or facial bones.

- **CRANIUM:**

The cranium is also known as brain box which is composed of 8 bones of which some are paired and some are unpaired in their numbers, the Parietal and temporal are paired bones whereas frontal, occipital, sphenoid, and ethmoid are unpaired.

Details of Cranium Bones:

1. frontal (1)
2. parietal (2)
3. temporal (2)



4. occipital (1)
5. sphenoid (1)
6. ethmoid (1)

JAWS:

- The jaws are of two types called upper jaw & lower jaw.
- The upper jaw is fixed whereas the lower jaw is mobile
- The jaws contain teeth
- The teeth are off various types called incisor canion premolars and molars.
- The teeth are embedded in sockets called alveoli.
- The dental formula of human is $\frac{I\ C\ PM\ M}{2:1:2:3} = \frac{8}{8} = 16 \times 2 = 32$

The lower jaw having a single bone called dentary.

SENSORY CAPSULE:

The Sensory capsules are of two types called:

1. Nasal Capsule

The Nasal capsule is associated with smell

2. Auditory Capsule

The Auditory capsule is associated with hearing.

The Auditory capsule having three bones on both side which are known as ossicle like mallus, incus and stapes.

SUSPESORY / FACIAL BONES:

There are 14 facial bones.

A single bone called a dentary supports it.

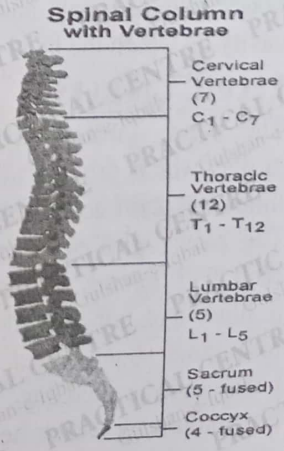
Facial bones	(14)
Mandible	(1)
maxilla	(2)
palatine bone	(2)
zygomatic bone	(2)
nasal bone	(2)
lacrimal bone	(2)
inferior nasal conchae	(2)
Vomer	(1)

Hyoid Bone:

A single bone which is about "U" shaped found in between the skull and the postcranial skeleton called the hyoid bone. And provide attachment of the tongue and muscles of the oral cavity.

VERTEBRAL COLUMN:

The vertebral column composed of a basic unit called vertebrae; the vertebral column composed 33 vertebrae of which only 26 can be count. Vertebral column can be divided into 5 distinct region like cervical region (neck region 7), thoracic region (12), lumbar region(5), Sacral region(5=1) and caudal region(4=1). It is present from the skull to the pelvis, to from backbone. It has 33 bones which are called vertebrae. These are named according to their location in the body e.g.



cervical, thoracic, lumbar, and pelvic. Normally the vertebral column has 4, curvature which provides more strength than the straight column.

Cervical vertebrate----------7

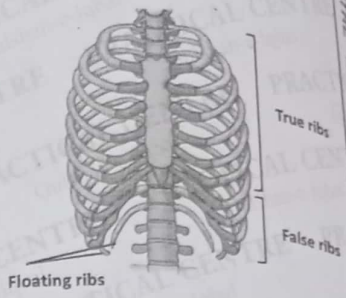
Thoracic vertebrae----------12

Lumbar vertebrae----------5

Pelvic(sacral 5 & caudal 4)--------9

3) RIB CAGE:

The ribs are in 12 pairs of which 10 pairs are fused in front whereas last two pairs are free called floating ribs out of 10 pairs the first seven pairs are known as true ribs which are directly attached with sternum whereas last the 3 pairs are known as false ribs because they are attached by means of coastal cartilage.



4) STERNUM:

The sternum is a single bone which is found in front chest region by which the ribs are attached.

2) APPENDICULAR SKELETON:

The appendicular skeleton composed of limbs and girdles.

The limbs are two types called forelimbs and hind limbs, the girdles are of two types called pectoral girdles and pelvic girdle.

Forelimbs: The forelimbs are found in pair and each forelimbs consists of 30 bones like: Humorous 1, radius 1, ulna 1, carpal 8, metacarpal 5, phalanges 14.

Hind limbs: The hind limbs also found in pair and each hind limb (leg) consists of 30 bones like: Femour 1, Tibia 1, Fibula 1, Patella 1, Tarsal 7, Metatarsal 5, Phalanges 14.

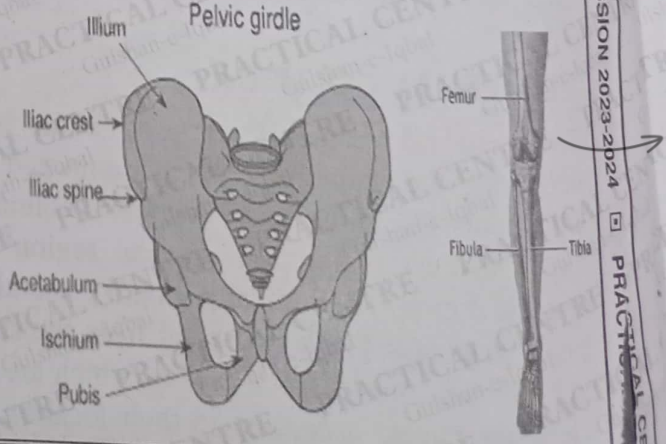
PECTORAL GIRDLES:

The pectoral girdles are also known as shoulder girdle which is composed of two rami(Parts) and each part composed of two bones called scapula and clavicle the pectoral girdles having a cavity called glenoid cavity by which the head of humorous get articulate.

PELVIC GIRDLES:

The pelvic girdles also known as hip girdles which provide attachment to hind limbs and also back bone.

The pelvic girdles having two half and each half having 3 bones called ileum, ischium and pubeius all 3 bones joint to form single bone called in nominate. The pelvic girdle having a cavity called acetabulum by which head of femour get attached.



NOTE:

The femur is the longest and strongest bone whereas auditory ossicles are the smallest bones of the body present in the middle ear. They carry sound waves.

FUNCTIONS OF SKELETON:

The endoskeleton in animals performs the following important functions.

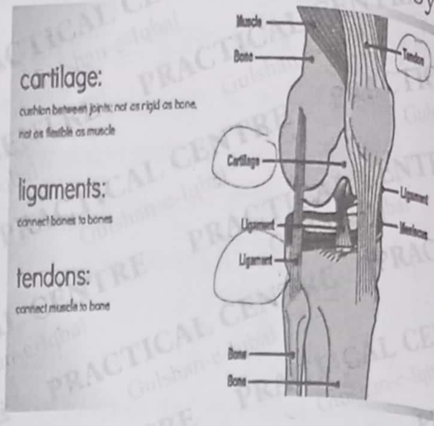
- It provides a supporting framework for the body.
- It gives the body its particular shape.
- It also protects various organs and, in collaboration with muscles, enables the body to move.
- The bone marrow produces blood cells and stores and supplies the minerals like calcium and phosphorus to the blood.

CARTILAGE	BONE
Mesoderm origin	Mesoderm origin
Lots of matrix	Lots of matrix
Gel-like tissue	Mineralized tissue
Stable tissue	Bone remodels
Lacunae	Lacunae present
Cells separated	Cells communicate
Avascular	Highly vascular
No nerves in matrix	Nerves in matrix

BONE	CARTILAGE
Bone is strong and nonflexible connective tissue.	Cartilages are flexible connective tissue.
It has hard matrix made of proteins, calcium and phosphorus.	Matrix is made of proteins and sugars.
It cannot be bend.	It can be bend.
Canaliculi connections are present between bone cells, osteocyte.	Canaliculi connections are absent between chondrocytes.
It provides shape and skeletal supports to the body.	It provide support and flexibility to the body and also smoothen bone surfaces at joints.
It forms skeleton.	It is found in nose, ear, trachea and larynx.
Avascular	Highly vascular
No nerves in matrix	Nerves in matrix

JOINT

The joint may be defined as the point at which the two bones are join called joint. The bones join together by means of ligament and the muscles are attached to bones by means of tendons.



TYPES OF JOINTS:

Broadly the joint is divided into three types:

Fibrous joints.

Cartilaginous joints

Moveable joint. (Synovial Joints)

1. FIBROUS JOINTS:

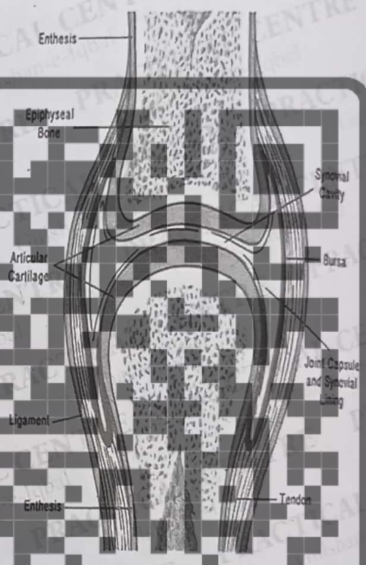
A joint where connecting bones do not show any movement and remain fixed by dense connective tissue containing collagenous fibers is a fibrous joint.

2. CARTILAGINOUS JOINTS:

A Joints where two bones are joined by hyaline or fibro cartilage is a cartilaginous joint

3. MOVEABLE JOINT: (SYNOVIAL JOINT)

A joint where considerable movement of the bones is possible is called a moveable joint. These joints are of two types:



HINGE JOINT:

This type of joint permits movement at a single axis or one plane. The movements are flexion, and extension and examples include the elbow joint, knee joint, ankle joint, and the joint between the phalanges of the finger and toes.

TYPES OF HINGE JOINT:

Following are the types of hinge joints:

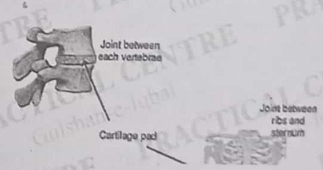
PIVOT JOINT:

This joint permits twisting movement and is found at the elbow joint near the hinge joint. At this joint elbow can rotate the palm upside down. The joint between the skull and spine is also a pivot joint, which allows the sideways movement of the head.

I. SLIDING JOINT:

This can be seen at the ankle or wrist. At this joint bones slide over one another to allow movement of the wrist or ankle in many directions.

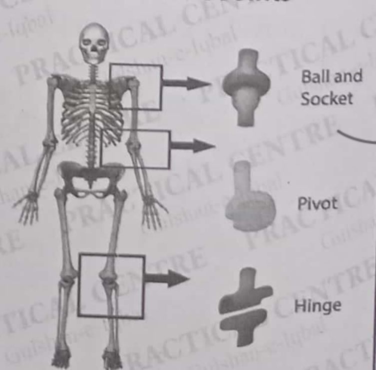
Slightly Moveable Joints



II. GLIDING JOINT:

The joints between the vertebrae are gliding joints. At these joints, the bones move easily over one another in a back-and-forth manner. Gliding joints make the backbone flexible.

Movable Joints



PARTIALLY MOVEABLE JOINTS:

These joints permit a little movement e.g. ribs are attached to vertebrae by partially movable joints. These joints permit ribs to move up and down during breathing.

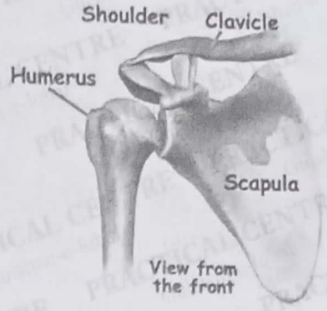
b) BALL & SOCKET JOINT:

These are the most freely moveable joints. At these joints, the bone shows its free Movement in all directions. The movements possible are flexion,

extension, abduction, rotation, and circumduction e.g. shoulder and hip joint.

STRUCTURE OF MOVEABLE JOINT (BALL & SOCKET)

The movement joints are encased in a fibrous capsule; the articulating surfaces of the bones are covered by a layer of articulator cartilage. The joint capsule (fibrous capsule) is lined by a synovial membrane which secretes synovial fluid. This fluid acts as a lubricant and buffer, it reduces the friction at joints and absorbs the excess heat that is generated during movement of the bones.



The shoulder joint

SKELETON RELATED DISORDERS:

Some of the skeleton-related disorders are as follows:

DISC-SLIP:

STRUCTURE OF DISC IN VERTEBRATES:

The vertebrae in the human skeleton contain an inter-vertebral disc, it is a cushion-like pad composed of an inner semi-fluid nucleus pulpous which acts as a rubber ball to give a disc its elasticity and compressibility and a strong outer ring of fibro-cartilage, the annulus fibrosis which holds the successive vertebrae. The disc acts as a shock absorber during walking, jumping, running, and to a lesser extent to bend laterally.

CAUSE OF DISC SLIP:

Severe or sudden physical trauma to spines for example from bending forward while lifting a heavy object may result in herniation of one more disc. The herniated discs are commonly called slipped discs. It usually involves the rupture of annulus fibrosis followed by protrusion of the spongy nucleus pulpous. It protrusion presses on the spinal cord or spinal nerves exiting from the cord generating severe pain or even destruction of this nervous structure.

TREATMENT:

Take prolonged rest on a hard bed. The use of painkillers helps to repair the damage. If this fails, then the disc may be removed by surgery.

SPONDYLOSIS:

It is a disease, which causes immobility and fusion of vertebral joints. It is a deformity of the joint of two vertebrae, particularly of the neck where the space between the two adjacent vertebrae narrows.

EFFECTS:

The most common effect is the pressure on the nerves emerging from the spinal cord which results in severe pain in the neck, shoulder upper limb, etc.

TREATMENT:

The pain is relieved by wearing a hard collar around the neck which keeps the affected vertebrae, a bit, apart and hence the pressure on the nerves is released.

ARTHRITIS:

Arthritis is an inflammatory or degenerative disease that damages joints.

SYMPTOMS:

The most common symptoms of the disease are pain, stiffness, swelling of the joint, and immovability. Chronic arthritis includes osteoarthritis, rheumatoid arthritis, and gouty arthritis.

CAUSES:

It may be hereditary, may be due to a viral infection due to an injury, or sometimes only due to aging. In this disease, the deposits of calcium, which make the cartilage hard, denature the smooth and flexible cartilage between the bones of a joint. The membrane, lining the joint thickens; fluid production is decreased, which consequently leads to increased friction.

TYPES OF ARTHRITIS:

Osteoarthritis: It is developed when joint cartilage breaks down from repeated stress. It is the most common form of arthritis.

Ankylosing spondylitis: It is arthritis of the spine usually at the lower back.

Gout: It is the deposition of hard crystals of uric acid in the joints.

Rheumatoid arthritis: It is a disease that causes the immune system or virus to attack the synovial membrane in your joints.

Treatment:

The only remedy is the replacement of the affected joints by artificial joints made up of rubber and plastic. Artificial joints are often used to replace stiff hip and knee joints.

SCIATICA:

It is characterized by stabbing pain radiating throughout the sciatic nerve. It results in injury of the proximal sciatic nerve, which might follow a fall, a herniated disc, or improper administration into the iliac vein.

Effect the skin

This may result in several lower limbimpairments depending on the precise nerve root injury. The legs become nearly useless. They cannot be flexed and all foot-ankle movement is lost.

RECOVERY:

Recovery from sciatic injury is very slow and incomplete.

FRACTURE:

Though bones are strong and hard sometimes they may be broken. During youth, most fractures result from trauma that may twist or break the bones such as sports injuries, automobile accident falls, etc. In old age, bones become thin and weak, and hence fractures occur more frequently. A broken bone is said to be a fractured bone.

TYPES OF BONE FRACTURES:

Simple Fracture: A simple fracture is also called a closed fracture in which bone is cracked but does not break the skin and is not exposed.

A compound fracture: It is characterized by the complete breaking of bone and the piece of bone is visibly piercing outside the skin.

Complicated fracture: In this fracture surrounding structures including organs, veins, arteries, or nerves become damaged.

- A fracture is treated by reduction followed by realignment of the broken bone ends.
- In case of compound fracture, fixing steel screws, rods or plates realigns the bones.
- This realigned bone is now made immovable for a few weeks by wrapping the affected area into plaster, a cost of plaster of Paris.
- Healing time is 8----------12 weeks, but it is much longer for large weights.
- The repair process of a simple fracture takes place in four phases:

1) HEMATOMA FORMATION:

A mass of clotted blood is formed near the fractured area. The immune system activates and induces swelling at the site of injury. Nociceptors develop pain sensation and due to suspended blood supply, the bone cells are deprived of nutrients and begin to die.

The role of hematoma is to seal the fractured site and to prevent the loss of blood.

2) FIBROCARTIL AGINOUS CALLUS FORMATION:

Capillaries grow into the **hematoma** and clear up the debris. **Osteoblast** develops from the periosteum and enters the hematoma. Osteoblast quickly divides and gives rise to the spongy bone in the region close to the new blood vessels. The next phase starts with the formation of new tissues called **granulation tissue.**

The **granulation tissue** contains new blood vessels and a complex of fibroblast, vascular endothelial cells, and macrophages within a matrix of collagen and fibrin.

The osteoblast develops the spongy bone.

3) BONY CALLUS FORMATION:

Osteoblasts and osteoclasts continue to migrate inward, multiply rapidly, and gradually convert the soft callus into a bony callus. As the bony callus formation progresses it is replaced with bone.

The hard callus formation is initiated around three weeks after the fracture and continues for about three months. During ossification cartilage consists of osteoblasts, osteoclasts, and bone matrix.

4) REMODELLING:

A bony callus is remodeled by the excess material on the outside of the bone when old bone tissues are removed and replaced with new ones that join both fractured sides. Remodeling starts when the osteoblast cells detect the fracture and induce monocytes to fuse to form a multinucleated osteoclast cell.

The osteoclast matures and activates to start resorbing bones as the bone resorption proceeds, osteoblasts start producing collagen to fill in the lacunae created by the osteoclasts and calcium phosphate begins to deposit, forming hydroxyapatite.

THE INJURIES IN JOINTS:

Joint injuries are associated with twisting or tearing due to overuse of muscles, repeated heavy physical activities, or any injury. The following are different types of joint injuries:

DISLOCATION:

A dislocation is a separation of two bones where they meet at a joint. This injury can be very painful and can temporarily deform and immobilize the joint.

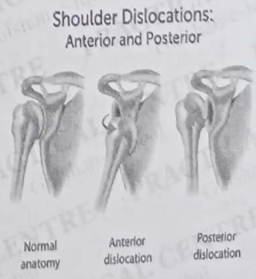
LOCATION:

The most common locations for dislocation are shoulders and fingers, but can also occur in elbows, knees, and hips. The cause is often a fall or a blow, sometimes from playing a contact sport.

Symptoms:

Signs and symptoms of a dislocation include:

- Joint is visibly deformed or out of place
- Numbness or tingling at the joint
- Swollen or discolored
- Limited ability to move
- Intense pain



Treatment:

Treatment of a dislocation depends on the location of the joint and the severity of the injury. Initial treatment for a dislocation involves rest, ice, compression, and elevation. Sometimes, the dislocated joint might go back into place naturally after this treatment. If this does not occur, there are several treatments your doctor may use, including:

Repositioning

The doctor may try to reposition the joint back into place. The patient may be given a sedative or anesthetic to remain comfortable and to allow the muscles near their joints to relax.

Immobilization

If your doctor was able to reposition your bones, you will then likely need to weather a splint or sling for several weeks to immobilize the joint.

Surgery

Surgery may be required to move your dislocated bones back into the correct positions if nearby blood vessels, nerves, or ligaments have been damaged. Surgery may be an option if you've had multiple dislocations, especially in the shoulder.

Recovery

Most people can expect to fully recover within a few weeks. However, for some joints, such as hips, full recovery may take several months. The healing time will also be longer if blood vessels or nerves are damaged in the dislocation.

It is important to remember that the area will be weakened and is at a greater risk of becoming dislocated in the future.

SPRAINS

Definition

A sprain is an injury to the ligaments around a joint. Ligaments are strong, flexible fibers that hold bones together. When a ligament is stretched too far or tears, the joint will become painful and swell.

Alternative Names

Joint sprain

Causes

Sprains are caused when a joint is forced to move into an unnatural position. For example, "twisting" one's ankle causes a sprain to the ligaments around the ankle.

Symptoms

Symptoms of a sprain include:

- Joint pain or muscle pain
- Swelling
- Joint stiffness
- Discoloration of the skin, especially bruising

The First Aid treatment for joint injuries and fractures.

First aid steps include:

- Apply ice right away to reduce swelling. Wrap the ice in cloth. Do not place ice directly on the skin.
- Wrap a bandage around the affected area to limit movement. Wrap firmly, but not tightly. Use a splint if needed.
- Keep the swollen joint raised above your heart, even while sleeping.
- Rest the affected joint for several days.
- Avoid putting stress on the joint because it can make the injury worse. A sling for the arm, crutches, or a brace for the leg can protect the injury.

Aspirin, ibuprofen, or other pain relievers can help. DO NOT give aspirin to children. Keep pressure off the injured area until the pain goes away. Most of the time, a mild sprain will heal in 7 to 10 days. It may take several weeks for pain to go away after a bad sprain. Health care providers may recommend crutches. Physical therapy can help in regain motion and strength in the injured area.

When to Contact a Medical Professional

The patient must go to the hospital right away or he must call any ambulance service or the local emergency number if he has:

- Broken bone.
- The joint appears out of position.
- Serious injury or severe pain.
- Hear a popping sound and have immediate problems using the joint.

Visit to a Doctor if:

- Swelling does not start to go away within 2 days.
- Patient has symptoms of infection, including red, warm, painful skin or a fever over 100°F (38°C).
- The pain does not go away after several weeks.

Prevention

The following steps may lower your risk for a sprain:

- Wear protective footwear during activities that place stress on your ankle and other joints.
- Make sure that shoes fit your feet properly.
- Avoid high-heeled shoes.
- Always warm up and stretch before doing exercise and sports.
- Avoid sports and activities for which you have not trained.

MUSCULAR SYSTEM

A system that consists of different types of muscles is called a muscular system.

The unit of the muscular system is muscle fiber.

Muscle Fibre:

An elongated, cylindrical, or spindle-shaped retractile structure that is made up of tissue is called muscle fiber.

Muscle fibers when grouped in bundles form muscles. They consist of:

Epimysium: Outermost covering of muscles.

Fascicle: Group of muscles inside epimysium.

Perimysium: A membrane that surrounds the Fascicle.

Endomysium: A membrane that surrounds each muscle fiber inside the Fascicle.

Muscles also contain blood and nerve supply to act as a movement.

TYPES OF VERTEBRATE MUSCLES:

Three types of muscles are found in vertebrate animals.

1. Striated voluntary or skeletal muscles.
2. Un-striated involuntary or smooth muscles.
3. Striated involuntary or cardiac muscles.

