B.Sc. ZOOLOGY

THIRD YEAR

PAPER – V : ANIMAL PHYSIOLOGY

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B.Sc. ZOOLOGY
SEMESTER V
CORE VI - ANIMAL PHYSIOLOGY

UNIT I

Nutrition – Food types, Vitamins and Minerals.

Enzymes – Classification, Mechanism of Enzyme action, Coenzymes, Digestion in man. Respiration – Respiratory pigments, transport of O and CO in man and Anaerobiosis. 2 2

UNIT II

Circulation - blood composition, origin and conduction of heart beat in man – blood pressure.

Excretion – Excretory products, Classification – structure of the mammalian kidney and urine formation.

UNIT III

Osmoregulation in Fishes, Osmoconfirmers, Osmoregulators.

Metabolism – Protein metabolism – Deamenation and Ornithine cycle, Carbohydrate – Glycogenesis, Glycolysis, Fat – β Oxidation.

UNIT IV

Nervous Coordination - Neuron, - Types – Conduction of nerve impulse - synaptic transmission – Neuro muscular junction - reflex action.

Effectors – Muscles - Types of muscles – ultra structure of skeletal muscle – Chemical composition and Physiology of Muscle contraction – Kymograph, actin and myosin.

UNIT V

Hormones – Endocrine glands Structure and functions : Pituitary, Thyroid, Islets f Langerhans, Adrenal, and Gonadial Hormone in man: Testis and Ovary.

REFERENCES:

1. Verma P.S. & Tyagi B.S. Animal Physiology, 6 edition. S.Chand & Co. Agarwal, V.K. Agarwal, R.A.Srivastava A.K. & Kausha Kumar, Animal physiology & Biochemistry, S. Chand & Co.,

2. Hoar, W.S (1987) General and Comparative physiology, prentice – Hall. M.K.Chanddrashekaran – Circadian Rhythms – Madras science foundation, Chennai.

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UNIT I

VITAMINS

The term 'vitamine' was introduced by Dr.Funk.

These are organic compounds.

The requirement of vitamins is small. But its deficiency leads to a variety of diseases. It act like hormones. Vitamins are essential to regulate the physiological activies in animals. They are thermolabile. At highly temperatures they are destroyed.

Classification of vitamins:

Based on their solubility in water and fat they are classified as water soluble vitamins and fat soluble vitamins. Vitamins A, D, E and are fat soluble vitamins. Vitamins B and C are water soluble vitamins.

FAT SOLUBLE VITAMINS

Vitamin. A:

It is otherwise called Retinol or Antixerophthalmic vitamin. It was discovered by me collum (1913).

It is in the form of Retinol and Retional2. Animals can synthesis vitamin A from carotene.

Sources:

Leafy vegetables, carrots, mangoes, yellow pumpkins, papayas, tomatoes etc., Besides these, the animal products that are rich in vitamin A are egg, milk, butter, fish – liver oil ghee etc.,

Functions:

- Promotes growth.
- It is an important component of retina.
- It is an essential for vision.
- It is essential for protein synthesis.
- It is essential for the maintenance of normal growth and shape of bones.
- It enhances fertility.
- Plays a vital role in carbohydrate metabolism and DNA.
- Essential for metabolism of DNA.

Deficiency:

Vitamin A deficiency leads to various diseases in children and adult.

- In children the deficiency leads to growth retardation.
- It causes night blindness or nyctalopia.
- It causes (reddening of eye, dryness and lusterless condition of eye) exophthalmia.
- Extreme conditions cause keratomalacia. (soft cofnea)
- It causes lachrymal gland degeneration and sweat and sebaceous gland degeneration.
- Over dose of vitamin A leads to hyper vitaminosis.
- It is characterized by drowsiness, sluggishness, severe head ache, etc.,

Vitamin D – Calciferol or Anti rachitic vitamin:

This vitamin was discovered by Mc collum (1922). It exists in five forms namely D1, D2, D3, D4, and D5. It is formed by the irradiation of sterols. So, it is a steroid compound.

Sources:

Fish liver oil, Butter, milk, egg, sunlight etc,

Functions:

- It plays an important role in the absorption of calcium and phosphate in the intestine.
- It is needed for calcium metabolism.
- Leads to normal development of bones and teeth.
- Helps for the deposition of calcium and phosphates in the bones.

Deficiency:

Vitamin D deficiency leads to the diseases namely Rickets, and osteomalacia.

Rickets:

The deficiency of vitamin D in children leads to a disease called Rickets. It occurs in children between the ages of 6-18 months. It is due to the laps of calcium absorption in bones. So, the bones seem to be soft. The leg bones bend to form bow legs. Joints become enlarged. The chest and pelvis bones are not property formed. Due to weakness of bone spinal curvature is seen. Delayed of dentition.

Osteomalacia:

In adults the vitamin D deficiency casuses osteomalacia.

Vitamin E (Tocopherol or Anisterility vitamin)

MATILL and CONCLIN (1920) discovered vitamin E. In male it is essential for fertility. In

female it is for the birth process. It exits in three forms namely α, β and γ to copherols.