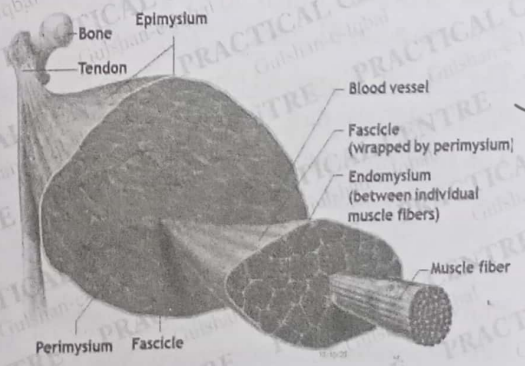
STRIATED VOLUNTARY OR SKELETAL MUSCLES

DEFINITION:

"Those muscles which are located on the skeleton striated in pattern and voluntary in action known as striated voluntary or skeletal muscles"

UNIT OF STRUCTURE:

The unit structure is the skeletal muscle fiber, a multinucleated cell.



SHAPE AND SIZE OF MUSCLE FIBRE:

A muscle fiber is a single, long, protoplasmic thread. Its general shape is cylindrical. An individual muscle fibre is usually 1 to 40mm long and 10 to 100um in diameter.

STRUCTURE OF MUSCLE FIBRE:

SARCOLEMMA:

Each muscle fiber is enclosed in a tubular sheath called a Sarcolemma. It is structureless, transparent, elastic, and tough. Its total thickness is o.1um

NUCLEI:

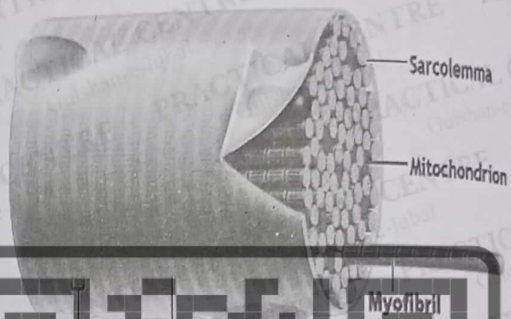
The inner surface of sarcolemma contains numerous nuclei (about 35 per mm). The total number depends upon the length of the fiber.

SARCOPLASM AND ORGANCELLES:

The internal of each muscle fiber is filled with undifferentiated cytoplasm which contains mitochondria, Golgi network, sarcoplasmic reticulum, pigments, and myoglobin. The sarcolemma is extensively folded and possesses a motor end plate.

Sarcolemma permits calcium ions to enter or leave the myofibril from their specific proteinic gateways.

The sarcoplasmic reticulum is a storehouse of Ca^{+2}. The sarcoplasmic reticulum is connected with a transverse tubule or T-tubule that runs perpendicular.



(b) Diagram of part of a muscle fiber showing the myofibrils. One myofibril is extended afrom the cut end of the fiber.

MYOFIBRILS:

Many un-branched parallel threads extend the whole length of muscle fiber and are found in the sarcoplasm called myofibrils. These myofibrils usually occur in bundles which are separated from each other by relatively abundant sarcoplasm. These are connected with the axon of motor neurons at a place called the **neuromuscular junction.**

ELECTRON MICROSCOPY OF MYOFIBRILS:

Each myofibril is a compound thread. It contains two types of fundamental units called myofilaments.

Each filament consists of chains of long protein molecules of actin and myosin.

Each myosin filament is thick, **16nm** in diameter composed of myosin monomers. It has two twisted strands with projected head outwards which form a cross link with actin filament.

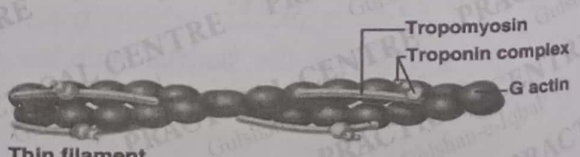
The thicker filaments (myosin) are restricted to the dark band.

The thin filaments are composed of actin and extend throughout the light band.

Actin consists of two strands of fibrous actin protein monomers 7-8 nm in diameter, intertwined that

Thin Filaments

1. Actin - two strands of fibrous (F) actin protein intertwined
2. Globular (G) actin - has active site for myosin
3. Tropomyosin molecules – regulatory protien that block active sites of G actin when muscle is relaxed
4. Troponin - small calcium-binding protein molecules stuck to tropomyosin



Thin filament

possess **Globular actin (G-actin)** active site for myosin.

The Actin bulb of Globular actin is insulated by another protein Tropomyosin that also contains troponin for calcium binding.

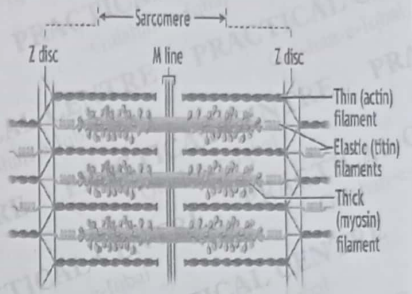
Troponin is a complex of three different subunits called troponin **C, I, and T.** binds Ca^{2+}, the troponin I **(Tn-I)** inhibit sactomyosin interaction, and troponin T **(Tn-T)** is used for binding tropomyosin.

MYOFIBRILLAR BANDING:

Each myofibril bears alternate dark and light bands about 300 to each millimeter.

DARK BAND ANISOTROPIC BAND OR A-BAND:

It is also called the Anisotropic band (abbreviated to A-band). This band is strongly refractile and Dark in the living fibril. It consists of myosin filament, overlapped by actin filament. Under polarized light, it looks dark due to the thick nature of myosin and doublerefraction.



(d) Enlargement of one sarcomere (sectioned lengthwise). Notice the myosin heads on the thick filaments.

H-BAND:

The middle region of the A-band is paler than the rest; it is called as H-band or Henson's band. It represents the region where actin filaments do not overlap the myosin. It looks pale in the living myofibril.

LIGHT BAND ISOTROPIC BAND OR I-BAND:

It is also called the Isotropic band (abbreviated to I-band). It consists of only thin actin filaments which are inserted on the "Z" disc or band. It looks brighter during microscopy. It is an area of actin where myosin is absent.

Z-BAND (ZWISCHENSCHEIB):

It is a vertical disc of actin that holds six filaments of actin on each side.

M-LINE:

It is used for making the connection between two thick filaments. It consists of Myomesin protein.

REGIONS IN MYOFIBRIL:

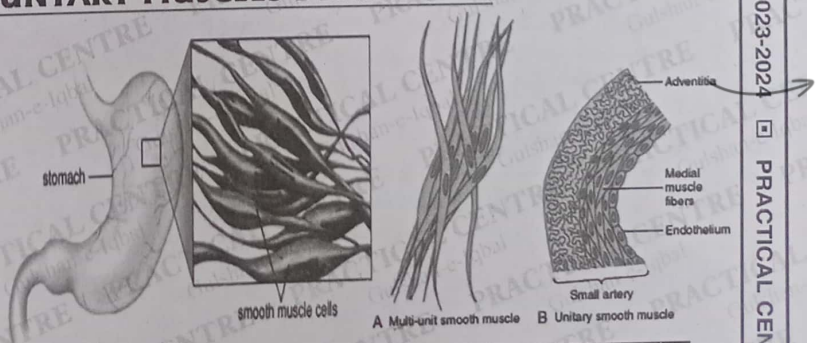
Three regions can be observed in a myofibril, one consisting of thick filaments only one of thin filaments only, and the third of thick thin filaments together.

The two filaments are connected by cross-bridges which exist in the region where the filaments overlap. These bridges project outward from the thick filaments at intervals.

SMOOTH MUSCLES

NON-STRIATEDINVOLUNTARY MUSCLES DEFINITION:

"Those muscles which are located on smooth organs of the body, not in under the control of our will and are nonstriated in their structure called as smooth muscles or Nonstriated involuntary muscles".



LOCATION:

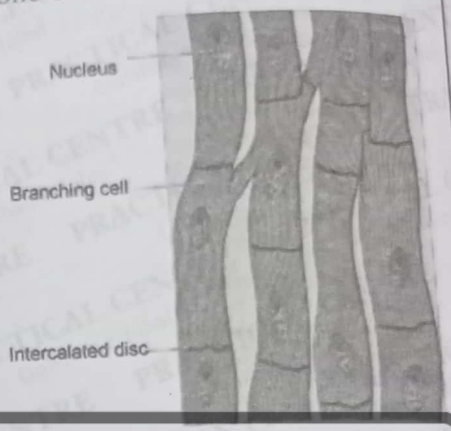
These are found in the walls of blood and lymph vessels, the alimentary tract, the urinary bladder, and the uterus.

CARDIAC MUSCLES:

- Those muscles which are found in the heart striated in their structure, and involuntary in their action are called cardiac muscles.

MICROSCOPIC STRUCTURE:

- When viewed under a microscope, cross stripes like voluntary muscles can be seen in their structure. Each fiber (cell) has a nucleus and one or more branches.
- The ends of the cells and their branches are in very close contact with the ends and branches of adjacent cells.
- Microscopically "joint" or intercalated disc can be seen as lines that are thicker and darker than ordinary cross stripes.
- This arrangement gives cardiac muscle the appearance of a sheet of muscle rather than a very large number of individual fibers.
- The end-to-end arrangement of cardiac muscle cells has significance in the way the heart contracts.



CONTRACTION:

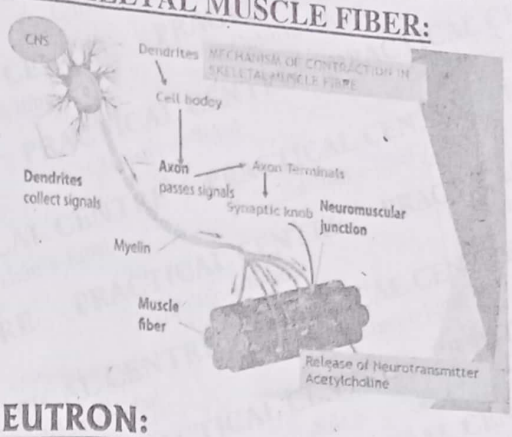
- The heartbeat originates from the wall of the atrium in a small mass of tissue called a pacemaker or Sinoatrial node (S.A node).
- From the pacemaker the beat is carried out to another point i.e. Atrio-ventricular node (A.V. node) by perkinji fibers, where it is relayed through muscles of the lower chamber.

Compare muscle tissue:

Skeletal	Cardiac	Smooth
Striation: striated	Somewhat striated	Non-striated
Cell: straight cylindrical parallel, non-branching	Tapered cylinders parallel & branched	Spindle shape
Nucleus: multi-nuclei, peripheral	Mostly uni-nucleus most peripheral	Uni-nucleus central
Discs: none	Intercalated	None
Location: attach bones	Cardiac wall	Hollow organs
Control: voluntary	Involuntary	Involuntary
Function: body movement	Heart contraction	Visceral & circulatory
Speed of contraction: fastest	intermediate	slowest

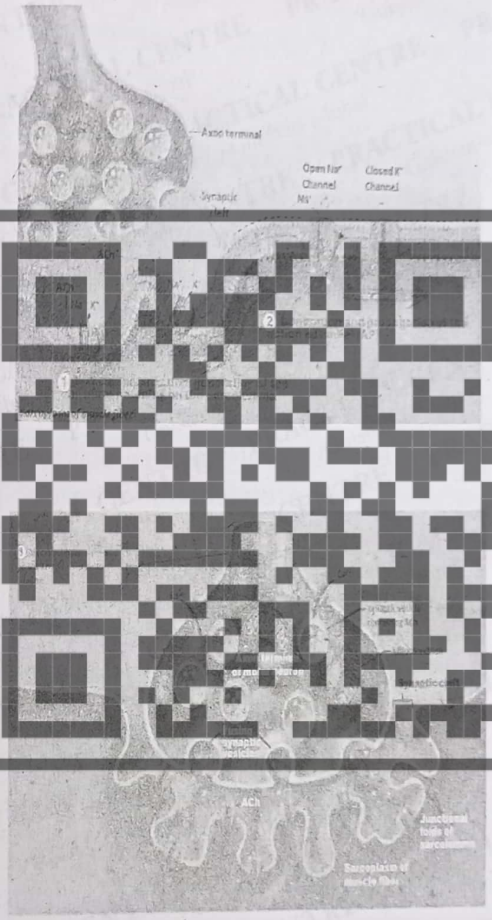
THE MECHANISM OF CONTRACTION IN SKELETAL MUSCLE FIBER:

Huge Huxley and Jean Hanson best explained the mechanism of skeletal muscle in the 1950s. According to them, the muscular contraction takes place as a result of the sliding action of the Actin filament over the Myosin filament. The attractive force that develops between the Actin and myosin filaments causes this sliding action of the filament. These forces are mechanical, electrical, chemical and electrostatic.



IMPULSE FROM C.N.S BY MOTOR NEUTRON:

When an impulse is transmitted from a motor neuron to a skeletal muscle fiber at the motor end plate. The Acetylcholine molecules are released by the synaptic knobs of a motor neuron, which bind to receptors on, the plasma membrane of the muscle cell and cause an active potential on the muscle. The impulse generated in a skeletal muscle cell is propagated deep into the interior of the cell along membranous folds, called transverse tubule (T). The T tubules are in close contact with the sarcoplasmic reticulum which functions as a storage site of calcium ions.



RELEASE OF CALCIUM IONS:

During resting conditions, the level of calcium ions within the cytoplasm is very low. The arrival of an active potential along the T tubule causes an increase in the permeability of the sarcoplasmic reticulum to calcium ions. These calcium ions bind to the troponin of thin filaments and expose the binding sites of myosin present on the actin molecules after depolarizing the tropomyosin for attachment to the Myosin bulbs.

SLIDING OF FILAMENTS:

The sliding of actin filaments over myosin takes place as a result of cross-bridge formation between actin and myosin, which results in the contraction of muscle fiber.

POWER STROKE:

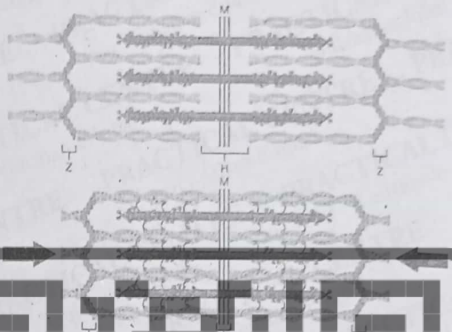
In this process myosin head rises by getting energy from ATP when bind ATP is hydrolyzed into ADP and phosphate by an enzyme ATPase. This causes the myosin heads to extend and attach to the binding site of an actin and both actin and myosin filaments are cross-linked to form a cross bridge. This action called power stroke is triggered allowing myosin to pull the actin filament towards the M line, thereby shortening the sarcomere. The myosin remains attached to the actin until a new molecule of ATP binds, freeing the myosin. When unbound from actin, the myosin heads resume their starting positions and are ready to begin a new sequence of actin binding.

Cycle of Activity of cross-bridge during muscle contraction. During muscle contraction, each bridge will complete its cycle of activity 100-500 times per second.

STRUCTURAL CHANGE DURING MUSCLE CONTRACTION:

1) The distance between the "Z" disc lessens progressively.
2) The length of "I" bands diminished progressively.
3) The "Z" disc comes in close contact with the "A" band.
4) The end of each "A" band remains constant.
5) The ends of each "A" band are crowded by the "Z" band.
6) The "H" band gradually diminished.

A.T.P AS THE SOURCE OF ENERGY:



For muscle contraction energy is supplied in the form of A.T.P. which is stored in mitochondria and produced by the oxidation of food. The presence of a large number of mitochondria is characteristic of skeletal muscle fibers which are located in the myofibril. During contraction A.T.P. (Adenosine triphosphate) are changed into A.D.P. by providing the energy for the contraction of muscle fibers.

Relaxation:

When nerve impulse stops, two events relax the muscle fiber.

First Step: The acetylcholine that remains in the synapse is rapidly decomposed by an enzyme called **acetylcholine-esterase.** This enzyme is present in synapses and on the membranes of the motor end plate. The action of acetylcholine-esterase prevents a single nerve impulse from continuously stimulating muscle fiber.

Second Step:

When acetylcholine is broken down, the stimulus to the sarcolemma and the membranes within the muscle fiber ceases.

Calcium Pump: The calcium pump which requires ATP quickly moves calcium ions back into the sarcoplasmic reticulum, decreasing the calcium ion concentration of the cytosol that leads to muscle relaxation.

ADDITIONAL ENERGY:

During muscle contraction, additional energy is supplied in the form of creatine phosphate. This compound can be replenished by the breakdown of Glycogen during anaerobic respiration.

THE ACTION OF ANTAGONISTIC MUSCLES IN THE MOVEMENT OF KNEE JOINT:

ANTAGONISTIC MUSCLES:

Those muscles which work in opposite action i.e. when one contracts the other relaxes are antagonistic muscles e.g. **protractor & retractor** muscles. **The knee joint** is the largest and most complex of the synovial joints. It is formed by an articulation of the distal end of the **femur** and proximal end of the **tibial** bone while anterior to the junction of these bones, **patella** bone is articulated. The antagonistic muscles of the knee joint are the group of **hamstring muscles** as **flexor muscles** and the group of **quadriceps muscles** as **extensor muscles.**

THE HAMSTRING MUSCLES:

Hamstring muscles refer to a group of three muscles located at the back of the thigh. They play a crucial role in various movements of the leg and are essential for activities like walking, running, and jumping.

The three hamstring muscles are:

1. **Biceps Femoris:** This is the most lateral (outer) of the three muscles. It has two parts- a long head and a short head. The long head originates from the ischial tuberosity (a part of the pelvis) and the short head originates from the femur (thigh bone). They both merge to form a single tendon and attach to the back of the leg.
2. **Semimembranosus:** This is located in the middle of the hamstring group. It originates from the ischial tuberosity and attaches to the back of the tibia (shin bone).
3. **Semitendinosus:** This muscle is the most medial (inner) of the three. It also originates from the ischial tuberosity and attaches to the tibia.

Together, these muscles work to flex the knee joint (bend the knee) and extend the hip joint (move the thigh backward). They are also important for stabilizing the knee during activities like walking or running.

THE QUADRICEPS MUSCLES:

are a group of four muscles located at the front of the thigh. They work together to extend (straighten) the knee joint and a hip flexor. Quadriceps Muscles are given below:

1. **Rectus Femoris:**
2. **Vastus Lateralis:**
3. **Vastus Medialis:**
4. **Vastus Intermedius:**

Together, these four muscles form the quadriceps group. They form the main bulk of the thigh. They are called the most powerful muscles of the body and play a crucial role in activities like walking, running, cycling, and jumping, as they're responsible for extending the knee joint.

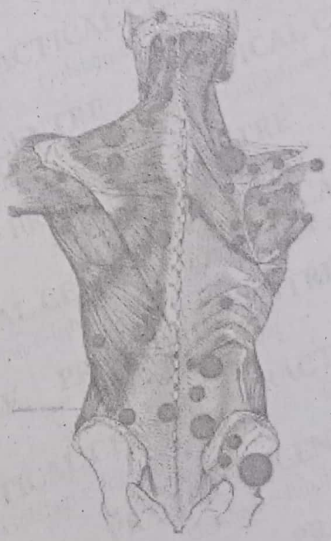
MUSCLE FATIGUE:

The accumulation of lactic acid in muscles causes muscle fatigue. In this condition, muscles lose their ability to contract.

The decline in muscle force generated over sustained periods of activity or due to pathological issues.

Causes

- Ion imbalance with in muscles,
- Nervous Fatigue and Loss of Desire
- Metabolic Fatigue
- Exercise and Aging
- Lactic Acid Accumulation

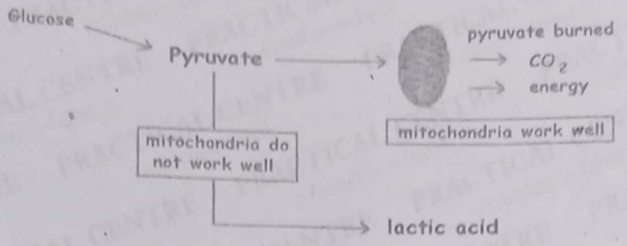


Effects

- Muscle Ache
- Burning
- Rapid Breathing
- Nausea
- Stomach Pain

Lactic Acid

- Byproduct of anaerobic respiration which strongly contributes to muscle fatigue



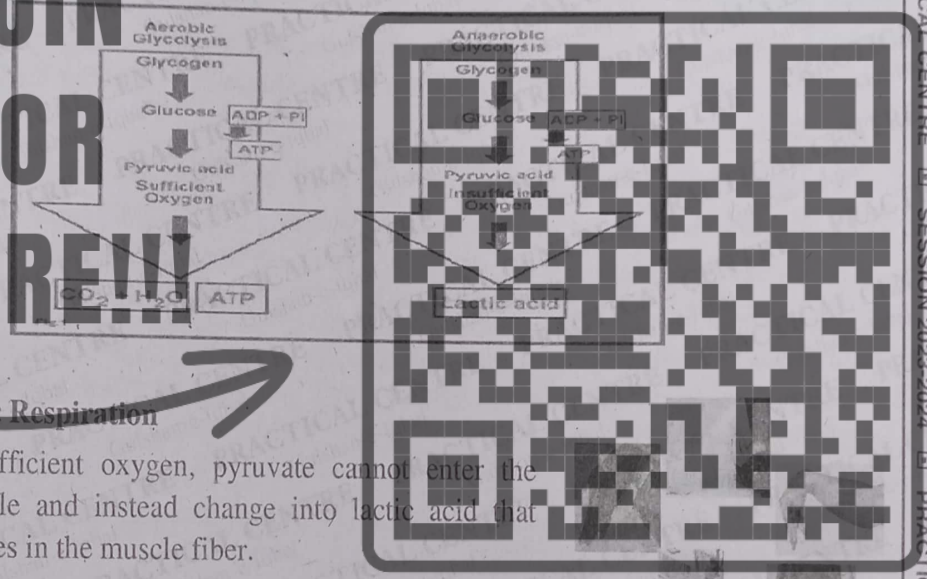
Lactic Acid Accumulation:

During exercise, the body uses oxygen to break down glucose for energy producing ATP required for muscle contraction.

In intense exercise, there may not be enough oxygen available to complete the process, so a substance called lactate is made.

Reduced circulation to muscle may result in glycogen depletion.

Reducing endurance capacity



In Anaerobic Respiration

- With insufficient oxygen, pyruvate cannot enter the Krebs cycle and instead change into lactic acid that accumulates in the muscle fiber.
- Lactic acid accumulation reduces pH to about 6.4-6.6, producing a stinging feeling in muscles when exercising

ABNORMAL MUSCLE CONTRACTION:

- It refers to a condition that does not meet the normal condition in the contraction of muscles.
- Tetany and muscle cramps are common abnormal muscle contractions.

1) TETANY:

- This disease is caused by low calcium in the blood.
- It increases the excitability of neurons and results in loss of sensation.
- Muscle twitches and convulsions occur.
- Hence the muscle fibers are held under a constant contraction.
- Because of the high level of stimulation, the calcium ions are not removed from the sarcoplasm and the contractile machinery thus keeps on generating maximum tension.

- This condition is called tetany.
- If untreated the system progresses to spasm of the larynx, respiratory paralysis, and ultimately death.

Symptoms of Tetany

Non-Severe	Severe
• Abdominal pain • Chronic diarrhea • Muscle pain • Tingling in hands or feet • Twitching fingers	• Loss of muscle coordination • Loss/change in vision • Paralysis • Seizures • Slurred speech • Sudden difficulty with memory, thinking, talking, writing or reading • Sudden weakness or numbness on one side

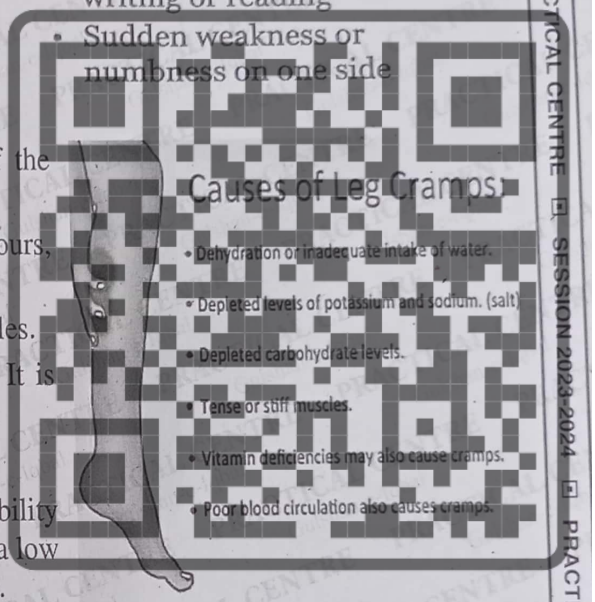
2) CRAMP:

It is also known as a titanic contraction of the entire muscle.

It lasts for just a few seconds or several hours, causing the muscle to become painful.

It is most common in the thigh and hip muscles.

It usually occurs at night or after exercise. It is also known as muscle pull.



CAUSE:

It usually occurs due to dehydration, irritability of the spinal cord, electrolyte imbalance, or a low sugar level, particularly after heavy exercise.

LIGAMENTS:

These are elastic cords-like structures that are formed of tough connective tissue. Bones are connected by ligaments. They are rigid but elastic structures.

TENDON:

The terminal ends of muscle fiber terminate into a thin structure that unites into bundles, when these combine with others they form a cord-like structure. These cords-like structures are called tendons which are used for the attachment of muscles to the bones.

Characteristic	Tetany	Tetanus
Definition	Hypocalcemia results from low blood calcium levels.	Bacterial infection caused by Clostridium tetani leads to muscle stiffness and spasms.
Cause	Low blood calcium levels are due to various reasons like hypoparathyroidism, alkalosis, or malnutrition.	Infection with Clostridium tetani bacteria entering through a wound or injury.

Symptoms	Muscle cramps, spasms, tingling, or numbness in extremities.	Painful muscle stiffness, particularly in the jaw (lockjaw), neck, and abdomen.
Trigger Factors	Hypoparathyroidism, alkalosis, malnutrition, vitamin D deficiency.	Puncture wounds, burns, crush injuries, or contaminated wounds.
Pathophysiology	Inadequate levels of calcium ions result in increased excitability of nerves and muscles.	Tetanus toxin produced by Clostridium tetani interferes with the release of neurotransmitters, causing sustained muscle contractions.
Duration	Tetany episodes may be short-lived and transient.	Tetanus symptoms can persist for weeks and may be severe.
Treatment	Calcium supplements, vitamin D, and addressing the underlying cause.	Tetanus immunization (vaccination), wound care, muscle relaxants, and antibiotics.
Prevention	Ensuring proper nutrition, and managing underlying conditions causing low calcium levels.	Tetanus vaccination (DTaP, Td, or Tdap) and prompt wound care.
Complications	Severe cases can lead to muscle spasms affecting respiratory muscles.	Complications can include respiratory failure, muscle rigidity, and in severe cases, death.
Prognosis	Generally good with proper treatment and management.	The prognosis depends on the severity of the infection and the promptness of treatment. Can be fatal if untreated.

NAMES OF DISEASES	TETANY	CRAMPS
What is it?	Suden involuntary contraction of striated muscles. Low level of calcium in blood.	Type of Tetanic Contraction. Also known as: Muscle Pull.
Process:	It triggers neuron immediately twitching rapidly even before the actin and myosin filaments of a muscle fibre had chance to their normal resting condition.	It usually occurs in a limb's muscles.
Caused due to:	Beacause the high level of Calcium ions not removed from sarcoplasm and thus generation maximum tension.	Occurs due to dehydration, electrolyte imbalance or a low blood sugar level.
IMPORTANT THING:	Tetany of respiratory organs if not treated immediately may prove fatal.	Mainly happen after heavy exercise, Sportsmen are more prone to it.

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BIOLOGY

CHAPTER # 17

CO-ORDINATION AND CONTROL

2023-24

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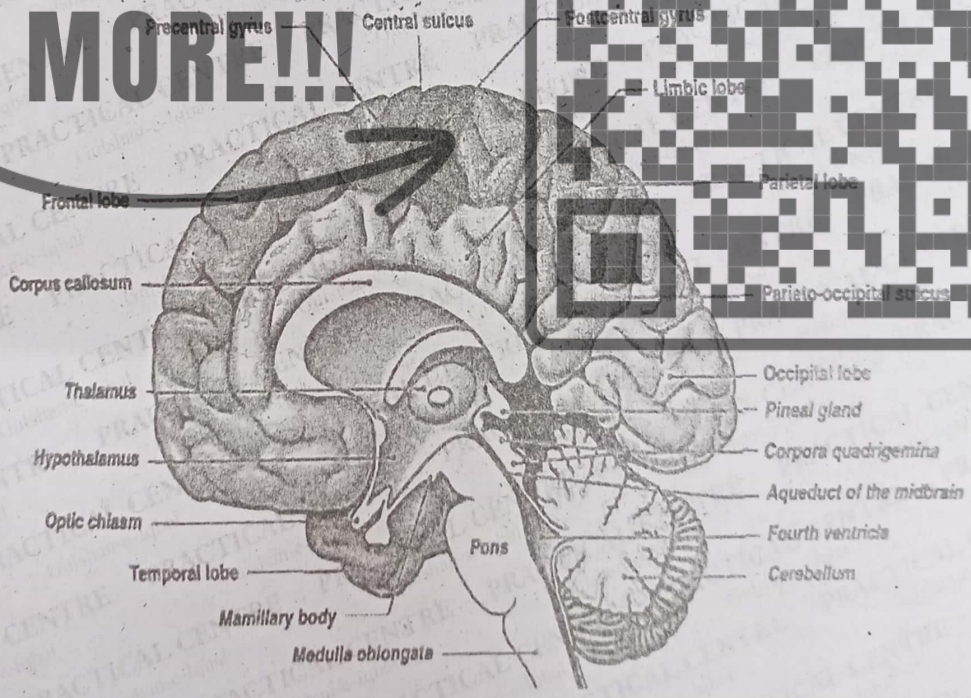
CO-ORDINATION AND CONTROL 17

KEY UNITS

- Nervous System on Man
- Steps involved in Nervous Coordination
- Neuron Structure and Types
- Nerve Impulse
- Transmission of Human Nervous System
- Sensory Receptors
- Effect of drugs on Nervous Coordination
- Disorder of Nervous System
- Diagnostic tests for Nervous disorders.



Architecture of Human Brain

DEFINITION:

The system which controls and co-ordinates different parts of the body is called nervous system.

NERVOUS COORDINATION:

All animals except sponges use a network of nerve cells which forms **nervous system,** which is the **quickest way of communication** in the body of an animal. This communication takes place through electrochemical messages called **nerve impulses.**

STEPS INVOLVED IN NERVOUS COORDINATION:

The nervous system consists of specialized cells called neurons, which perform following functions like:

1. Informations are required from the internal or external environment or from other neurons.
2. These informations are integrated and produce an appropriate output signal.
3. The signals are conducted to its terminal ending which may be away from it.
4. The signals are transmitted to other nerve cells, glands or muscles.
5. The metabolic activities that maintain the integrity of the cell must be coordinate. Receptors are the receptionist of our body.

RECEPTORS AS TRANSDUCERS:

They are composed of neurons or modified epithelial cells that are individually, or in groups, form sensory organs along with other tissues like eyes, ears, tongue etc. All receptors act like a transducer which convert signals which receive a form of energy and convert into at a form called nerve impulse.

TYPES OF RECEPTORS:

On the basis of types of energy they detect, receptors can be classified into the following five types:

(i) Mechanoreceptors: The receptors which are stimulated by mechanical energy can be classified into stimuli of pressure, touch, stretch, motion and sound and all forms of mechanical energy are called Mechanoreceptors.

(ii) Pain receptor (Nociceptors): A stimulus that causes or is about to cause tissue damage is perceived by the body as pain. The receptors that perceive pain are called Pain receptors or Nociceptors.

(iii) Thermoreceptors: The receptors which detect the sensation of changes in temperature are called Thermoreceptors. They help in thermoregulation by keeping an eye on the surface and internal core temperature.

(iv) Osmoreceptors: The specialized receptors that respond to individual kinds of molecules are called osmoreceptors. For example, osmoreceptors in human brain (hypothalamus) detect changes in total solute concentration of the blood and stimulate thirst when osmolarity increases.

(v) Chemoreceptors: The receptors which detect the nature of chemical which is dissolves in solution called chemoreceptrs.

Olfactory receptors: The receptors which are found in nasal epithelium which detects smell are called olfactory receptors.

(vi) **Gustatory receptors:** The receptor found in the tongue for taste are called gustatory receptors.

Photoreceptors: The receptors which detect visible and ultra violet light are known as Photoreceptor and they are organized in eyes as rods and cone cells.

EFFECTORS:

Muscles and glands are generally effectors when they receive command from central nervous system to produce a response.

THE PATH OF A MESSAGE TRANSMITTED TO THE CENTRAL NERVOUS SYSTEM:

The stimuli are detected by specific sensors called (receptors) which can be sensory neuron, nerve endings of an organ or another type of cell. For example, sensors in the eyes, ears, muscles, skin etc. These sensors transmit impulse to the central nervous system through sensory neurons. The CNS is composed of brain and spinal cord which receives impulses. It gather information and analyze them. Effector organs receive impulses from the brain or spinal cord through motor neuron.

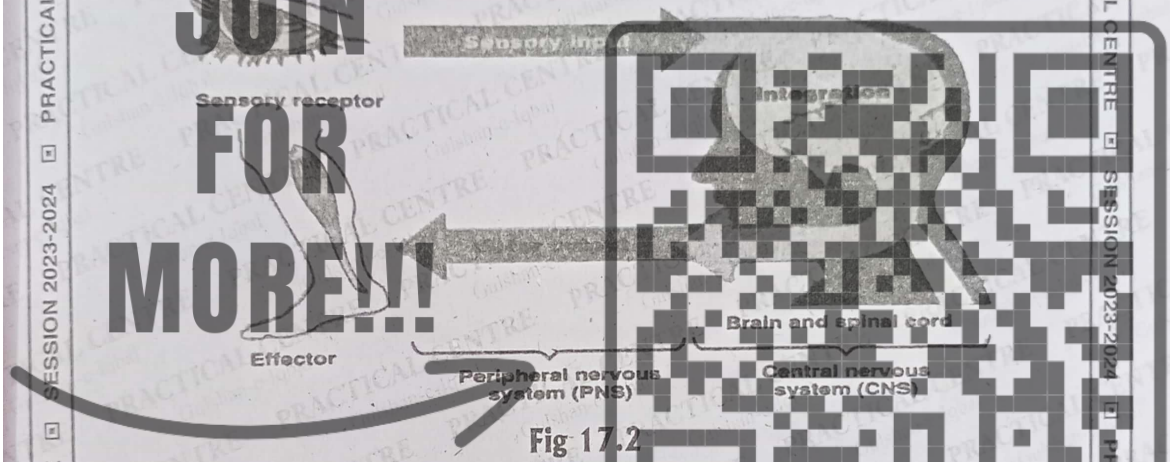


Fig 17.2

NEURON:

Neuron are the structural and functional unit of the nervous system which has an ability to generate, conduct and transmit signals (nerve impulse) from one destination of the body to another part of the body.

STRUCTURE OF NEURON:

A Neuron consists of the following three parts:

SOMA OR CELL BODY:

A neuron has relatively large cell body (soma) which contains a nucleus and variety of cell organelles in cytoplasm. In the cytoplasm, Nissl's bodies or granules are present. Nissl's granules are group of ribosomes, associated with protein synthesis. Soma is covered with membrane called neurolema. One of the main functions of the cell body is to produce neurotransmitters, which are chemicals stored in secretory vesicles at the end of axon.

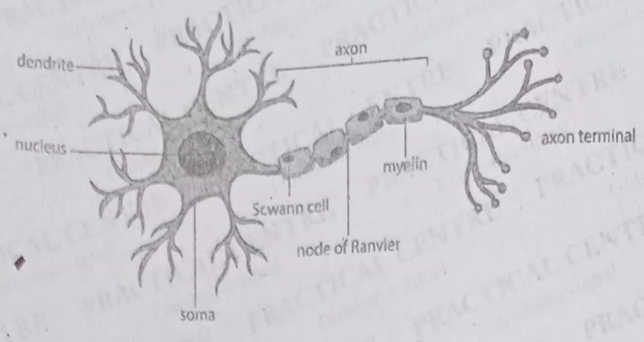


Fig 17.3 Structure of Neuron

DENDRITES:

The dendrites are cytoplasmic extensions which originate form one end of cell body (soma). They are specialized to receive signals from other neurons or external environment. Their branched form provides a large surface to receive stimulation.

AXON: (Greek: Axon = Axis)

Axon is a long fibre which extends outwards from the soma, making neurons the longest cells in the body. The cytoplasm of an axon is called an axoplasm which is covered with axolemma. Axon is primarily involved in carrying the nerve impulses from soma to the end of neuron and then transmitting it to other neuron or effectors. Axon that has myelin sheath is called myelinated fibre and those which lacks myelin is called Non-myelinated neuron.

Node of Ranvier or Neurofibril Nodes: A non-myelinated part of axon between two Schwann cells is called Node of Ranvier or Neuro fibril Nodes.

NEUROGLIA OR GLIAL CELLS:

The supporting cells which structurally and functionally support neurons are collectively called neuroglia. They perform variety of functions including supplying nutrients to neurons, removing waste from neurons, guiding axon migration and providing immune functions. Neuroglia are of two types;

Schwann cells: The type of neuroglial cells which produce myelin in the neurons of peripheral nervous system (PNS).

Oligodendrocytes: They are the type of neuroglial cells which produce myelin in the neuron of central nervous system (CNS).

TYPES OF NEURONS:

SENSORY NEURON (AFFERENT NEURON):

The sensory neuron carries sensory impulses from receptors to central nervous system (CNS). They are generally found in sensory organs such as eyes, nose, skin, tongue and ear. They are stimulated by chemical and physical inputs from environment such as sound, heat and light. Sensory neurons facilitates the movement of sensory signal from receptors to CNS.

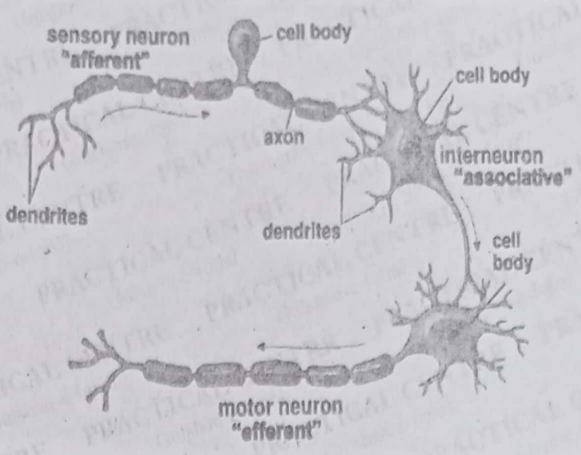


Fig 17.4 Types of Neurons

MOTOR NEURON (EFFERENT NEURON):

The motor neurons facilitate the transmission of impulses from central nervous system to the effectors. They play an important role in the voluntary and involuntary movement of the body.

INTERNEURON (ASSOCIATION NEURON):

Internetrons act as mediator between sensory neuron, motor neuron and central nervous system. They help in the smooth transmission of impulses.

REFLEX ACTION:

The action which is carried out without the use of animal called R/A. Reflex action are spontaneous involuntary responses which are performed unconsciously. The pathway along which impulses are transmitted from receptor to an effector, is called reflex arc. Examples of human reflexes are:

1. Knee jerk reaction.
2. Withdrawal reflexes of hand by touching with hot object.
3. Closing of Eye by sharp light

Fig 17.5 Reflex Action

The R/A my be mono-synaptic or polysynaptic generally the reflex action involve 2 neurons called sensory & motor neurons.

NERVE IMPULSE:

The electrochemical signal generated, propagated and transmitted by neuron is called nerve impulse. It depends on the flow of ions across neurolemma. The signal starts to create a gradient a across plasma membrane.

GENERATION AND TRANSMISSION OF NERVE IMPULSE:

Nerve impulse is electrochemical transmission of messages through neurons.
It travels through the neuron due to voltage proteinic gated channels in the neurolemma.
These channels open and close in response to electrical voltage.

DISTRIBUTION OF IONS:

Neurolema is polarized i.e., negatively charged from inside with respect to outside due to distribution of ions.

The concentration of potassium (K^+) is thirty times greater inside the cell than outside.

The concentration of sodium (Na^+) is ten times greater outside than inside the cell.

This distribution of ions is created by sodium, potassium pumps which actively transport sodium out and potassium inside the cell.

The channels are specific for particular ion and restrict any other ions to pass through it.

The negative ions inside neurolemma are (Cl^-), PO_4^{-2}, SO_4^{-2} and some proteins that are produced inside and cannot diffuse outside the cell.

RESTING MEMBRANE POTENTIAL (RMP):

The electric potential present on the unstimulated, inactive neurolemma is called Resting membrane potential. It is -70mv.

This polarity is due to unequal distribution of ions across the neurolemma.

There is greater concentration of sodium ions outside as compared to the inside and there is greater concentration of potassium ions inside then outside.

The cell possesses potassium and sodium leakage channels that allow movement of these two cations.

Neuron have far more potassium leakage channels than sodium channels, therefore potassium diffuses out of the neurolemma at a much faster rate than the leaking in of sodium.

Because competitively more cations are leaving the cell than they are entering, negative charge develops inside the cell relative to outside of neurolemma.

The sodium potassium pumps help to maintain the resting potential, once established.

The sodium potassium pump brings two K^+ ions into the cell will three Na^+ ions per ATP consumed.

The Cl^- tends to accumulate outside the cell because they are repelled by negatively charged proteins within the cytoplasm.

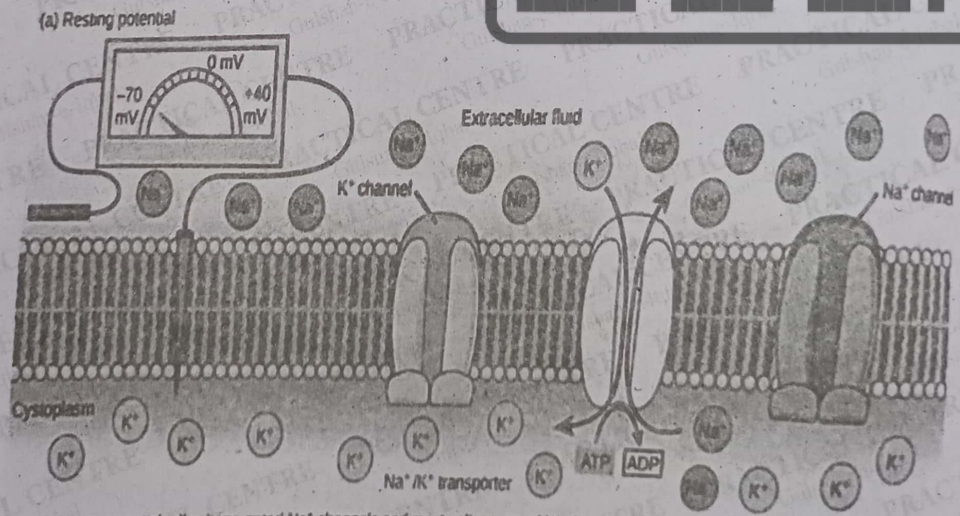


Fig 17.6

ACTION MEMBRANE POTENTIAL (AMP):

The temporary localized reversal of the polarity of neurolemma, when it is stimulated is called Action membrane potential. It occurs in two steps:

DEPOLARIZATION:

During depolarization, the membrane potential rapidly shifts from negative to positive. While the sodium potassium pump continues to work, the voltage gated channels, that had been closed while the cell was in resting membrane potential, are opened in response to an initial change in voltage.

The sodium ion rushes back into the cell through sodium voltage gated channels, as a result, positive charge is developed inside the cell, which changes membrane potential from negative to positive.

Once depolarization is complete, the voltage gated channels close again.

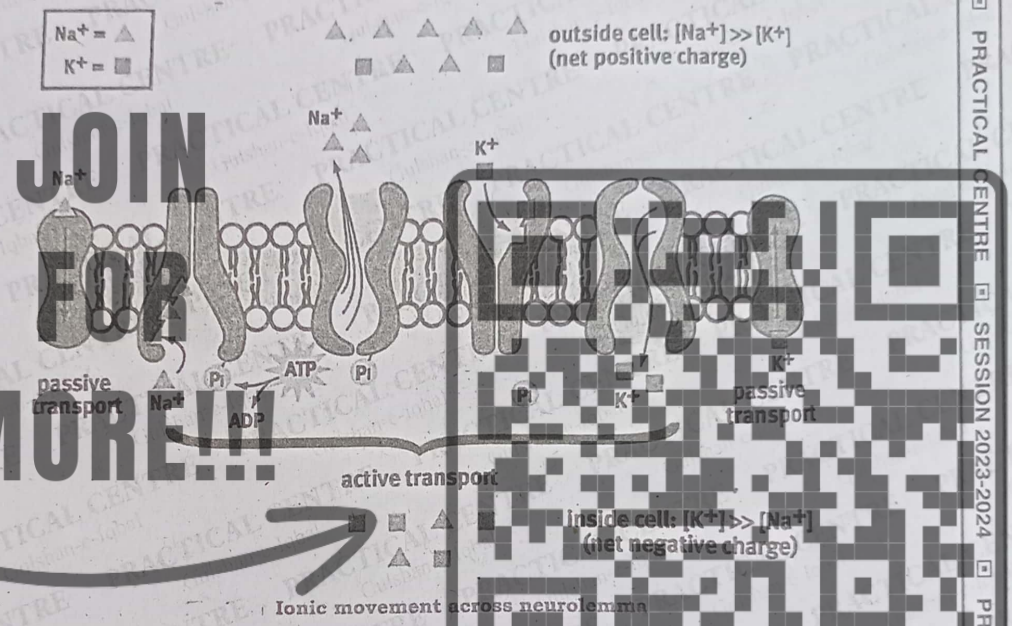


Fig 17.7

REPOLARIZATION:

The restoration of neurolemma to resting membrane potential is termed as Repolarization. It is a condition in which electrical balance is restored inside and outside the neurolemma.