Sources :

Wheat germ oils, cotton seed oil, egg yolk, milk, etc.,

Functions:

It is essential for the normal functioning of reproduction in rats. Normal functioning of musiles.

For the biosynthesis of coenzyme Q. It acts as an antioxidant.

Deficiency:

- In females the vitamin E deficiency leads to loss of ability to conceive.
- In males it causes degeneration of testis and permanent sterility.
- In rate and guinea pigs the deficiency leads to nutrition muscular dystrophy.
- In chicks embryonic mortality exudative diathesis and encpehalomalacia.
- In man it causes habitual abortion, muscular dystrophies, heart disorders etc.

Vitamin K (Antrihaemmorhagic vitamin)

Vitamin K was discovered by DAM (1935) It is essential for blood coagulation.

Sources:

Cabbage, spinach, tomato, Soya bean, liver, fish, milk, ghee, egg etc.,

Fuctions:

Essential for blood clotting. It participates in the synthesisi of prothrombin in the liver.

It participates in respiratory chair mechanism in mitochondria.

Deficiency:

Vitamin K deficiency leads to non-coagulation of blood. So, loss of blood occurs.

Water soluble vitamins

Vitamin B and C are water soluble vitamins. Vitamin B complex includes B1, B2, B6 and B12

Vitamin B1(thiamine)

It is isolated by Jansen and Donath (1952) and synthesized by Williams (1936) Source- outer germ and bran layers.

Functions:

It help in transferring the terminal phosphates form ATP to from thiamine pyrophosphate, which acts as a coenzyme in glycoly tic pathway and Krebs's cycle.

It activates carboxylases.

It activates the enzymes that are responsible for the synthesis of fats form carbohydrates and proteins.

Deficiency:

The deficiency of B1 leads to Beriberi. Due to Berberi. Oedema is found in legs.

- It causes loss of Appetite (anorexia).
- Accumuulation of pyruvic acid in blood, brain, cerpro-spinal fiuid and nerves.
- It leads to polynephritis.
- Enlargement and weakness of heart.
- Heart failure.
- Muscular atrophy etc,
- Gastric atony, indigestion and constipation. Tenderness of the feet and legs lameness and paralysis.

Vitamin B2 (Riboflavin)

Vitamin B2 was ioslated by Warburg (1932) and Christian. Sources-muscle, egg, grains, milk, liver, kindney, nuts, peas etc.,

Functions:

Riboflavin has the co-enzymes flavinmonoeotide (FMN) and flavin monomucleotide (FMN) and flavin adenine dinulotide (FAD). These two co- enzymes are essential for respiratory chain mechanism and several other enzyme systems.

Deficiency:

- B2 deficiency leads to the formation of fissures in lips and at the corner of mouth.
- Sore tongue
- Seborrheic dermatitis affecting the face, ears, nose and forehead.
- Avascularization of cornea.(photophobia & Keratitis)
- Dry, scaly skil.
- Retared growth.

Vitamin B3-(Pantothenic acid)

It was discovered by WILDIERS (1901) and isolated by Williams (1933) and synthesized by STILLER (1940)

Sources: yeast, liver, egg, peas, wheat, rice bran etc,.

Functions:

Essential for various basic metabolic reactions.

Deficiency:

In man, vitamin B3 deficiency leads to, burning feet syndrome. In other animals it causes,

Dermatitis,

Degeneratation of myelin, spinal cord, thymus etc,. It also causes gastrointestinal disturbances etc.,

Vitamin B5 (Nicotinic acid)

The presence of nicotinic acid in biological materials was first shown by Suzuki(1912)

It was isolated by VICEROY (1923) from yeast. Prior to these findings.

It was first obtained by Huber in 1807 from the alkaloid nicotine

Sources:

Bran, muscles, fish, barley, maize, nuts, yeast, beet etc,

Functions:

- Essential for growth.
- Promotes fat synthesis from carbohydrates
- It is formed in DPN and NADP, coenzyme
- Antipellagra vitamin
- Plays a vital role in oxidation and metabolism.

Deficiency

Deficiency of vitamin B5 causes pellagra. In dogs it causes black tongue.

The symptoms of pellagra are, dermatitis, diarrhoea and dementia, gastrointestinal disorders, swollen, glossy and beefy tongue, head ache etc.

Vitamin B6 (pyridoixine)

It was discovered by Gyorgy (1934)

Sources:

Yeast, leafy vegetables, germs of grains and cereals liver egg etc.,

Functions:

It causes acrodynia;anemia and convulsions Dermatitis. occurs in jaws, tail, nose, mouth and ears etc.,

Scaliness, loss of hair, retarded growth etc, are also some character that appear due to the deficiency of vitamin B6

Vitamin B7

It was discovered by Bateman (1916).

Sources-yeast, egg, milk etc,

Functions

- Act as coenzyme for carboxylation.
- It converts pyruvic acid into oxaloacetic acid.
- It participated in the synthesis of lipids and carbamyl phosphate.
- Prevents dermatitis in dogs and rats.