During repolarization, efflux of potassium ions through the potassium channels occurs. As a result of opening of potassium voltage gated channels, sodium voltage gated channels are closed, as a result of which no sodium ions will move inside the membrane.

Until potassium voltage gated channels close, the number of K+ ions that moved across the membrane are enough to restore the initial polarized potential state. This return to the resting state usually takes from 10 to 30 milliseconds.

The sodium potassium pump works continuously throughout this process.

REFRACTORY PERIOD:

The refractory period is a brief period after the successful transmission of a nerve impulse.

During this period, neurolemma prepares itself for the conduction of second impulse after the restoration of resting membrane potential. It persists for only 2 milliseconds. During this period, sodium potassium ATP pump causes the movement of sodium and potassium ions against the concentration gradient. For every two potassium ions that are pumped inside, three sodium ions are pumped outside by sodium potassium ATP pump.

HYPERPOLARIZATION:

When the membrane potential becomes more negative than the resting membrane potential, the membrane is said to be hyperpolarized.

During repolarization, due to continuous movement of potassium ions to outside through K^+ channels or Cl^- influx through Cl^- channels, the resting potential exceeds - 70mV to -75mV.

The resting membrane potential is ultimately re-established by the closing of all voltage gated channels and the activity of sodium potassium ATP pump.

VELOCITIES OF NERVE IMPULSE:

Animals have evolved following two ways to increase the velocity of nerve impulses:

The velocity of conduction increases with the increase in diameter of the axon. Larger the diameter of axon, lesser it will cause resistance in the conduction of impulse. This is because electrical resistance is inversely proportional to cross sectional area.

Myelinated neurons conduct impulses rapidly because action potential is only produced at nodes of Ranvier, therefore it jumps from node to node which results in faster transmission of up to 150 milli second in some neurons. This is called saltatory conduction.

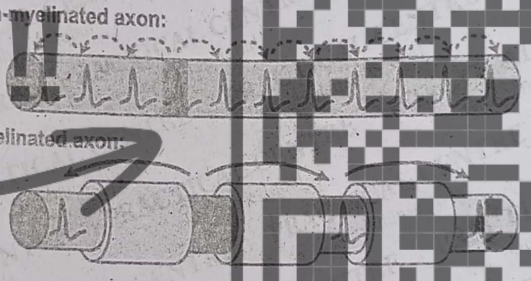


Fig 17.8

SYNAPSE:

A junction, where the impulse moves from one neuron to another, is called Synapse. Synapse is found between two neurons, between sensory receptor and sensory neuron, between motor neuron and muscle cell and between neuron and gland's cell.

STRUCTURE OF SYNAPSE:

It consists of following three components:

PRE-SYNAPTIC CELL: The neuron which transmits action potential to the synapse is called pre-synaptic cell (Axon).

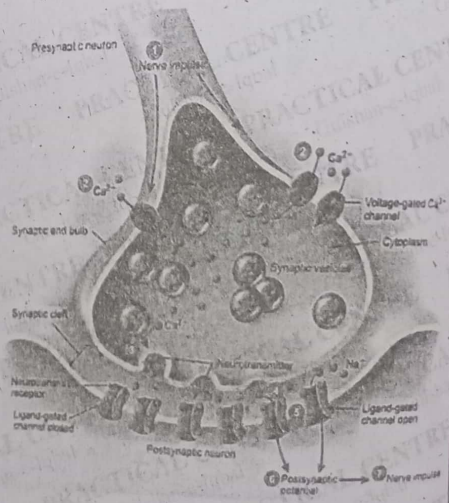


Fig 17.9 Synapse

POST SYNAPTIC CELL: The cell receiving the impulse on the other side of synapse is post synaptic cell. It is the membrane of dendrites of neighboring neuron or it may be a muscle membrane (motor end plate).

SYNAPTIC CLEFT: The gap between pre-synaptic cell and post-synaptic cell is called synaptic cleft.

MECHANISM OF SYNAPTIC TRANSMISSION:

The movement of impulse across the synapse is called a synaptic transmission. The two basic types of synapses are:

ELECTRICAL SYNAPSE:

An electrical synapse is a mechanical and electrically conductive link between two neighboring neurons that is formed at a narrow gap between the pre- and post synaptic neurons known as a gap junction.

It makes possible for impulses to transmit from neuron to neuron without delay and with no loss of signal strength.

Electrical synapses in CNS synchronize the activity of neurons responsible for some rapid stereotypical movements.

Electrical synapses are common in invertebrates but less so in vertebrates.

CHEMICAL SYNAPSE:

The majority of synapses in vertebrates is chemical synapses. The end of pre-synaptic axon is swollen and contains numerous synaptic vesicles, each packed with a chemical substance called neurotransmitter. When action potential arrives at the end of axon, it stimulates the opening of voltage gated calcium channels, causing inward diffusion of calcium. The influx of calcium triggers a complex series of events that lead to the fusion of synaptic vesicles with the plasma membrane. These vesicles release neurotransmitters into synaptic cleft by exocytosis. Neurotransmitter binds to the receptors present on the membrane of post synaptic cell which generates action potential. The neurotransmitter is then reabsorbed by the pre synaptic cell for reuse.

CLASSIFICATION OF NEUROTRANSMITTERS:

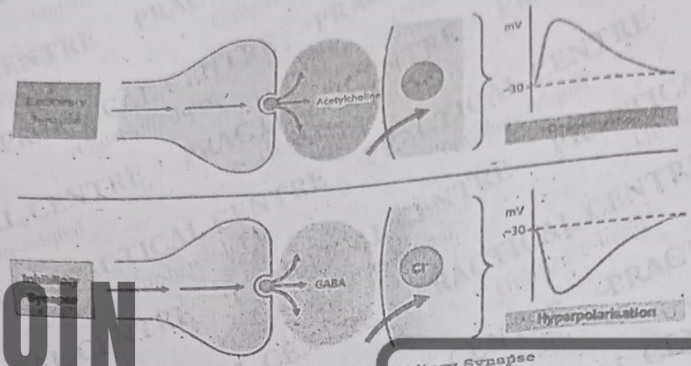
Neurotransmitters are classified into following two categories:

EXCITATORY NEUROTRANSMITTERS:

The receptors at excitatory synapse controls gated channels that allow Na+ to enter the cell and K+ to leave the cell, which results in depolarization. This electric change is called excitatory postsynaptic potential (EPSP). The chemicals which cause this excitatory postsynaptic potential are called excitatory neurotransmitters. Acetylcholine is common neurotransmitter which can be excitatory or inhibitory depending on the type of receptor. Biogenic amines are neurotransmitters derived from amino acids. They commonly function in central nervous system. They include epinephrine, nor epinephrine, dopamine, serotonin. Dopamine and serotonin affect sleep, mood, and attention in learning. Balance of these neurotransmitters is associated with disorders such as **Parkinson's disease** which is caused due to low levels of dopamine and **Schizophrenia** is due to excess levels of dopamine.

INHIBITORY NEUROTRANSMITTERS:

At an inhibitory synapse, the binding of neurotransmitter to the post synaptic membrane hyperpolarizes membrane by opening ion channels which makes more permeable to either K+ which rushes out of the cell or Cl- which enters the cell because of large concentration gradient or to both of these ions.
This makes membrane even more negative than the resting membrane potential, making it difficult for action potential to be generated.
The voltage changes associated with chemical signaling at an inhibitory synapse are called inhibitory postsynaptic potential (IPSP).
The chemicals which cause these voltage changes are called inhibitory neurotransmitters such as gamma amino butyric acid (GABA), Glycine, glutamate and asparate.



Excitatory and Inhibitory Synapse

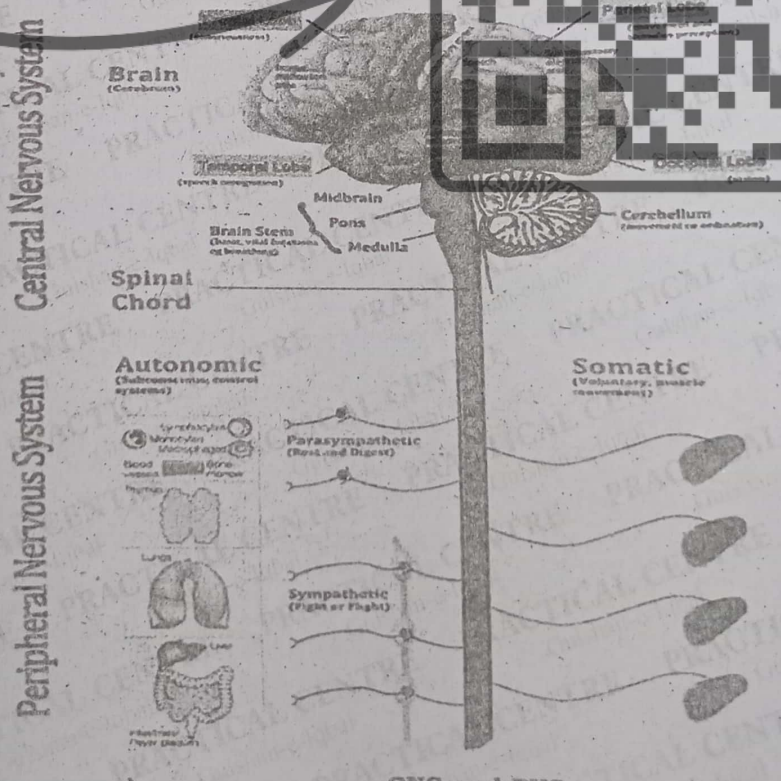
Fig 17.10

BASIC ORGANIZATION OF HUMAN NERVOUS SYSTEM:

Human nervous system is a type of centralized nervous system. It consists of:

Central nervous system (CNS): which includes the brain and spinal cord, which have central location and lie in the midline of the body.

Peripheral nervous system (PNS): consist of nerves arising from brain and spinal cord and have a peripheral location in the body.



CNS and PNS

Fig 17.11

ARCHITECTURE OF BRAIN AND SPINAL CORD:

CENTRAL NERVOUS SYSTEM (CNS):

CNS is an integration center of the nervous system, where sensory information is received and processed, thoughts are generated and responses are directed. CNS consists of10 to 100 billion inter neurons or association neurons.

PROTECTION:

The CNS is protected in three ways:

BONY ARMOUR: The first line of defense is bony armor consisting of skull that surrounds the brain and the vertebral column that protects the spinal cord.

MENINGES: Beneath bony armour, three layers of connection tissues are present called **meninges.**

Dura mater: Outer layer which is present next to cranium.

Arachnoid mater: Middle layer.

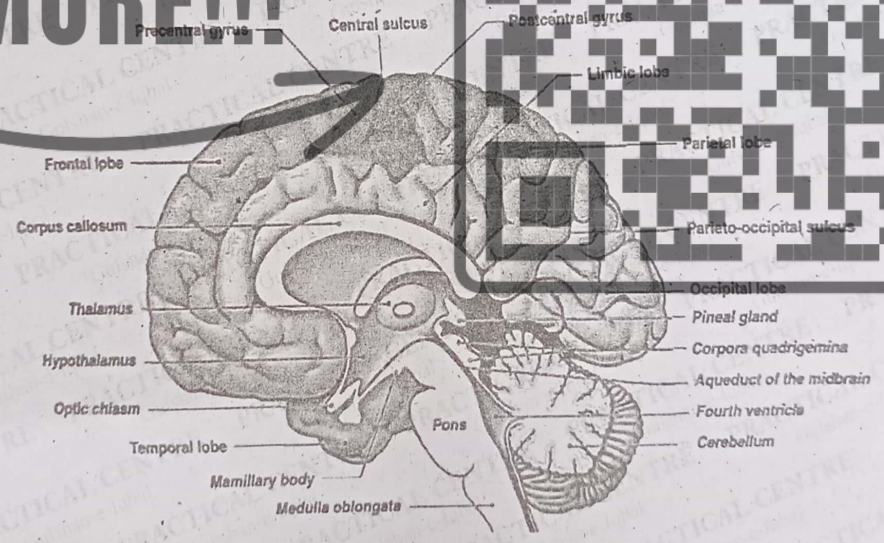
Pia mater: Inner layer which is present next to nervous tissues.

CEREBRO-SPINAL FLUID (CSF): Between arachnoid mater and pia mater, clear lymph - like liquid is present which cushions the brain and spinal cord. This liquid is called cerebrospinal fluid.

BRAIN:

The human brain is large and complicated, approximately 1.4 kg (3 pounds) in weight, depending on the body weight and sex of each individual. Human brain, like other higher animals, is divided in the following parts:

i. FORE BRAIN ii. MID BRAIN iii. HIND BRAIN



Architecture of Human Brain

Fig 17.12

i. FORE BRAIN: It is the largest and most anterior portion of brain which is further divided into following two regions:

A. TELENCEPHALON:

It is also known as cerebrum. It is the largest and most important of fore brain.

Cerebrum is further divided into two semi-half portions called cerebral hemispheres. The cerebral hemispheres communicate with each other by a large band of axons called corpus callosum.

Each hemisphere is composed of outer grey matter and inner white matter.

The gray matter area is called cerebral cortex. It is the most sofisticated information processing centre of the brain. It contains over 10 to 50 billion neurons.

Cerebral cortex is highly folded and composed of numerous inter-neurons.

The surface of cerebral cortex is highly convoluted which increases the surface area of the cortex.

The cerebral cortex is divided into four regions based on anatomy i.e., frontal, parietal, temporal and occipital lobes.

ACTIVITY OF CEREBRAL CORTEX:

The activities of cerebral cortex fall into sensory area, association area and motor area.

Sensory area: This area receives inputs from different parts of the body.

Association area: This area is a site of higher mental activities i.e., intelligence, reasoning and memory. It interprets or analyze the incoming information.

Motor area: This area controls the responses of the body.

B. DIENCEPHALON:

It is the posterior part of fore brain and is further divided in the following two parts:

THALAMUS: It is major integrating centre and also the main input centre for sensory information going to the cerebrum and the main output centre for motor information leaving the cerebrum. The sensory information in sorted out in thalamus and sent to appropriate higher brain centre for further integration and interpretation.

ii. LIMBIC SYSTEM: It is a diverse group of structures located in an arc between the thalamus and the cerebrum. It consists of following three parts:

a) **Hypothalamus:** It lies below thalamus. It contains many different clusters of neurons. Some of these are neurosecretory cells that release hormones. Through its hormone production and neural conduction, it acts as a major coordinating centre controlling body temperature, hunger, thirst, water balance, menstrual cycle and autonomic nervous system. It also elicits emotions such as rage, fear, pleasure and sexual arousal.

Amygdala: It is responsible for the production of appropriate behavioral responses to environmental stimuli. It controls the feelings and emotions of loneliness, fear, hate and sexual arousal.

Hippocampus: It is named so because of its resemblance with sea horse. It plays an important role in the formation of long-term memory and is thus required for learning.

MID- BRAIN: Mid-brain is extremely reduced in humans. It is the relay center and contains reticular formation. Reticular formation extends from central core of the

medulla, through pons, midbrain and into the lower regions of the forebrain. It plays a role in sleep, arousal, emotion, muscle tone, certain movement and reflexes.

HIND BRAIN: It is the most posterior portion of brain composed of the following portions:

a) **Medulla Oblongata:** The medulla controls several autonomic functions such as breathing, heart-rate, blood pressure, swallowing, hiccupping, sneezing, vomiting, digestion etc.

b) **Cerebellum:**

is important in coordinating movement of the body. It is the second largest part of the brain and is much convoluted like cerebrum. It receives sensory information about the position of joints and the length of muscles as well as information from auditory and visual systems. Cerebellum provides automatic coordination of movement and balance.

c) **Pons:**

Pons is located above medulla. Itinfluences transitions between sleep and wakefulness and between stages of sleep. It also influences rate of pattern of breathing.

BRAIN STEM:

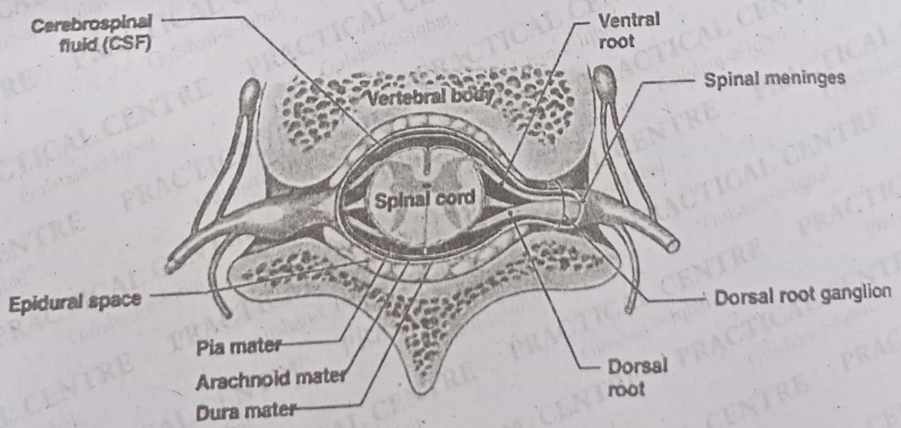
It is the region at the base of brain that is located between cervical spinal cord and the deep cerebral hemispheres. It plays a role in controlling involuntary body functions like breathing and heartbeat. In humans, brain stem consist of three distinct parts i.e., medulla oblongata (myelencephalon), pons (metencephalon) and mid brain (mesencephalon).

SPINAL CORD:

Spinal cord is neural cable extending from brain, down through the backbone. It is enclosed and protected by vertebral column and meninges. Messages from the body and the brain run up and down the spinal cord. It also functions in reflexes such as sudden involuntary movement of muscles. It consists of two zones:

White Matter: It is the outer zone of spinal cord which consist of axons of sensory neurons in dorsal column and axons of motor neurons in ventral column.

Gray Matter: It is the inner zone of spinal cord which consist of cell bodies of interneurons, motor neurons and neuroglia.



Cross section of Spinal cord

Fig 17.13

CRANIAL AND SPINAL NERVES IN MAN (Peripheral Nervous System):

The peripheral nervous system consists of paired cranial and spinal nerves and associated ganglia. There are 12 pairs of cranial nerves which originate from the brain and innervate organs of the head and upper body. There are 31 pairs of spinal nerves which originate in the spinal cord and innervate the entire body.

Most of cranial nerves contain both sensory and motor neurons, a few of the cranial nerves are sensory only (the olfactory and optic nerves).

Spinal nerve separates into sensory and motor components. The axons of sensory neurons enter the dorsal surface of the spinal cord and form the dorsal root of the spinal nerves, whereas motor axons leave from the ventral surface of the spinal cord and form the ventral root of the spinal nerve.

The cell bodies of sensory neurons are grouped together outside each level of spinal cord, in the dorsal root ganglia. The bodies of motor neurons, on the other hand, are located within the spinal cord and so are not located in ganglia.

SOMATIC AND AUTONOMIC NERVOUS SYSTEM

The motor portion of the peripheral nervous system is subdivided into two parts, somatic nervous system and autonomic nervous system.

SOMATIC NERVOUS SYSTEM:

The somatic nervous system is voluntary in function and work under conscious control. Its neurons stimulate the skeletal muscles which contract in response to conscious commands.

AUTONOMIC NERVOUS SYSTEM:

The autonomic nervous system is involuntary which regulate the internal environment by controlling smooth and cardiac muscles and the organs of the gastrointestinal tract, cardiovascular, excretory and endocrine system. It consists of two sub-divisions i.e., sympathetic and parasympathetic nervous system.

SYMPATHETIC NERVOUS SYSTEM:

The sympathetic nervous system acts on organs in ways that prepare the body for stressful or highly energetic activity such as fighting, escaping or giving a speech during such "Fight-or-Flight" activities. It consists of thoracic and lumber nerves originate from spinal cord.

PARASYMPATHETIC NERVOUS SYSTEM

The parasympathetic nervous system regulates maintenance activities that can be carried on at leisure, often called "rest and rumination". Under its control, the digestive tract becomes active, heart rate slows, and air passage in the lungs constrict. It consists of cranial nerves from the brain and sacral nerves from spinal cord.

S.NO.	PARASYMPATHETIC NERVOUSSYSTEM	SYMPATHETIC NERVOUS SYSTEM
1.	It is formed by four cranial nerves (including vagus nerve) and a spinal nerve arising from sacral vertebrae. Therefore, it is also called Cranio-sacral Outflow.	It is formed by spinal nerves arising from the thoracic and lumber region of the vertebral column. Therefore, it is also called Thoracolumbar Outflow.
2.	It gets activated during the activities related to the relaxed or normal state of the body.	It gets activated during the activities related to the emergency state (fight/flight conditions) of the body.
3.	It controls activities such contraction of pupil of eye, digestion of food, slow heart beat etc.	It controls activities such as increased heart beat and breathing rate and slow digestion etc.
4.	It uses Acetylcholine as neurotransmitter.	It uses Epinephrine and Nor-epinephrine as neurotransmitter.

SENSORY RECEPTORS AND THEIR WORKING:

SMELL RECEPTORS (OLFACTORY RECEPTORS): Human sense of smell involves chemoreceptors in the nasal cavity, with a small olfactory epithelium compared to dogs. The dendrites of olfactory neurons end in tassels of cilia that project into the nasal mucosa while their axons project directly into the cerebral cortex.

When odorous substance diffuses into this region, it binds to specific receptor molecules on the plasma membrane of the olfactory cilia. There may be 1000 types of receptor proteins embedded in the olfactory cilia. Each receptor protein is specialized to bind a particular type of molecule and stimulate the olfactory neuron to send a message to the brain.

TASTE RECEPTORS: The receptors cells for taste (Gustation) are modified epithelial cells organized into taste buds. Human tongue bears about 10000 taste buds. Most of the taste buds are on the surface of the tongue or are associated with nipple-like projections called papillae on the tongue. There are five basic taste perceptions, sweet, sour, salty, bitter and umami (perception of glutamate and other an-Iino acids that give a hearty taste to many proteins rich foods such as meat, cheese and butter).

SENSORY RECEPTORS IN HUMAN SKIN:

Several types of mechanoreceptors are present in the skin. Some lie in dermis and some in subcutaneous tissues. These receptors contain sensory cells which detect various forms of physical contact, known as the sense of touch.

PHASIC RECEPTORS: The phasic receptors include hair follicle receptors and Meissner's corpuscles, which are present on surfaces that do not contain hair, such as the fingers, palms and nipples.

TONIC RECEPTORS: The tonic receptors consist of Ruffini's corpuscles in the dermis and touch, dome endings (Merkel's disks) located near the surface of the skin. These receptors monitor the duration of touch and the extent to which it is applied.

PRESSURE SENSATION RECEPTORS: Deep below the skin pressure are sensation receptors called Pacinian corpuscles. In human, a class of receptors having naked dendrites are present in the epidermis of skin, which are called nociceptors. Nociceptors detect sensation of noxious substances as well as tissue damage.

EFFECT OF DRUGS ON NERVOUS CO-ORDINATION:

Drugs that provide pain relief, such as Morphine or Demerol block synapses in the pain pathways of the brain or spinal cord. Brain can temper its perception of pain through endorphins. Endorphins allows a person to function in emergency conditions by blocking perception of pain until the emergency is over.

NARCOTIC DRUGS:

Common narcotic drugs are heroin, cannabis, nicotine, alcohol and inhalants.

HEROIN: Heroin is a white powder with a bitter taste. It is a highly addictive drug which is derived from the morphine alkaloid, found in opium poppy plants. It exhibits euphoric (Rush) anti-anxiety and pain-relieving properties.

CANNABIS: The cannabis plant (*Cannabis sativa*) is found in temperate and tropical areas. It is one of the most widely consumed drugs throughout the world. In many countries, herbal cannabis and cannabis resin are formally known as marijuana and hashish (hash) which cause mild euphoria, with alteration in vision and judgement.

NICOTINE: It is an alkaloid of tobacco which binds directly to specific receptor on post synaptic neurons of the brain. Nicotine receptors normally bind the neurotransmitter, acetylcholine. Nicotine stimulates heart rate, blood pressure and increased muscular activity.

ALCOHOL: Alcohol interferes with the brain's communication pathways, and can affect the way the brain looks and work. These disruptions can change mood and behaviour and make it harder to think clearly and move with coordination.

INHALANTS: Inhalants are volatile substances found in the home or workplace such as spray paints, markers, glues, and cleaning fluids. They contain dangerous substances that have psychoactive (mind altering) properties when inhaled.

DRUG ADDICTION AND DRUG TOLERANCE:

Drug addiction is a complex neurobiological disorder, which affects a person's brain and behaviour in a way that they lose the ability to resist the urge to use drugs.

DRUG ADDICTION:

Drug addiction is dependence on illegal drugs like cocaine, nicotine or addictive substances like medication drug, alcohol etc. The dependence on drugs usually starts

with an experiment. A person takes a drug because of the way which make him feel. Repeated misuse of drugs changes how brain works, it makes a person lose self-control and messes with the desire to take drugs.

DRUG TOLERANCE:

Drug tolerance occurs due to repeated and prolonged exposure to nicotine and caffeine. The drug loses its efficiency and as a result, larger and larger doses must be taken to produce the same effect.

DISORDERS OF NERVOUS SYSTEM AND DIAGNOSTIC TESTS:

Nervous disorders may be classified as vascular, infection structural, functional and degenerative.

VASCULAR DISORDERS OF THE CNS:

Nervous disorder due to abnormality in blood circulation is called vascular disorder of the nervous system e.g., stroke and Hematoma.

STROKE: It is caused by an interference with blood supply to the brain. It may occur when a blood vessel bursts in the brain, when blood flow in cerebral artery is blocked by a blood clot.

Cause: The cause of stroke includes hypertension, smoking, diabetes mellitus, high alcohol intake and cocaine abuse.

Symptoms: The loss of blood flow to the brain damage tissues within the brain symptoms of stroke show up in the body parts controlled by the damaged area of the brain. Loss of balance and co-ordination severe and sudden headache, paralysis, weakness in the arm, face and leg.

Treatment: a stroke is a medical emergency; immediate treatment can save lives and reduce disability treatment depends on these verity and type of stroke. Treatment will focus on restoring blood flow anticoagulants and platelets aggregation inhibitor is given blood pressure management and nursing care is essential.

HEMATOMA:

The massive accumulation of blood into the space between the brain and its outermost covering is called hematoma.

Cause: Hematoma is due to hypertension.

Symptoms: Hematoma symptoms include loss of consciousness, sudden, confusion, pale skin colour and seizures.

Treatment: It depends on the extent of the hematoma and the presence of other injuries. Depending on the severity of the injury, management may include surgery to drain blood and remove the blood clot.

INFECTIOUS DISORDERS OF THE CNS:

Nervous disorders due to infection of virus, bacteria, fungi and protozoan e.g., meningitis and encephalitis.

MENINGITIS: It is an inflammation of the fluid and membranes (meninges) surrounding the brain and spinal cord.

Cause: viral infections are the most common cause of this disease, followed by bacterial infections and, rarely, fungal.

Symptoms: Usually include sudden high fever, stiffness in neck, and headache with nausea or vomiting, it may cause paralysis coma or death.

Treatment: Depends on the type of disease. Bacterial meningitis must be treated immediately with intravenous antibiotics and more recently, corticosteroids. Viral meningitis cannot be cured with antibiotics and most cases improve on their own in several weeks, spread through coughing, sneezing (air borne rout).

ENCEPHALITIS: It is an inflammation of the brain.

Cause: Virus and rarely fungus cause encephalitis.

Symptoms: Encephalitis symptoms include fever, headache and confusion may cause muscle weakness, dementia and irritability.

Treatment: Encephalitis needs to be treated urgently. Treatment involves tackling the underlying cause, relieving symptoms and supporting bodily functions.

STRUCTURAL DISORDER OF CNS:

Nervous disorder which disturbs the structure of brain and spinal cord.

TUMOUR: A brain tumor is a growth of cells in the brain that divides in an abnormal, uncontrollable way.

Cause: It is caused by mutation and radiations.

Symptoms: The sign and symptoms depend on the size, location and rate of growth of brain tumor, it may include, headache, vision problems, seizures, paralysis, coma and death.

Treatment: Includes surgery, radiation therapy, chemotherapy and targeted therapy.

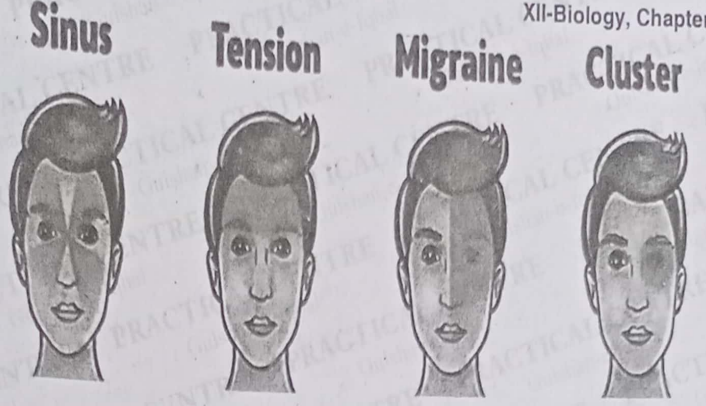
FUNCTIONAL DISORDER OF THE CNS

Headache:

Headache is defined as pain arising from the head or upper neck of the body. Pain originates from the tissues and structures that surround the skull, the brain itself has no nerves that give rise to the sensation of paint. There are three major categories of headache based upon the source of the pain:

Primary headache: Includes migraine, tension, and cluster headaches.

Secondary headache: It is due to an underlying or infection problem in the head or neck, dental pain from infected teeth, pain from an infected sinus, and bleeding in the brain or infections like encephalitis or meningitis.



Types of Headaches

Fig 17.14

CRANIAL NEURALGIAS, FACIAL PAIN AND OTHER HEADACHE:

Cranial neuroglia means inflammation of one of the 12 cranial nerves coming from the brain that control the muscles and carry sensory signals to and from the head and neck.

Cause: It is caused by inflammation or irritation of structures that surrounds the brain.

Symptoms: Pain that begins in the back of the head and upper neck.

Treatment: Treated with pain medications to control headache.

DEGENERATIVE DISORDERS OF THE CNS:

ALZHEIMER'S DISEASE:

Alzheimer's is a progressive disease in which neurons of brain particularly neurons of cortex and hippocampus are gradually destroyed. This causes memory loss which is also called dementia.

CAUSE: It is due to certain inherited genes.

SYMPTOMS:

In early stage, new or recent memories are difficult to recall and hard to learn.

In mild stage, individual may have delusion, hallucination.

TREATMENT:

There is no cure for Alzheimer's. The goal of treatment is to manage symptoms slow down progression of disease.

PARKINSON'S DISEASE:

This disease is concerned with brain. It occurs either by degeneration or damage to nervous tissues within the basal ganglia of brain.

CAUSE: Neurons in the brain which produce dopamine are destroyed.

SYMPTOMS:

Tremors in the arm or leg which worse are at the time when limb is at rest.

In later stages, disease affects both sides of the body and causes stiffness, weakness and trembling of muscles.

TREATMENT:

There is no cure for Parkinson's disease but treatments are available to help relieve the symptoms.

OTHER DISEASES:

MULTIPLE SCLEROSIS:

It is an auto-immune disease which affects the central nervous system.

HUNTINGTON'S DISEASE:

It is due to gradual breakdown of the nerve cells of the brain. It affects physical movement, emotions and cognitive abilities.

DIAGNOSTIC TEST FOR NERVOUS DISORDERS:

Different diagnostic tests are used to diagnose nervous disorders. e.g., EEG, CT scan and MRI.

ELECTROENCEPHALOGRAM (EEG):

It is a neuroimaging test which can detect and record minute changes in electrical activity within the brain. It uses macro electrodes (large, flat electrodes stuck to the skin or scalp). It produces a chart (an encephalogram) which shows how brain waves vary by frequency and amplitude of electrical output from the brain changes over time.

COMPUTED TOMOGRAPHY (CT SCAN)

Computed tomography refers to a computerized x-ray imaging procedure in which an x-ray beam rotates around the body, producing signals that are processed by the machine's computer to generate cross sectional images or slices. These slices are called tomographic images and can provide more detailed information than conventional x-rays.

MAGNETIC RESONANCE IMAGING (MRI):

It is a radiological technique that uses magnetism, radio wave and a computer to produce detailed image of body structures. The MRI scanner is a tube surrounded by a circular magnet. The patient is placed on a moveable bed that is inserted into the magnet. The magnet creates a strong magnetic field that aligns the protons of hydrogen atoms which are then exposed to a beam of radio wave, this spins the various protons of the body, and they produce a faint signal that is detected by the receiver portion of the MRI scanner. A computer processes the receiver information, which produces an image.

PRACTICAL CENTRE

CLASS XII

BIOLOGY

CHAPTER # 18

CHEMICAL CO-ORDINATION

2023-24

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CHEMICAL CO-ORDINATION

18

CHEMICAL COORDINATION:

The chemicals which secreted form different part of the body like as **neurotransmitters, pheromones and hormones** which regulate the activities of other cells of the body called Chemical Co-ordination.

PHEROMONES:

Pheromones are chemicals which are secreted in minute amounts to stimulate particular response from another organism of the same species.

HORMONES:

Hormones are the secretions of endocrine glands which are released directly into the blood and affect the working of particular target cells. A minute quantity has a profound effect on the behaviour, development, growth, and reproduction etc. of an organism.

CHEMICAL NATURE OF HORMONES (TYPES OF HORMONES)

Hormones are chemically classified into following types:

i. **PEPTIDE AND PROTEIN HORMONES:** The peptide hormones consist of short chain of amino acids (**ADH, Oxytocin etc.**) whereas the protein hormones consist of long chain of amino acids (**glucagon, insulin, prolactin** etc.)

ii. **MODIFIED AMINO ACIDS HORMONES:** This class of hormones is made by chemical modification of amino acids. They are also called biogenic amines. They include hormones released from adrenal medulla, thyroid and pineal gland.

- **Hormones of Adrenal medulla:** These hormones are derived from tyrosine (Catecholamines). E.g., epinephrin and nor-epinephrine.
- **Hormones of Thyroid gland:** They are also derived from tyrosine. E.g., Thyroxin.
- **Hormones of Pineal gland:** Pineal gland secretes melatonin which is derived from Tryptophan.

iii. **STEROID HORMONES:** These hormones are formed by enzymatic modification of cholesterol. E.g., **estrogen, progesterone, testosterone, aldosterone etc.**

PATH OF CHEMICAL MESSENGER:

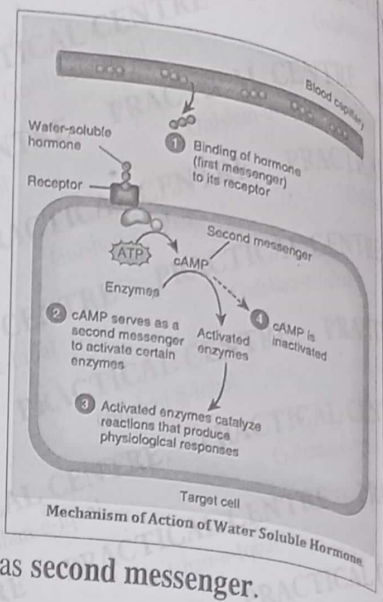
Hormones are secreted int the blood through which it reaches every cell of the body. The specificity of hormone is determined by receptors on target cells. If a cell lacks receptor for a hormone, the hormone will have no affect on that cell. Thus, hormone affects only those cells which have its particular receptor.

Multiple effects produced by single hormone depend on nature of the target cell. Receptors are either present on the surface of the cell or inside the cell.

MODE OF HORMONE ACTION: (WORKING OF HORMONES)

WORKING OF PROTEIN HORMONES:

- Protein hormones are soluble in water but insoluble in lipids. Therefore, they cannot enter through the cell membrane.
- When peptide hormone reaches its target cell, it becomes attached to the receptor molecule on the cell membrane which results in the formation of hormone-receptor complex.

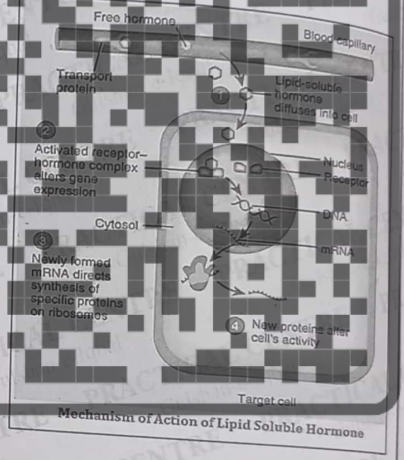


Mechanism of Action of Water Soluble Hormone

- This complex activates the enzyme **adenylate cyclase** on the inner side of cell membrane.
- Adenylate cyclase coverts ATP into **cyclic Adenosine Monophosphate (cAMP)** which serves as **second messenger.**
- cAMP activates specific enzymes which brings about the appropriate response within the cell.

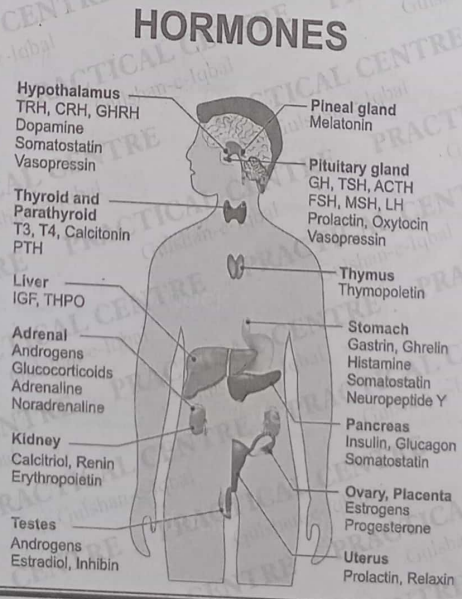
WORKING OF STEROID HORMONES:

- The steroid hormones, being fat soluble, directly diffuse through the plasma membrane into the cell.
- In the cytoplasm, it becomes attached to the specific receptor and forms hormone-receptor complex.
- This complex is carried into the nucleus where it activates the appropriate genes and under the instruction of these genes, enzymes are synthesized to bring about specific responses.



Mechanism of Action of Lipid Soluble Hormone

ENDOCRINE GLANDS:



1. HYPOTHALAMUS:

Hypothalamus is a part of brain located just below the thalamus and serves as a connecting link between the nervous and endocrine systems. It consists of two groups of neurosecretory cells.

One group of neurosecretory cells produces two types of hormones i.e., **releasing hormones/factors and inhibiting hormones/factors**. Releasing hormones/factors regulate the release of hormones from the anterior lobe of pituitary gland while the inhibiting hormones/factors cause inhibition of hormone from the target glands.

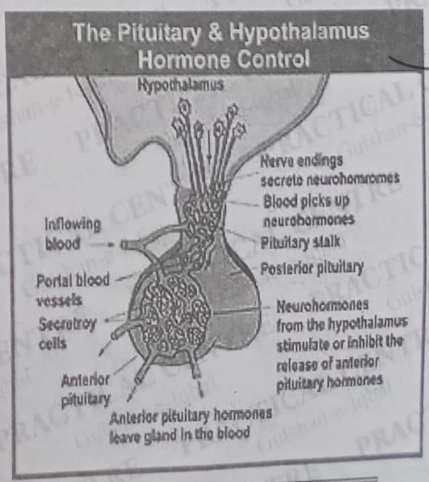
The other group of neuro-secretory cells secretes **Antidiuretic hormone (ADH) and Oxytocin** which are stored in their axon terminals located in the posterior pituitary gland.

RELEASING AND INHIBITING HORMONES OF HYPOTHALAMUS:

S.No.	HORMONE	FUNCTION
1.	Thyrotropin releasing hormone (TRH)	Stimulate the release of thyroid stimulating hormone (TSH)
2.	Corticotropin releasing hormone (CRH)	Stimulate the release of adrenocorticotropin hormone (ACTH)
3.	Gonadotropin releasing hormone (GnRH)	Stimulate the release of LH and FSH.
4.	Growth hormone releasing hormone (GnRH)	Stimulate the release of growth hormone (GH)
5.	Growth hormone inhibiting hormone (GHIH)	Inhibits the secretion of growth hormone.
6.	Prolactin inhibiting hormone (PIH)	Inhibit the secretion of prolactin.
7.	Melanocyte inhibiting hormone (MIH)	Inhibit the secretion of MSH.

2. PITUITARY GLAND: (HYPOPHYSIS)

It is a small pea-sized structure, attached with a short stalk of nerve fibers to the hypothalamus. It was also previously called master gland because of its influence on other endocrine glands. However, pituitary gland is itself under the influence of hypothalamus. It consists of two lobes, the glandular anterior lobe or adenohypophysis and the posterior lobe or fibrous neurohypophysis.



A. ANTERIOR LOBE(ADENOHYPOPHYSIS):

The anterior lobe produces seven essential hormones which stimulate the growth of their target organs and stimulate the production and secretion of hormones from other endocrine glands. A group of hormones secreted by anterior lobe are collectively termed as tropic hormones or tropins. Tropic hormones act on other endocrine glands to stimulate secretion of hormone from these glands.

i. **Adrenocorticotropic hormone (ACTH):** This hormone is protein in nature. It stimulates the release of hormone from adrenal cortex.

ii. **Melanocyte stimulating hormone (MSH):** It stimulates the synthesis and dispersion of melanin pigment in the skin.

iii. **Somatotropic hormone (STH) or Growth hormone (GH):** This hormone is protein in nature. It stimulates the growth of bones and muscles.

iv. **Prolactin:** This hormone stimulates the production of milk from mammary glands.

v. **Thyroid stimulating hormone (TSH):** This hormone is Glycoprotein in nature. It stimulates the secretion of thyroxine from the thyroid gland.

vi. **Follicle stimulating hormone (FSH):** This hormone is Glycoprotein in nature. It stimulates the formation of follicles in the ovary.

vii. **Luteinizing hormone (LH):** This hormone is protein in nature. It stimulates the formation of corpus luteum and ovulation in the ovary.

B. POSTERIOR LOBE (NEUROHYPOPHYSIS):

The hormones, released from posterior lobe of pituitary gland, are stored secretions of hypothalamus. The hormones include:

i. **Antidiuretic hormone (ADH):** It increases the reabsorption of water into the blood by kidney and therefore decreases urine output.

ii. **Oxytocin:** It stimulates contraction of uterus during labour and release of milk from the mammary glands during breast feeding.

3. THYROID GLAND:

The human thyroid gland is a bi-lobed butterfly-shaped structure, located at the base of neck in front trachea. It secretes three major hormones:

i. **Thyroxin (tetra-iodo thyronine or T4):** It consists of four atoms of iodine and is secreted in greater amount but is less potent than T3.It influences most of the cells in the body, increasing their metabolic rate. Its functions include increasing consumption of oxygen and heart rate, stimulating breakdown of glucose through synthesis of enzymes.

ii. **Triiodothyronine or T3:** It contains three atoms of iodine. It is released in small amount but is more potent than T4.

iii. **Calcitonin (Thyrocalcitonin):** Raised blood calcium stimulates the production of calcitonin. It causes the deposition of excess calcium in bones.

THYROID DISORDERS:

A: HYPERTHYROIDISM:

The higher levels of thyroxin in the blood results in Hyperthyroidism. It may produce symptoms such as profuse sweating, weight loss, heat intolerance, irritability and high blood pressure.

B: HYPOTHYROIDISM:

The low levels of thyroxin in the blood results in Hypothyroidism. It may lead to following disorders:

i. CRETINISM:

It occurs due to the deficiency of thyroxin in the early age. Its symptoms include:

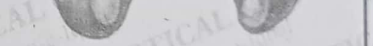
- Stunted growth.
- Mental retardation.
- Coarse facial features.
- Reproductive organs do not function normally.

ii. GOITER:

A goiter is an abnormal enlargement of thyroid gland. It occurs due to low intake of iodine in diet. It is usually painless. A large goiter can cause cough and make it difficult for one to swallow or breathe.

4. PARATHYROID GLAND:

These are two pairs of pea-sized glands, dorsally adjacent to the two lobes of thyroid gland in the neck. They release **Parathyroid hormone (PTH)** or **Parathormone** in response to low levels of calcium and regulate the serum calcium concentration.



Functions:

- It stimulates the reabsorption of calcium in the kidneys and leads to activation of Vitamin D needed for absorption of calcium in the intestine.
- It stimulates osteoclasts cells of bones to release calcium in the blood.

5. PANCREAS:

Pancreas is a heterocrine gland i.e., both exocrine and endocrine in function. Most of pancreatic cells are exocrine in function but there are patches of cells called **"Islets of Langerhans"** which have endocrine function. Islets of Langerhans have two types of cells; **alpha cells** which secrete Glucagon and **beta cells** which secrete Insulin. Both of these hormones have antagonistic effect and regulate blood glucose.

a) GLUCAGON:

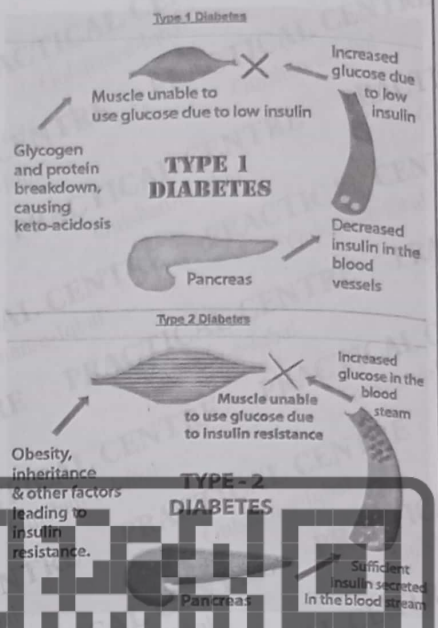
It is secreted in response to low level of blood glucose. It activates a liver enzyme that breaks down glycogen-releasing glucose bringing glucose levels to normal in the

blood. It also promotes lipid breakdown, releasing fatty acids that are metabolized for energy.

b) INSULIN: It is secreted in response to higher level of glucose in the blood. It lowers the blood glucose level by causing body cells to take up glucose or metabolizes it for energy or converts it to fat or glycogen for storage.

DIABETES MELLITUS:

It is a disease in which there is a persistently high blood glucose level.There are two types of diabetes:



a) Diabetes Type I:

In this type, beta cells are destroyed by the lymphocytes due to autoimmune disorder.It is caused when antibodies are produced against beta cells in islets of Langerhans. In this case, patient is treated by insulin injections.

b) Diabetes Type II:

It is a more common type of diabetes in which insulin is produced normally but the target cells lose insulin receptor so they gradually decrease taking up glucose. Patient can lead normal life by taking low fat, low sugar diet and regular exercise. Oral drugs may be used to enhance insulin action or secretion.

6. ADRENAL GLAND:

Adrenal gland is located just above each kidney and consists of two parts; an outer cortex and an inner medulla.

ADRENAL CORTEX:

It works under the stimulation of ACTH, secreted by the pituitary gland. Its hormones are collectively called corticosteroid hormones, some of which are as follows:

i. GLUCOCORTICOIDS:

They help to regulate glucose balance.

CORTISOL:

It is produced in the state of anxiety, fever and diseases. It promotes the hydrolysis of muscle proteins to amino acids. These amino acids are then broken down by liver into glucose by gluconeogenesis (conversion of amino acid into glucose). It also reduces the inflammatory responses and pain.

DISORDERS RELATED TO CORTISOL:

a) CUSHING SYNDROME: It occurs due to over-secretion of cortisol. Its symptoms include:

- High blood pressure.
- Weight gain.

- Muscle wasting.
- Weak bones.
- Mood swings.
- Hypertension.

b) ADDISON'S DISEASE:

It occurs due to low secretion of cortical and may also be a consequence of autoimmune process. Lack of cortisol results in drop of glucose and high susceptibility to any kind of stress due to insufficient energy supply. In this state, even a mild infection can cause death. Its symptoms include:

- Weakness.
- Weight loss.
- Low blood sugar.
- Reduced blood pressure.

ii. MINERALOCORTICOID:

They help to regulate mineral balance.

a) ALDOSTERON:

It increases the reabsorption of Na^+ and Cl^- ions by the kidney, thus regulating blood volume and blood pressure.

RAAS (Renin Angiotensin Aldosterone System):

- During low blood sodium level, the kidneys secrete an enzyme, renin which convertsa plasma protein, angiotensinogen to angiotensin-I.
- Angiotensin-I is converted into Angiotensin in the lungs, which stimulates adrenal cortex to release aldosterone.
- Renin system affects blood in two ways. Firstly, angiotensin constricts the arteries raising blood pressure.
- Secondly aldosterone causes increase in sodium absorption, maintaining sodium levels. When sodium levels are high, secretion of ADH (anti-diuretic hormone) is stimulated which causes re-absorption of water and thus blood volume and blood pressure is maintained.

b) ANDROGENS:

Androgens are similar to testosterone (male hormone) and are produced in both the sexes. They affect bones and muscle development and metabolism.

In male, it is responsible for the development of secondary sexual characters such as growth of facial hairs, deepening of voice and increase in muscle bulk.

In females, one of its main purposes is to be converted into estrogen. However, its over-secretion may lead to masculinization. (e.g., appearance of beard).

ADRENAL MEDULLA:

The adrenal medulla works under the influence of sympathetic nervous system. It secretes epinephrine and nor-epinephrine during emergency situation (fight and flight conditions).

i. **Epinephrine (adrenaline):**

It increase heartbeat, blood glucose, breathing rate and metabolic rate.

ii. **Norepinephrine (nor-adrenaline):**

It functions like epinephrine but its main function is to sustain blood pressure.

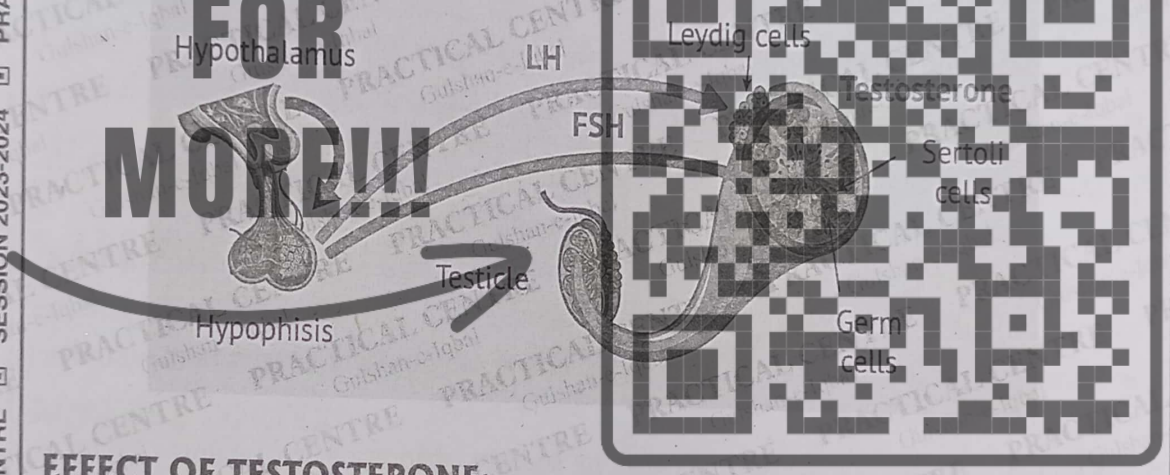
7. GONADS:

A gonad, sex gland or reproductive gland is a mixed gland that produces gametes as well as sex hormones in an organism. The male gonads are the **testes** and the female gonads are the **ovaries**.

i. TESTES:

Testes are male gonads which secretes male sex hormones. Follicle-stimulating hormone (FSH) released from anterior pituitary gland stimulates **Sertoli cells** of testes to facilitate sperm development.

LH released from anterior pituitary stimulates **Leydig cells** located in interstitial tissue of testes to release testosterone. It is produced early in the development of an embryo and ensures that the fetus develops into male.



EFFECT OF TESTOSTERONE:

Testosterone produces both anabolic and androgenic effects in males.

ANABOLIC EFFECTS:

It includes muscle mass, muscle strength, increased bone density, bone strength, linear growth and bone maturation.

ANDROGENIIC EFFECTS:

It includes maturation of sex organs, formation of scrotum in fetus, deepening of voice and growth of facial hairs.

ii. OVARIES:

The ovaries are female gonads which produce both ovum and female sex hormones. Ovaries secrete two lipophilic hormones, oestrogen and progesterone.

ESTROGEN:

maintains female reproductive system and development of the secondary sexual characters in female such as breast development, fat distribution in hips, legs and breast, armpit and pubic hairs and menarch (start of menstrual cycle). Low levels of oestrogen cause mood swings, depression, headaches, irregular periods and sleep problems.

PROGESTERONE:

Progesterone is primarily involved in the preparation and maintenance of the uterus which supports the growth and development of an embryo. Thus, it helps in regulating menstruation and maintaining pregnancy.

8. PINEAL GLAND:

It is a tiny, cone-shaped body behind the third ventricle of the brain. It secretes **melatonin** which has various functions, most important of which is to help modulate sleep patterns. Its production is stimulated by darkness and inhibited by light.

OTHER ENDOCRINE TISSUES:

i. HORMONES OF DIGESTIVE TRACT:

- **GASTRIN:**
  It is a peptide hormone. It stimulates mucosal growth, gastric motility and secretion of HCl in stomach.
- **SECRETIN:**
  It is a peptide hormone, produced by the wall of duodenum. It stimulates the release of bicarbonate and water from the pancreas to neutralize the acidity in the duodenum.
- **CHOLECYSTOKININ:**
  It is also a peptide hormone, produced by the walls of duodenum. It stimulates the contraction of gall bladder and release of digestive enzymes from the pancreas.

ii. HORMONES OF KIDNEY:

- **ANGIOTENSIN:**
  It regulates blood pressure.
- **ERYTHROPOIETIN:**
  It stimulates the production of RBCs in the bone marrow.

iii. HORMONES OF HEART:

- **ATRIAL NATRIURETIC HORMONE:**
  It stimulates the excretion of salt and water from the kidneys to reduce blood pressure.

iv. PROSTAGLANDINS:

The prostaglandins are a group of lipids, made at the sites of tissue damage or infection that are involved in dealing with injury and illness. They control processes such as

inflammation, blood flow, formation of blood clots and the induction of labour.

v. HORMONES OF PLACENTA:

- **HUMAN CHORIONIC GONADOTROPIN (HCG):** It is also known as the pregnancy hormone, because it supports the development of the foetus.
- **PROGESTERONE:** It helps in regulating menstruation and maintaining pregnancy.

FEEDBACK MECHANISM:

Chemical co-ordination is regulated by feedback mechanism. Feedback mechanism is the check and balance mechanism, through which homeostasis is carried out in the body.

TYPES OF FEEDBACK MECHANISMS:

There are two mechanisms to maintain blood hormonal levels i.e., negative and positive feedbacks.

vi. NEGATIVE FEEDBACK: It refers to the opposite effect produced in relation to any change in the body fluids. e.g.: eating rich sugary food causes raised glucose level in the blood. It triggers the mechanism, which decreases the blood glucose back to normal limit.

vii. POSITIVE FEEDBACK:

It refers to the series of similar effects produced in relation to the change in the body fluids. E.g.: during childbirth, oxytocin is released from posterior lobe of pituitary gland. It stimulates the contraction of uterus. The uterine contractions cause further release of oxytocin. Similarly, during breastfeeding, oxytocin is released which stimulates the release of milk. The milk ejection stimulates further release of oxytocin.

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BIOLOGY

CHAPTER # 19

ANIMAL BEHAVIOUR

2023-24

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ANIMAL BEHAVIOUR 19

KEY UNITS

- THE NATURE OF BEHAVIOUR
- INNATE BEHAVIOUR
- LEARNING BEHAVIOUR
- SOCIAL BEHAVIOUR

Fig. 19.1

INTRODUCTION:

The Living organisms have the capacity to response against any change in the environment. The response must be adoptive to survive and reproduce. It is the behaviour of an organism which changes in response to any stimulus. Stimulus is anything which brings about change. The origin of stimulus may be outside or inside an organism. The behaviour of an organism is inherited but it can be modified with the passage of time and experience.

Definition:

Behaviour is defined as the aggregates of responses for some stimuli for a given situation over a period of time.

THE NATURE OF BEHAVIOUR:

Behaviour of Organism in response to stimuli.

What an organism does, and how it acts, is collectively known as behaviour. The response of an organism against any stimulus varies from very simple to more complex one. Like responding the aroma of food is a simple response whereas fixed action pattern is a complex behaviour.

The study of behaviour in animals is called ***Ethology***. (Gr. ethiologica meaning depicting)

Fig. 19.2

Relation between Stimulus and Behaviour:

The stimulus brings any detectable change which may be physical or chemical. It must have occurred within environment and enables an organism to response. The body is covered with numerous receptors which detect any change in the surrounding and change it into nerve impulse which will analyze by integrator or sensory organs and then the decision is made weather to respond the signals or it may be ignored.

Interpretations and Response to Stimuli:

The receptors detect any change inside or outside the body. They send message to the CNS through sensory nerve.CNS also known as integrator can receive, gather and analyze the messages.CNS give orders to the effectors through motor nerve.

For example, Reflex action.

Different Ways to Response Stimuli:

The living organism may response to any stimulus in three ways. It can be positive, negative or ignored. In a ***positive*** response your pet become happy to see the meal. In a ***negative*** response pigeons close their eyes to see a threat. A child ***ignores*** you if you show anger on his/her any action.

Fig. 19.3

Relation between Heredity and Behaviour:

The nervous and chemical response can influence the behaviour of an organism. Actually, genes are responsible for any behavioral response because genes develop nervous system. Behaviour is also depended upon secretions of various hormones which are made up of proteins. Proteins are made up of amino acid which is coded by genes.

The animals can exhibit various types of behaviour due to variations in their genes. Artificial selection brings various genes due to selective interbreeding which have different response to a same stimulus. e.g. Dogs, Pigeons, Parrots etc.

Fig. 19.4

BIOLOGICAL RYTHMS:

Bio-rhythm are the physiological frequent pattern of aggregate activities, in an organism against the episodic changes which occur in the environment.

In a living system, the mechanism, which controls the physiological activities internally, without the influence of external signal, is called ***Biological Clock.***

If a bio-rhythm appears repeatedly for a specific period of day or 24 hours called ***Circadian Rhythms.*** Some animals have annual rhythms or ***Circannual Rhythms*** like migration of bird, hibernation and matting.

- Either their timing is controlled externally (Exogenous rhythms) or there is internal timing (Endogenous rhythms). Exogenous rhythms are controlled by external changes, such as 24 hours cycle of day and night.
- Endogenous rhythms are controlled by biochemical and physiological changes, within the organisms. In a number of organisms, it seems a blend of both exogenous and endogenous rhythms. Some examples of rhythms are given below.

Those living organisms which are active during daylight are classified as ***Diurnal*** animals. Animals hunt, graze or feed during daylight and fall asleep at night. Their eye-sights are better in daylight. Sunlight plays a vital role to drive these animals about their routine. *For example:* Butterflies, bird and mammals, including man.

Those living organisms which are active at night are called *Nocturnal* animals. They search for their food in the dark. Their eyes are usually large and unable to watch clearly in bright light. They are not dependent upon sunlight for their routine. *For example:* Cockroach, Owls, Bats etc.

Those living organisms, which are active throughout the day, are grouped as *Crepuscular* animals. They are active in early morning (Dawn) or in early evening (Dusk). They can utilize both types of light i.e. bright and dull more efficiently. *For example:* Mosquito.

Fig. 19.5

TYPES OF BEHAVIOUR:

Nearly all the behaviours, we observe in animals, are adaptive. Animal behaviour can be explained in two ways:

I) INNATE (INSTINCT) BEHAVIOUR
II) LEARNING BEAVIOUR
III) SOCIAL BEHAVIOUR

(I) INNATE BEHAVIOUR:

Innate behaviour involves automatic pre-programmed, genetically determined, stereotype activities which do not involve any learning. A fish has inherited power of

swimming by birth. A bird has inherited a power of flying, these are examples of innate behaviour.

Fig. 19.6

There are two types of innate behaviour:

A) ORIENTATION BEHAVIOUR
B) NON-ORIENTATION BEHAVIOUR

A) ORIENTATION BEHAVIOUR:

In this kind of behaviour, an organism shows movement and changes its direction in response to a source of stimuli.

It has following two types:

a. KINESIS b. TAXIS

a. Kinesis:

This behaviour is related to the direction of stimulus. It may be towards or away from the stimulus. The movement towards the stimulus is called positive taxis while the one away from the stimulus is called negative taxis. A moth moves towards light. This is positive phototaxis. It may be phototaxis in response of light, chemotaxis in response to chemical, hydro taxis due to water or thigmotaxis due to touch.

Fig. 19.6a

b. Taxis:

In this behaviour, an organism changes the speed of random movements which help them to survive in the environment. It is a type of orientation movement. The rate of movement is dependent upon the intensity of movement. e.g. wood-lice move about quickly in dry conditions but slow down and stop in humid areas.

B) NON-ORIENTATION BEHAVIOUR

In this type of behaviour, as a result of any stimulus, animals do not show movement in a particular direction. On the basis of complexity, these behaviours are more profound than orientation behaviour.The common types are reflexes, instincts and motivations etc.

a) REFLEXES:

It is the simplest type of behaviour. It is the movement of body parts, such as knee-jerks, blinking of eyes, and withdrawal of hand from a hot object. These are stereotyped, short-lived, rapid responses, mediated by nervous system. During knee jerk, the spinal cord stimulates and through motor nerve, contracts extensor muscles which result in kicking action. Sometimes, the whole body of an animal is involved in reflex action. This type of reflex action is exhibited by invertebrates (worms, snails etc.). This will happen when a nerve fibre carries a very fast message to all muscles, as a result, they contract rapidly and instantaneously.

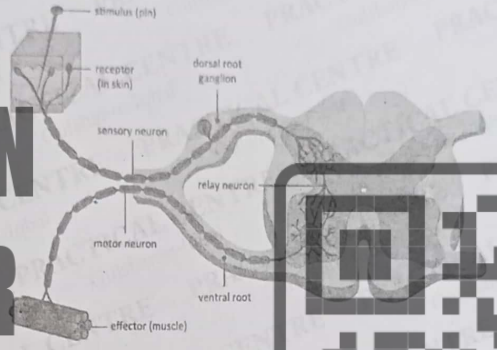

Fig. 19.7

b) INSTINCTIVE BEHAVIOUR:

It is a kind of innate behaviour which belongs to non-orientation behaviour. It is a built-in and stereotype-inherited behaviour pattern, which is not modified by learning or practice. In this behaviour, the whole body of the animal is involved and shows its own characters.

It is stereotype, genetically programmed complex behaviour which evolves gradually and develops side by side with the development of nervous system. It is also called fixed action pattern.

Following are the types of instinctive behaviour:

i. Migration of Salmon fish:

Migration of salmon is tremendous. Salmons are born in fresh water. Female deposits her eggs in fresh water and male sheds his sperms on her eggs which is called *Spawning*. When eggs are hatched, the young spend their early life in fresh water then they move to deep oceans, thousands of miles away. Here, they feed and grow for six months to seven years. After two or three years, salmon transforms into *Smolt* (sexually mature).

During breeding season, these smolts stop feeding and move towards the fresh water spring where they were born. The journey starts from oceanic feeding ground to hundreds of miles away from their spawning grounds where they hatched.

This will risk their life with exhaustion or by predation, only a small group can reach there. This migration is a good example of instinct behaviour.

ii. Dances of Bee:

Honeybees shows very interesting behaviour of communication system to convey signals to other bees to indicate distance and direction of food. Bees (scout) give information to other bees from the hive about the nectar.

The bees perform two types of dance:

- Round Dance
- Waggle Dance.

If the source of food is within 90 metres from the hive, the bees perform round dance. If a source is beyond 90 m, the bees perform waggle dance.

This will indicate the proper direction and distance. The dance may be repeated several times and the sun serves as compass.

This type of communication is the best example of innate behaviour.

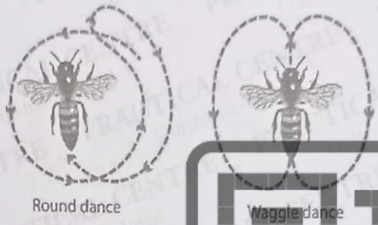

Fig. 19.8

iii. Nest Building:

This behaviour is also categorized in Innate behaviour. Different birds have different strategies to build their nest. For instance a long tailed tailor-bird builds a nest for its mate to lay eggs. Its nest is between the leaves and twigs of the plant and hangs on the soft branches. The tailor bird does not learn nesting from older birds and has no prior experience. It builds nest by its innate behaviour.

iv. Building of Spider's orb web:

The circular or orb web by common spider is a very common web. It is made up of silk thread which is secreted by special silk glands which are present in the abdomen of the spider. The silk is made up of sceroprotein which become hard on exposure to air.

Spider follows a main rule and then the sub rules. By following the program of primary rule, the spider can build a web without having a plan for it. It the example of highly complex instinct behaviour.

v. Courtship behaviour of Stickleback fish:

This behaviour is triggered or released by an external sensory stimulus known as sign stimulus or releaser. The example is found in male three spined stickleback fish which develop on sexual maturity-bright throat and red belly called nuptial coloration. When the breeding season starts the territorial male builds a nest.

Male become aggressive and dominant to protect its nest from other males and attacks other males that enter his territory. But when a female with silver belly enters, the male welcomes it and stimulates spawning by pods the base of her tail. After spawning, the

female leaves the nest but the male enters the nest and fertilize them. The male stays close to the nest to protect, fan and look after the newly hatched fish. This behaviour also shows innate behaviour without prior experience.

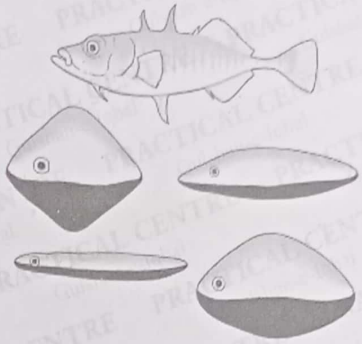

Fig. 19.9

(II) LEARNING BEHAVIOUR:

Learning behaviour is the modification of behaviour by previous experience. Learning behaviour is an acquired behaviour that is brought about by training or practice which has to be repeated over and over, until behaviour is learned, or acquired permanently.

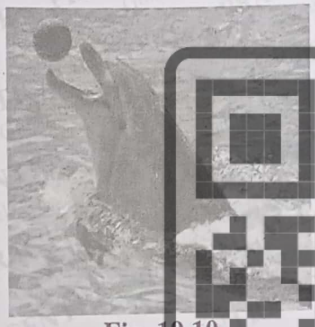

Fig. 19.10

Following are the main types of learning behaviour.

i. Habituation
ii. Imprinting
iii. Conditioning (Classic conditioning)
iv. Trial And Error (Operant conditioning)
v. Latent Learning
vi. Insight Learning

(i) Habituation:

Habitation is the simplest kind of learning. In this type of behaviour, the animal stops responding to a repeated stimulus, which is neither beneficial nor harmful. Birds feeding along the road, or perched on pole, or a tree along a busy highway, ignore the speedy cars. They became habitual and they even feed in the middle of highway.

This habituation is significant and saves energy and time.

(ii)Imprinting:

In 1930,Konrad discovered this behaviour. Imprinting occurs during early stage of life of birds and mammals. Konrad studied that ducklings follow the first large, noisy, moving object they see after hatching, thereafter, they will continue to follow the object even if their true mother is not there.

Fig. 19.11

(iii) Classic Condition:

This type of behaviour is associated with some reward or punishment. Ivan Pavlov, in 1902,performed an experiment, using a dog. He showed food to a hungry dog at a particular time with a bell ring. The mouth of the dog started salivation. After some period, he stopped the food but on ringing a bell alone, the dog's mouth started salivation. The response of salivation was first associated with food but now it was associated with bell. A new stimulus which had a meaning for the dog.

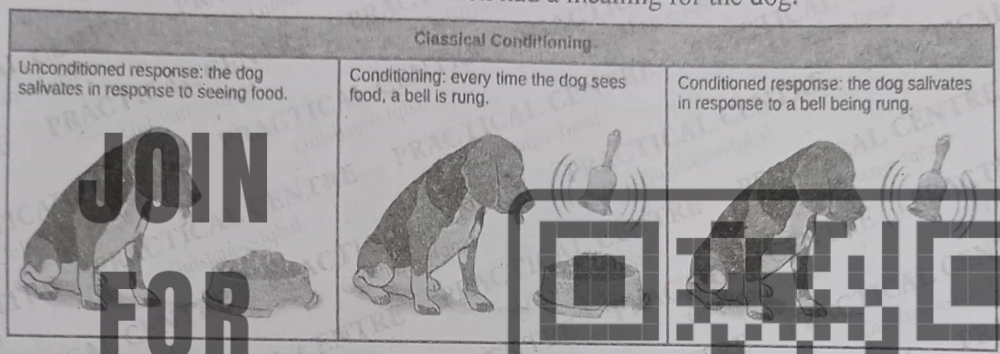

Fig. 19.12

(iv) Operant Condition (Trial and error):

In this kind of behaviour, the animal learns something by an award or punishment. An American psychologist, B.F. Skinner, developed a Skinner box for his experiments with hungry pigeons or mice on conditioning. Inside the box, there was a lever with operated food supply. When the lever was pressed by the animal, a sample of food was delivered. After several accidents of pressing the lever, the hungry animals learned to press the lever at the time of their hunger.

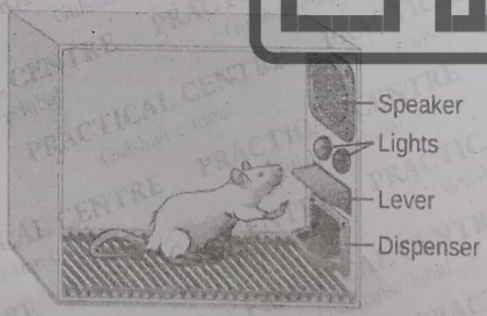

Fig. 19.13

(v) Latent Learning:

This type of learning is not associated with some reward or punishment. The ability of rats to find their way in underground tunnels is very remarkable. If a rat is placed in a maze, it runs and keeps on wandering to find the end without being awarded. This type of learning is useful when a predator persues them. Only then, the rats make use of their latent learning.

(vi) Insight Learning:

Insight learning is the highest form of learning. In this case, the animal shows its behaviour according to situation. Chimpanzees have to develop this highest degree of insight learning. According to Kohler, chimpanzees can use devices to get bananas or apples which are out of their reach. Chimpanzees will pile up boxes or use a pole or sometimes, two chimpanzees may also co-operate with each other to achieve the goal.

Fig. 19.14

III. SOCIAL LEARNING:

The interaction between two or more individuals which belong to the same species and live together is called Social behaviour. This gives many benefits to the animals like avoiding predators, finding food and looking after their offsprings. This type of learning can be modified and may vary from species to species.

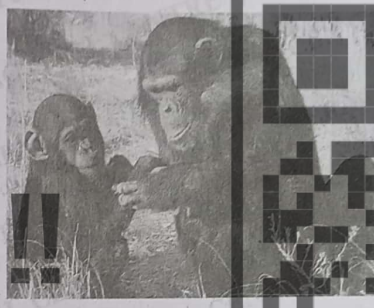

Fig. 19.15

Aggregation:

It is considered as a simple group of animals which live together due to feeding, drinking and mating. They have limited interaction and do not interact socially in behaviour. For example, a group of various species of birds, a school of fish etc.

Animal Society:

Living organisms which belong to the same species live together and have cooperative social relationship. This is called social group and Society. They exhibit social or mutual behaviour.

They have permanent and long lasting association. Each individual exchanges food, water, body care and sexual favour.

Fig. 19.16

Hostile and Helpful Interspecific Interaction:

In many social insects, hostile and helpful interactions are observed side by side. The best example is seen in honey bees. In their hive, there are three castes of honeybees i.e. workers, drones and queen. It looks hostile when a worker is getting old, her coworker killed her. But it is helpful that every caste works together, for instance, workers collect the nectar and made honey, drones protect the hive and fertilize the eggs and queen lays the eggs.

Agonistic Behaviour:

In the animal world, due to limited resources, animals are usually involved in conflicts due to limited resources of food, mates or territory. These conflicts are solved by the *Agonistic behaviour*. In this behaviour, one animal attacks other animal or becomes aggressive including threats and sometimes combat to determine the right of mating or access to resources. Sometimes, male indicates signals to warn other competitors. Agonistic behaviour decides the territory and dominant hierarchy.

Territory:

A territory is defined as a confined area which an animal reserves for feeding, mating and raising young ones. This area is established by agonistic behaviour by a male to avoid interference or competition from other males.

Once the territory marked by various methods like pug marks, scratching, pee or dung etc. other animals will not enter into it. If they enter, it will be taken as a declared war against the territory male.

Types of Territorial Behaviour:

Animals from insects to worm or fish or birds to mammals show very aggressive behaviour regarding their territory.

Following are some examples of territorial behaviour in various animals:

a. Territorial Behaviour in Gorillas:

Gorilla is non territorial social mammal lives in a group commonly called as troop. A troop may have 1 to 4 old and strong male called silverback. Some juvenile male, are also present called black back. And several adult and immature females.

The silverback is a dominant alpha male of a troop who makes all troops decisions and gef larger. He has the right for mate. Silverback is more aggressive than other troops members because the safety of troop is his responsibility. He exhibits aggressive territorial behaviour by standing on his two legs and beat profoundly his chest address the threat.

The adolescent female transfer from other troop into new troop before reproducing age which is 8 years in gorillas can get her rank on the basis of her recruitment order in her new troop. Late arrivals are not supposed to get the benefits of high-ranking females.

On the other hand, adolescent male departs from their families remain alone until they form their own family.

Fig. 19.17

b. Territorial Behaviour in Baboons:

Baboons are dimorphic i.e. their males are larger than their females. Males are territorial and aggressive. They frighten other by showing their large sharp canines. Baboons travel throughout the day for food and rest on trees. The alpha male guides the troop to the feeding ground, water holes and safer trees for rest.

In baboon family, to be a dominant, is not an easy task. It is the responsibility of dominant male to fight predators and invaders which may cause severe injury or death. In baboon, vocalization and displays is enough to defend a territory instead of fighting.

Dominance Hierarchy:

It is defined as the situation in which the animal determines a rank which decides the access to resources like food, mating and grooming services for other members of a social family.Individuals on top of hierarchy have the right for mating, excess food and safe territories.This behaviour takes place due to the exhibition of aggressive behaviour and due to the response to aggression.

Fig. 19.18

i. Pecking Orders of Chicken:

Dominance hierarchy can be observed in chickens as a good example.

When several unfamiliar hens are placed together, they response by chasing, fighting and pecking among themselves until there is established a prominent pecking order. The alpha hen has the right to access resources first like food, water and roosting sites. The alpha hen usually drives off all the other hens by threats instead of actual pecking. The beta or second rank hen reduces all other hens except alpha hen and gradually lower down the rank to the omega. Once the hierarchy is set, a peaceful co-existence is possible.

Fig. 19.19

Altruism:

In animal world, many social behaviours are selfish in which they behave for their own benefit. This kind of behaviour increases the rate of survival and success of reproductive outcome at the expense of others. On the other hand, this type of behaviour is performed by animals without showing self-interest. Animals withdraw their own reproductive potential to rewards other animals. In social animals like insects, the reproduction is confined to only one pair i.e. the queen and her mate.

Altruism in the Organization of Honey Bee:

Honeybees are social insect which live together in a colony or group in an organized manner. The colony has three types of bees castes i.e. the queen, the workers and the drones.

The queen lays fertilized and unfertilized eggs which develop into other bees. New queen develops from fertilized egg. The larva of the queen feed upon special food called Royal jelly.

Both old and new queen simultaneously develop in the same hive for a short time.

Sometimes, the emerging queen may be killed by the other members of hive and the business will run as usual. Or the emerging queen may create a group called swarm and leave the hive to establish a new hive.

On the other hand, sometimes the old queen moves from her hive with her swarm and develops a new hive or may killed, lost or removed and the new queen becomes the owner of hive.

The drones are male bees which develop from unfertilized egg and their function is to fertilize the unfertilized eggs of queen. The mating take place during flight. Drones die just after mating. The workers are sterile females developed from fertilizes eggs. Workers are in abundance but smaller in size. The workers can do all the duties like cleaning hive, formation of beeswax, forage for hive, care and protection for the queen and hive. Although the workers spend their lives in serving and feeding other members of hive, they are sterile.

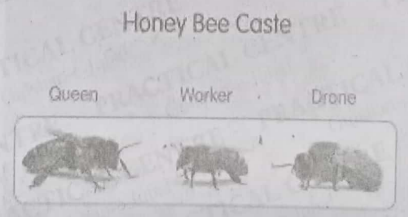

Fig. 19.20

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CHAPTER # 20

REPRODUCTION

2023-24

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REPRODUCTION

20

Major Concept:

(1) Human Reproductive system
(2) Disorders of Reproductive system
(3) Sexually Transmitted Diseases

REPRODUCTION:

Definition:

Reproduction is a biological phenomenon in which the living organism can produce its own kind for the continuity of its race.

Type of reproduction:

Reproduction can be divided into two types:
(1) Asexual reproduction (2) Sexual reproduction.

(1) Asexul Reproduction:

In Asexual reproduction, the gametes or sex cells are not involved. The new individuals are produced by somatic cells of the body. In asexual reproduction, only one parent is required and the new individuals have the same genetic information as the parent. Asexual reproduction may take place by various methods, like (a) Fission (b) Budding (c) Regeneration (d) Parthenogenesis (e) Cloning (f) Plasmatomy (g) Twins etc. Generally the asexual reproduction takes place in lower forms of animals.

(2) Sexual Reproduction:

Sexual reproduction is a process, in which the gametes, germs cells or sex cells are involved like sperms and ova which fuse to form zygote, which leads to an embryo and the embryo changes into an adult. This is called sexual reproduction, by which individuals are produced, having different genetic materials as compared to their signal parent and show variation and variety in their race; sexual reproduction generally takes place in higher forms of animals and humans. In sexual reproduction, various steps are involved like gametogenesis, mating, fertilization, embryonic development, hatching and birth etc. All these steps are regulated by means of hormones, cellular differentiation etc.

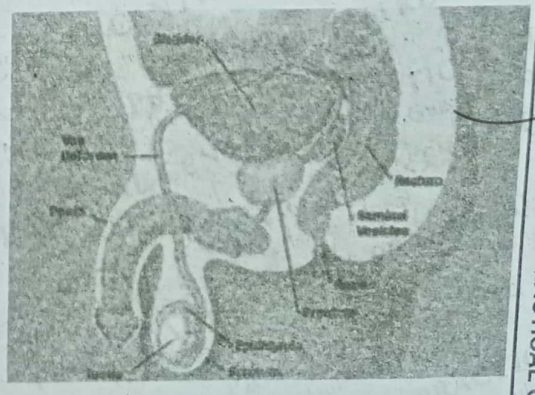
Human Reproductive system:

The human reproductive system is a complex network of organs and tissues which work together to perform such process.

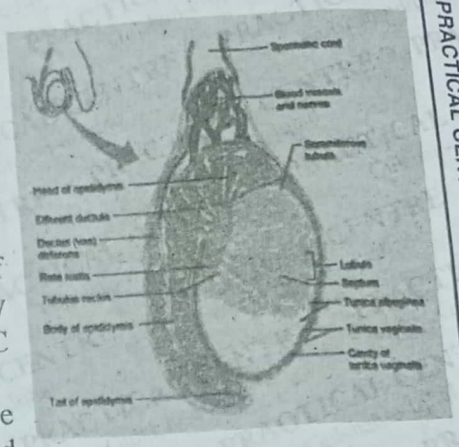
Humans are uni sexual or dioecious or hetrophrodite in nature i.e. the male and female are found in separate sets of the body, the male having male reproductive organs like testes and the female having a pair of ovaries; the male produces sperms and the female produces ova (egg) which fuse to form the zygote and the female supports the development of embryo during pregnancy.

Male Reproductive system:

The human male reproductive system is composed of internal and external genitalia. The internal genitalia include a pair of testes (gonads), some accessory organs which produce some kind of secretion, store sperms for some time and also nourish the sperms whereas the external genitalia include the scrotum and male copulatory apparatus called penis.



The Male Gonads or Testes:



(1) The testes are male reproductive organs which are developed inside the abdomen in early stage of development but they come out from the body and remain hanging in a muscular pouch, called scrotum.

(2) The testes require low temperature for their best function.

(3) Generally, about 34°C is best for proper function of testes so they come out from the inside of the body to outside, the normal body temperature is 37°C which is not suitable for the function of testes.

(4) The testes are generally rounded or oval in shape which are developed by mesoderms of embryo and composed of tightly packet tubules, called seminiferous tubules.

(5) About 500 seminiferous tubules are found in each testes.

(6) By the walls of tubules the sperms are produced.

(7) The sperm-producing cells in the tubules are known as sertoli cells which are responsible for the production of sperms.

(8) The production of sperms takes place by means of a process called spermatogenesis.

(9) The testes are involved in the production of sperms as well as the production of male reproductive hormone, called testosterone.

Accessory ducts:

(1) The sperms produced in the testes get transferred in tube-like structure, called epididymis.

(2) The epididymis and testes are interconnected by network of fine tubules called vasa efferentia.

(3) The epididymis is about 6 meters long and found around the testes.

(4) The sperms get stored for some time in epididymis and pass maturation division before entering vas deferens.

(5) The vas deferens is a thick-walled tube in which the sperms get stored for some time before ejaculation.

(6) Each vas deferens has a swollen part called ampulla, in which the sperms are stored and it acts as a reservoir.

(7) The secretions are produced by seminal vesicle and prostate gland in which the sperms get mixed to form a fluid-like structure called semen.

(8) The semen provides fluid medium for the movement of sperms, it also provides nourishment to sperms and it neutralizes the acidic condition of the urethra which is developed after urination.

(9) The sperm, in the form of semen, is transferred in the urethra which is a common passage for urine and sperms.

(10) The urethra opens outside by means of an aperture, called urino-genital aperture.

External Genitalia:

The external genitalia include a muscular penis and scrotum.

Penis:

(1) The penis is the male copulatory apparatus which deposits sperm inside the female genital tract.
(2) The penis is composed of a head region, called glans or tip.
(3) The glans is a sensitive part of penis which contains the opening of urethra.
(4) Generally, in males, it is covered by a fold of skin, called the foreskin.
(5) The penis has a shaft region which contains erectile tissues called corpus cavernosum.
(6) The penis is attached to the body by means of root in the pelvis area.

Scrotum:

(1) The scrotum is a muscular pouch in which testes remain hanging.
(2) The scrotum is found in between the thighs.
(3) The scrotum maintains low temperature for functioning of testes.

The Male Accessory Glands:

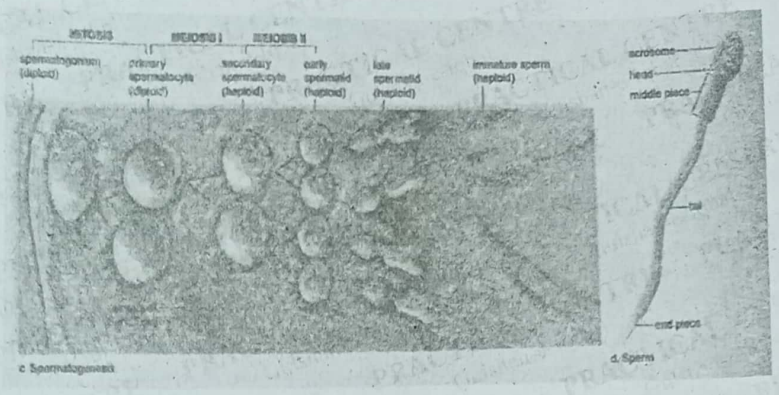
(1) The Male accessory glands are (a) prostate gland (b) cowpiers gland (bulbo-urethral gland) (c) seminal vesicle; these glands secrete some kind of secretion in which the sperm gets mixed, it provides nourishment, movement to sperm and neutralizes the acidic effect of urine developed in the urethera after urination in both male and female genital tract, the secretion along with sperms is known as semen, which is a creamy white paste-like structure.

Organ	Function
Testes	Produce sperm and sex hormones
Epididymides	Sites of maturation and some storage of sperm
Vasa deferentia	Conducts and stores sperm
Seminal vesicles	Add fluid to semen
Prostate gland	Adds fluid to semen
Urethra	Conducts sperm (and urine)
Bulbo-urethral gland	Adds fluid to semen

Spermatogenesis:

- Spermatogenesis is a biological phenomenon in which the formation of sperm by means of male gonads takes place.
- The production of sperm takes place by seminiferous tubules of testes.
- The sperm's mother cells are known as spermatogonia which continuously divide to produce a large number of daughter cells by means of mitosis.
- The cells of spermatogonia get enlarged and are called primary spermatocytes.
- The primary spermatocytes get divided by means of meiosis.
- The primary spermatocytes divide to produce secondary spermatocytes during phase – I of meiosis.
- The secondary spermatocytes have half the number of chromosomes (n).
- The secondary spermatocytes get divided to produce spermatids by Phase-II of meiosis.
- The spermatids get changed into mature sperms called spermatozoans.
- Each sperm, having four parts, is called acron (acrosome), head, neck and tail.
- The acron produces the enzyme and gets penetrated in the ova by making an aperture in the egg membrane.

- The head having the nucleus, the neck region having some ATPs and the tail made up of flagella for movement.



Hormonal Control of Male Reproductive System:

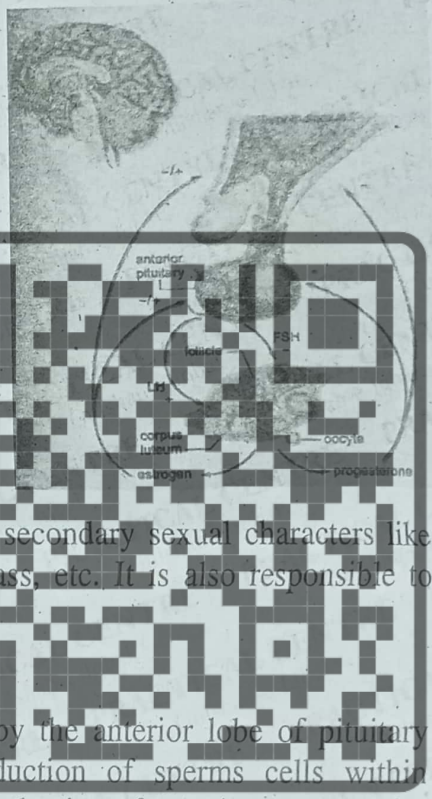
The male reproductive system is controlled by many hormones like:

(1) Testosterone

(2) Follicle stimulating hormone

(3) LH (Luteinizing Hormone)

(4) Gonadotropin hormone



Tesosterone:

The tesosterone is produced by testes which play important role in the development of male reproductive organs including testes, prostate gland, seminal vesicle, etc. It is responsible for controlling secondary sexual characters like development of hair on face, deep voice, muscle mass, etc. It is also responsible to stimulate the production of sperms.

Follicle-stimulating hormone:

The follicle-stimulating hormone is produced by the anterior lobe of pituitary gland. It affects the testes and promotes the production of sperms cells within seminiferous tubules of testes, it also stimulates the production of protein necessary for the production of sperm. The FSH hormones are also inhabited by peptile hormone, released from sertoli cells of testes.

LH (Luteinizing Hormone):

The luteinizing hormone is also released from anterior lobe of the pituitary gland and it affects the testes and stimulates the production of testosterone by leydigs cells, the testosterone is released in blood stream.

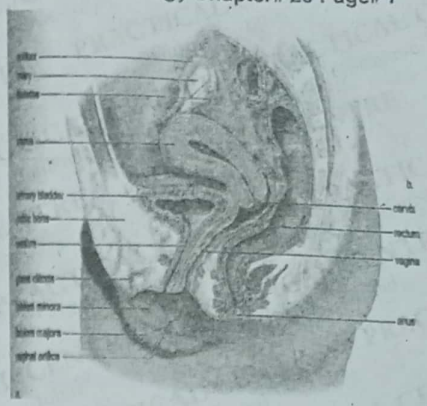
Gonadotropin hormone:

It is released from the hypothalamus and it affects the production of FSH and LH hormone by pituitary gland, it regulates negative feedback, as the level of tesosterone get decreased is stiumulate the production of gonadotropin hormone which affect the pituitary gland to release FSH and LH which affects the releasing of testosterone production, as the level rises, it inhabits the production of gonadotropin hormone which decreases the production of FSH and LH.

Female Reproductive System:

The Human Female reproductive system consists of the following parts like:

(1) A pair of Ovaries
(2) A pair of Oviducts
(3) Single muscular uterus
(4) Cervix / Neck
(5) Vagina
(6) Female genital aperture
(7) A pair of Labia Minor
(8) A pair of Labia Major



A Pair of Ovaries:

(1) The Ovaries are located in the lower abdominal cavity, one on either side of the abdominal region and remain attached to the body wall by means of mesentery.
(2) Each ovary is covered by tough protective capsule and contains large number of follicle cells.
(3) Each follicle cell has single ovum or egg cell which is surrounded by follicle cell.
(4) The egg cell is nourished by follicle cell.
(5) Each female ovary contains about 200,000 potential egg cells at the time of birth, but only 350 - 450 egg cells mature which came from the ovary into the oviduct for possible fertilization in the whole female life.
(6) After maturity of woman, one egg is released from the ovary into the oviduct every month and releasing of ova from ovary is alternate.
(7) The end of female reproductive cycle is known as menupause.
(8) The follicle cell of the ovary also secretes female reproductive hormone called oestrogen which controls female sexual behavior, secondary sexual characters, development of myometrium and also develops mammary glands.

A Pair of Oviducts / Fallopian tube:

(1) A pair of oviducts are found in the female reproductive system which receive ova from the ovary by ciliated funnel.
(2) The oviduct is a site for the fertilization of ova and the early development of embryo also takes place in the oviduct.
(3) The oviduct also carries ova from the ovary into the uterus for further development of embryo.
(4) The oviducts are provided with cilia which are directed toward the uterus for the transplantion of embryo in the uterus.
(5) Each oviduct is about 10cm long.

Single muscular uterus:

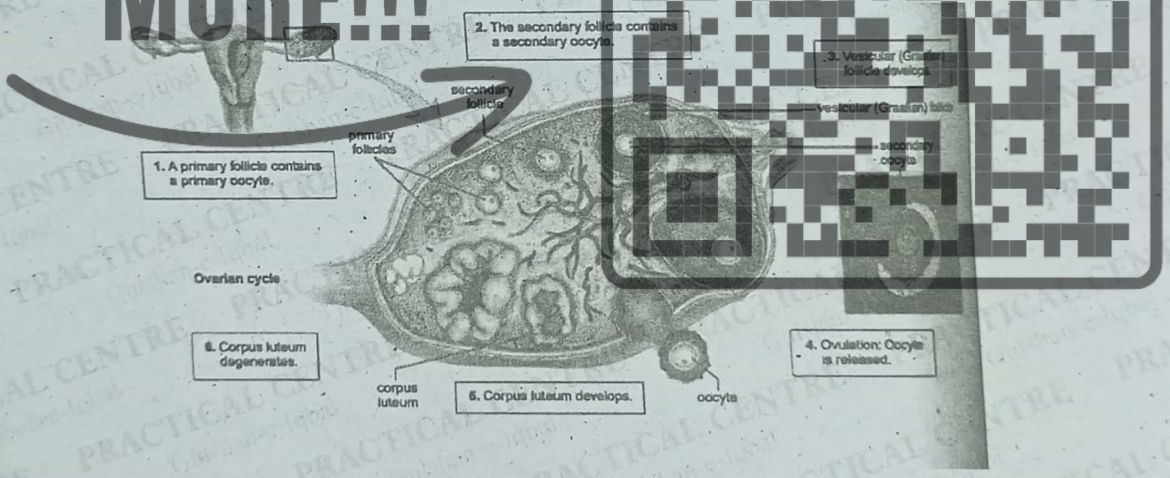
(1) The uterus is a muscular organ which is pear-shaped in structure and located in between the bladder and rectum.
(2) The uterus can be divided into three parts called fundus, body, and cervix.
(3) The body is the main part of uterus which starts just below the level of oviduct.
(4) The cervix is the extended part which is downward in direction and opens in the vagina.
(5) The uterus is composed of mayometrium, endometerium, and perimeterium.
(6) The endometerium is the innermost layer which is provided with rich blood vessels which contain blood.
(7) The mayometrium is the muscular and middle layer of uterus.
(8) The perimetrium is the outermost layer which covers the uterus.
(9) The cervix is a narrow opening, it provides passage between the vagina and uterus cavity.

Vagina: The vagina is a tube-like structure, which is utilized for the reception of sperms and delivery of embryo, so it is also known as birth canal.

Organ	Function
Ovaries	Produce egg and sex hormones
Oviducts (fallopian tubes)	Conduct egg; location of fertilization
Uterus (womb)	Houses developing embryo and fetus
Vagina	Receives sperm & serves as birth canal

The Ovarian Cycle:

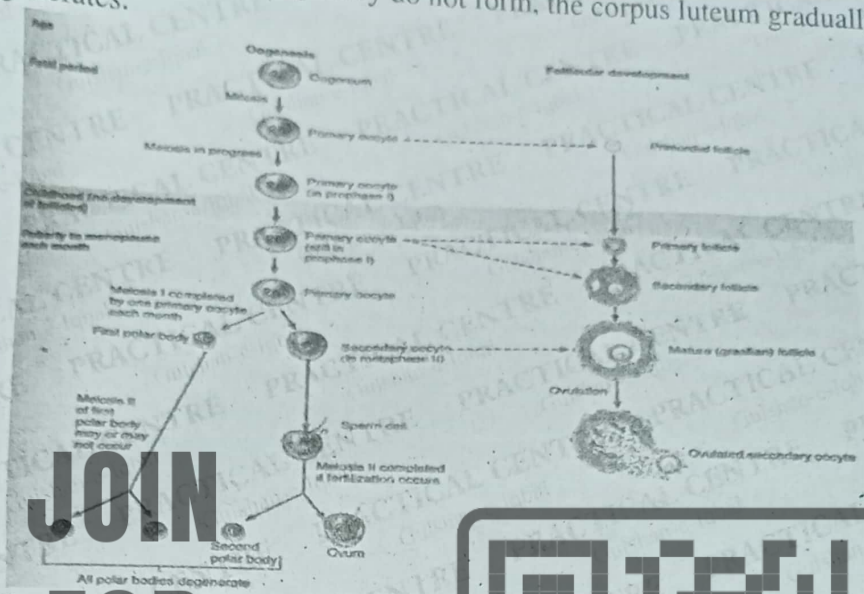
(1) The human female releases at least one ovum after every 28days of a month after maturity, the releasing from ova by ovary in cyclic mannar called ovarian cycle.
(2) The Ovarian cycle, found in human female, is different from the oesterous cycle, found in females, of mammals.
(3) The oesterous cycle appears once or two times in a year whereas the ovarian cycle is repeated after every 28 days of a month.
(4) As a result of oesterous cycle, two or more eggs are released from the ovary.
(5) As a result of ovarian cycle, at least one ovum is released from the ovary.
(6) During oesterous cycle, the female sexual behaviour gets changed and it is ready to be fertilized.
(7) During ovarian cycle, the female sexual behaviour does not change.
(8) During oesterous cycle some pheromones are released which attract the opposite partner.
(9) The ovarian cycle includes change of ovarian follicle to secondary follicle and then, finally, graafian follicle.
(10) The ovarian cycle is regulated by FSH and LH hormone of pituitary gland.
(12) The primary follicle cell contains primary Oocyte which is covered by epithelial cells.
(13) The secondary follicle is characterized by the presence of follicular fluid which surrounds the Oocyte; the graafial follicle is characterized by the presence of cavity which is filled with fluid.
(14) The graafian follicle gradually increases in size and finally protrudes out on the surface of the ovary.



Oogenesis:

(1) Oogenesis is a biological phenomenon in which the formation of ova from the ovary takes place.
(2) The formation of ova takes place by means of germs cells called Oogonia.
(3) The Oogonium divides by means of mitosis to produce large number of cells called Oogonia.
(4) The Oogonium gets enlarged in size to form primary Oocyte.
(5) The primary Oocyte gets divided by means of meiosis to produce secondary Oocyte and small polar body.
(6) The secondary Oocyte and polar body again divide to produce mature ovum and three polar bodies.
(7) The mature ovum is ready to be fertilized whereas the three polar bodies get degenerated.
(8) The mature ovum is released from the ovary and enters the oviduct for possible fertilization.

(9) The graafian follicle gets changed into another structure, called corpus luteum.
(10) The ovum contains 23 numbers of chromosomes and the sperm also contains 23 number of chromosomes. After the fusion of egg and sperm, the zygote is formed, which contains 46 numbers of chromosomes.
(11) If the fertilization and pregnancy do not form, the corpus luteum gradually degenerates.



The Uterine Cycle or Menstrual Cycle:

(1) The first sign of maturity of woman is the begining of menstrual cycle which starts at the age of 13 years and remains continuous upto late 50 years of age.
(2) The complete stoppage of menstrual cycle or reproductive cycle is known as meno pause.
(3) During menstrual cycle, the uterus is prepared for the implantation and the development of embryo.
(4) The menstrual cycle gets repeated after every 28 days of a month.
(5) At least one ovum gets matured and comes in the oviduct for possible fertilization in each menstrual cycle.
(6) The releasing of ova takes place by the ovary alternatively.
(7) The menstrual cycle is regulated by a number of hormones like oestrogen progesterone follicle stimulating hormone (FSH) and luteinizing hormone (LH).
(8) The menstrual cycle can be divided into the following four phases like menstruation phase, follicular phase, or proliferative phase, ovulation phase, corpus lutium phase.

Menstruation Phase (Day 1– Day 5):

(1) The menstruation phase is also known as M phase.
(2) The M phase is composed of about 5 days of a month.
(3) The blood comes out from the body on the first day and remains continuous up to day five called day first.
(4) During this phase, the inner lining of the uterus gets shaded off and the blood comes out from the inner walls of the uterus, called endometrium.
(5) The menstrual flow contains dead cells of uterus, dead ova and mucus with blood.
(6) The M phase gets started just after corpus Lutetium phase.
(7) During this phase, the progesterone is stopped and the body is aware that the fertilization of ova has not taken place and the pregnancy cannot occur.
(8) The menstrual flow comes out from the body through the vagina.

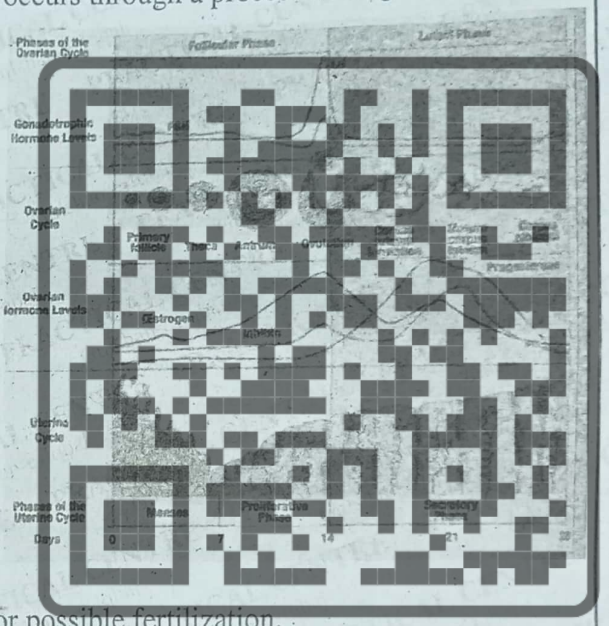
Follicular Phase, Or Proliferative Phase (Day 6 – Day 12):

(1) The follicular phase is also known as **F. phase.**
(2) The follicular phase gets started just after the M phase.

(3) The follicular phase gets started from day 6 and remains continuous upto day 12 of menstrual cycle.
(4) During this phase one or few follicle cells of the ovary get stimulated and start to develop ova.
(5) But, only one follicle cell remains alive to nourish the ova and the remaining cells get degenerated.
(6) During this phase, the anterior lobe of pituitary gland get started to release a hormone called FSH hormone, which affects the follicle cell to prepare ova.
(7) The degenerative follicle cells start to secrete another hormone called oestrogen, which affects the endometerium of uterus to increase blood vessels and flow of blood.
(8) The uterus become soft and spongy and prepares for possible implantation of embryo.
(9) Oestrogen also affects the development of mammary glands to produce milk.
(10) Oestrogen also controls the development of secondary sexual characters in women.
(11) Oestrogen controls female sexual behaviour.
(12) As the level of oestrogem gets increased in the blood, the secretion of FSH hormones gradually decreases and the LH hormone starts to be secreted by the pituitary gland.
(13) The formation of ova by follicle cells occurs through a process of Oogenesis.

Ovulation Phase (Day 13 – Day 15):

(1) The ovulation phase is also known as O phase.
(2) The ovulation phase is the shortest phase of menstrual cycle which is only composed of three days or less than five days.
(3) During this phase, the anterior lobe of pituitary gland secretes another hormone called luteinizing hormone (LH) which affects the mature follicle cell to release ova from the ovary into the oviduct.
(4) The mature follicle cell is also known as graafian follicle.
(5) The mature ova come in the oviduct for possible fertilization.
(6) The empty follicle cell gets changed into another structure, called corpus Luteum phase.



Corpus Lateum Phase (Day 16 – Day 28):

(1) The corpus luteum phase is also known as Post-oviulatory phase.
(2) The corpus luteum phase is the longest phase of menstrual cycle which is composed of about 13 days of menstrual cycle.
(3) During this phase, the empty follicle cell gets changed into another structure by the deposition of fat, called corpus luteum.
(4) The corpus luteum secretes as another hormone, called progesterone.
(5) The progesterone affects the endometrium of uterus to increase the vascular lining and increase the flow of blood.

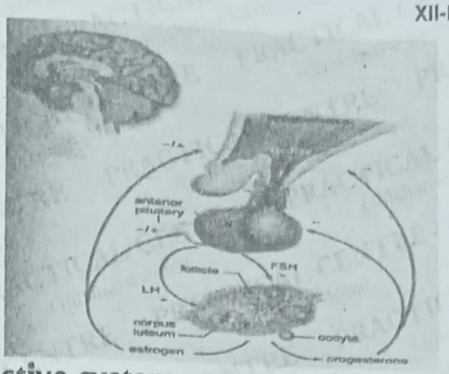
(6) In the endometrium of the uterus, some glands are developed which secrete nutrition for possible embryo.
(7) The progesterone also stops the next menstrual cycle in case of pregnancy.
(8) The progesterone helps in the implantation of embryo in the uterus.
(9) If fertilization does not take place, the corpus luteum gradually decreases and production of progesterone gets stopped.
(10) As a result of low level of progesterone, the inner lining of uterus gradually breaks which results in the release of blood from the walls of uterus which indicates the end of this phase and start of the next phase again, that is the new menstrual cycle gets started.

Fertilization and Pregnancy:

(1) As a result of fertilization, the embryo undergoes development and migrates from the oviduct towards the uterus.
(2) The embryo gets implanted in the walls of the uterus (endometrium) itself.
(3) The development of placenta take place by embryonic and mothers tissue.
(4) The placenta is the tissue connection between the mother and the developing child, by which the exchange of gases and exchange of nutrients take place between the mother and developing child.
(5) The corpus luteum, which is initially developed by the follicle cell, remains persistent by the hormone which is produced by the cells of placenta, called human chorionic gonadotropin hormone (HCG).
(6) The placenta also produces oestrogen and progesterone during late development of embryo.
(7) The oestrogen and progesterone have dual nature. They stop the activity of anterior lobe of pituitary gland for the development of new ova by follicle cell.
(8) It also maintains endometrium lining of the uterus and also eliminates the need of corpus luteum.
(9) During pregnancy, menstruation ceases to occur.

Oestrogen and Progesterone:

(1) The oestrogen and progesterone play an important role in the development of female reproductive system.
(2) The hormones control the development of secondary sexual character.
(3) The oestrogen develops female reproductive organs, hair and distribution of fat.
(4) The oestrogen also controls the development of mammary glands to produce milk.
(5) The hormone also helps in the deposition of fat under the skin within sub-cutaneous tissue, called adipose tissue, it also expands the pelvic girdle in the female.



Disorder of Reproductive system:

(1) A large number of disorders are found in the human reproductive system which can affect the functioning of both male and female reproductive systems which may lead to infertility, sexual dysfunction and other health problems.

(2) The disorder may be due to genetic, environmental or lifestyle or the age of the person.

Infertility:

(1) Infertility is a condition in which the person cannot conceive a child after regular mating in one year. It can affect both, male and female.

Causes of Male infertility:

(a) Abnormal sperm production and their function:

(1) The quantity, concentration and motility and morphology of sperm play an important role in the function of sperm, the amount of sperm is known as sperm count.

(2) The number of sperms (count) vary from person to person but less than 20 million is regarded as low sperm count, called oligo spermia.

(3) A common disease, called Azoospermia in which sperms are totally absent in ejaculation which may cause male infertility.

(b) Ejaculation disorder:

(1) It is a common condition, in which the semen enters the bladder instead of being expelled out or erectile dysfunction can result in infertility.

(c) Obstruction:

(1) The blockage in male reproductive tract, like the absence of vas deferens which may be congenital.

(2) It may be due to any infection.

(3) It may be due to surgeries which may prevent the transport of sperms.

(d) Life style factor:

(1) The lifestyles can affect male infertility, like excessive use of alcohol, smoking, use of drugs, obesity, exposure to environmental toxin or prolonged exposure to high temperature.

Causes of Female infertility:

(a) Ovulation disorder:

(1) The irregular or absent ovulation prevents the release of egg which is necessary for fertilization.

(2) The main cause may be hormonal imbalance, polycystic ovary syndrome (PCOS), thyroid disorder or premature ovarian failure.

(b) Oviduct Blockage (fallopian tube):

(1) The blockage of oviduct can stop the transport of egg and sperm due to which fertilization becomes impossible.

(2) The main cause is pelvic inflammatory disease, endometriosis, or pelvic surgeries.

(c) Uterine or cervical problem:

(1) The abnormality in uterus or cervix can stop the implantation of fertilized egg or it may block the passage for sperm. This may be due to uterine fibroids, polyps or cervical stenosis which can cause infertility in women.

(d) Endometriosis:

(1) It is a condition in which the lining of uterus grows outside the uterus which affects the ovaries, fallopian tubes and other pelvic organs.

(2) Endometriosis can cause imflammation, scaring and structural abnormalities which can cause infertility in women.

(e) Age related factor:

(1) The quality, and quantity of eggs get declined with the age of women and it causes problem in conception.

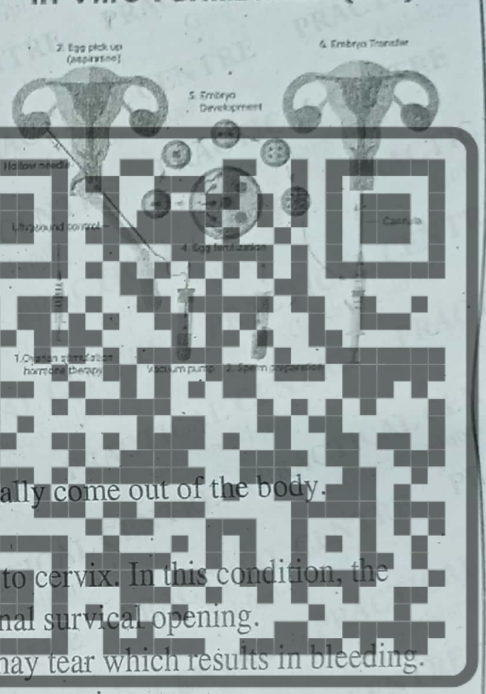
(2) The overage of mother is associated with high rate of infertility and pregnancy complication.

IVF in vitro fertilization:

(1) IVF is also known as test tube baby conception.

(2) In this procedure, the mature egg is taken out from the ovary of the woman and got fertilized by the sperm of the male in a test tube.

(3) After early development, the embryo is transferred in the uterus of mother for further development.



Miscarriage:

(1) A miscarriage is a loss of pregnancy before the 20th week of gestation.

(2) In this condition, the foetus stops to develop.

(3) The pregnant tissues (embryonic tissues) eventually come out of the body.

Causes of Miscarriage:

(1) The developing embryo may be at a place close to cervix. In this condition, the placenta may partially or entirely cross the internal survical opening.

(2) The area of placenta over the cervical opening may tear which results in bleeding.

(3) The uterus may extend as the embryo and placenta continue to grow.

(4) The haemorrhage caused by a normal position of placenta can cause it to separate from the uterine wall.

(5) The life of the mother is in danger due to miscarriage.

Miscarriage v/s Abortion:

(1) Miscarriage and abortion are totally different conditions.

(2) Miscarriage occurs due to a number of causes, including uterus or placenta or uterus issues.

(3) On the other hand, abortion is the deliberate termination of pregnancy.

(4) It may take place due to a number of reasons like unintended pregnancy or mother's and child's health issues.

Sexually transmitted diseases (STD):

(1) Sexually transmitted diseases are those which are transferred from one person to another person by sexual contact.

(2) The healthy person can acquire disease from the infected person during sexual intercourse.

(3) Some sexually transmitted diseases are as follows:

(1) Gonorrhea:

(a) Causative agent:

Gonorrhea is a sexually transmitted disease which is caused by a bacterium called Neisseria gonorrhoeae which affects both male and female genital tract and reproductive system.

Transmission:

(1) Gonorrhea is transmitted by sexual contact or by oral contact with infected person.
(2) Bacteria can infect the genital tract mouth, throat, and rectum.

Symptoms of gonorrhea:

(1) The common symptoms of gonorrhea are:
(i) Painful and burning sensation during and after urination.
(ii) Increased amount of discharge in females through vagina.
(iii) Pain and swelling in testicles of male.
(iv) Painful bowel movement and rectal itching.
(v) Sore throat and difficulty in swallowing.

Treatment of Gonorrhoea:

(1) Gonorrhea can be treated by prolonged use of antibiotics.

(1) Syphilis:

(a) Causative agent:

Syphilis is a sexually transmitted disease which is caused by a bacterium, called Treponema palladium, which affects various organs and system like the nervous system.

Transmission:

(1) Syphilis is transmitted by sexual contact through genital and oral contact.

Symptoms of syphilis:

(1) Syphilis proceeds through various distinct stages like:
(i) The first stage is characterized by the present of painless sore at infection site called chancre.
(ii) In the second stage, rashes alongwith-flu like symptoms develop.
(iii) The third or latent stage is symptom free but the infection can still be transmitted.
(iv) If syphilis is left untreated, it can progress to the tertiary or fourth stage which can cause severe complications which affect various organs like heart, brain,and bones.
(v) The neurological and cardio-vascular issues develop in the last stage of syphilis.

Treatment of Syphilis:

(1) Syphilis can be treated by prolonged use of antibiotics.
(2) The use of antibiotics depends upon the state and severity of infection.

AIDS:

(a) Causative agent:

The AIDs (Acquired immuno deficiency syndrome) is caused by a virus, called HIV(Human Immuno Deficiency Virus) which attacks the helper T cells, which is a type of lymphocyte.

Global Impact:

AIDs develops high impact on global scale, AIDs may become epidemic and millions of people have been infected by HIV, AIDs may be due to health care, education and resources, the Africans have particularly been affected by majority of HIV infection and AIDS related deaths, the AIDS may affect humans of all ages, gender and geographical locations.

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