Deficiency:

Causes dermatitis in dogs & rats.

In man, it causes, Dermatitis of extre mities. Increase blood cholesterol level.

Shows symptoms like thiamin deficiency

Vitamin B9 (folic acid)

It was discovered by Day.

The main sources of vitamin B9 are – green leafy vegetables, liver, kidney and beef.

Functions:

Act as a coenzyme. Participate in RNA synthesis

Participate in the formation and maturation of RBC.

Deficiency:

Causes megaloblastic anemia during pregency

Vitamin B12 (cyanocobalamine)

It was first isolated from the liver by Smith and Parker. (1948) Sources liver, egg, meat, fish etc.,

Functions:

It is involved in metabolic reactions.

Participate in nucleic acid synthesis.

Stimulates bone marrow to produce WBC and platelets. Helps in the formation and maturation of RBC.

Induce microbial growth.

Synthesize lipids from carbohydrates.

Prevents hyperglycemia and pernicious anaemia

Deficiency

Pernicious anemia

Hyperglycemia

Inositol

It was isolated by Scherer from muscles.

Sources-yeast, brain, kidney, spleen, liver, soyabean, citrus fruits vegetables, grains, milk etc.,

Functions

Prevents fat deposition in liver (lipotrophic action) Essential for normal reproduction and growth.

Deficiency

Deficiency of inositol causes alopecia in nice and spectacle eyes in rates.

No prominent symptoms are seen in man.

Vitamin C (Ascorbic acid or antiscorbutic vitamin) It was isolated by szent gyorgyi. (1928) Reichstein (1933) synthesized it

Sources: abundant in citrus fruits. (lemon, pineapple, orange etc,) eauli flower, cabbage, milk, liver, kidney etc.,

Functions:

- Acts as a bydrogen carrier thus it regulated oxidation reduction rates inside the cell.
- Helps to convert pyruvic acid into homogentisic acid.
- Regulates carbohydrate metabolism

- Actively participate in would healing process.
- Essential for the synthsis of adrenal hormones and gonadial hormones.
- Vitamin C is essential for the formation of fibroblasts, osteoblands etc.,
- Helps to absorb iron in the intestine.

Deficiency

- It causes scurvy (bleeding guns)
- Deformaed bones and teeth
- Anaemia
- Delay in blood clotting and would healing
- Due to brittleness of bone, it leads to fracture.

ENZYMES

Generally enzymes are called biocatalysts.

Because they speed up the biological reactions within the living system. They are proteins in nature.

They are soluble and colloidal substances.

The term 'Enzyme' was first introduced by W-Kuhne in 1878.

Classification of enzymes:

The classification of enzymes is based on several features like, Substrates, the reactions, the synthesis, chemical nature etc.,

Classification based on substrate:

Substrates are the substances on which an enzyme can act. Carboxylases are enzymes act on carbohydrates.

Proteases act on Proteins Lipases act on Lipids etc.,

Classification based on reaction:

Hydrolases are enzymes which catalyse hydrolysis. Reductases – Reducation reation.

Phosphorylases – Phosphorylation. Isomerases – Isomerizion etc.,

Classification based on substrate and Reaction:

(Eg). Phruvic decarboxylase – Removes O_2 from Pyruvic aid.

Classification based on synthesis:

(Eg). Citric acid synthetase. This enzyme synthesis citric acid.

Classification based on the Discoverer:

(Eg).Pepsin, Trypsin, Ptyalin, etc.,

Classification based on enzyme-commission:

Transferases, Oxido reductases, Hydrolases, Lyases, Isomerases, Lygases.

The transferases are enzyme which catalyze the transfer of a group (other than hydrogen) between two substances.

The Hydrolases- catalyze the substrates by adding water across the bond.

Classification based on E.C.Numbers:

The commission on enzyme named the enzymes by a code number called enzyme commission number. According to that, each enzyme is named by a 4 digit number.

Types of enzymes:

Endoenzymes: The enzymes that function within the cells are called endoenzymes. (eg). Metabolic enzymes.

Exoenzymes: These enzymes are liberated by the living cells. They catalyse the vital reactions outside the cell. (eg). The digestive enzymes.

Holoenzymes:

Most of the enzymes contain a protein part and a non-protein part. Such enzymes are called Holoenzymes. The protein part of the enzyme is known as apoenzyme and the non-protein part of it is called the prothetic group.

Thus Apoenzyme + Prosthetic group $\longrightarrow$ Holoenzyme

Isoenzyme

Isoenzymes are the multiple forms of a given enzyme, that occurs within

the same animal species. They show different physical and chemical properties but perform similar catalytic activity. They are coded by different genes.

So, their amino acid composition is also different. Thus their isoelectric values, P^H values also differ. They have different immunological behavior.

Antienzymes:

Antienzymes neutralize the effect of other enzymes. These are secreted by the endoparasites to protect themselves from the action of digestive enzymes of the host.

(Eg). The endoparasitic worm ascaris secrete antienzyme that inhibit the action of the digestive enzymes of man. (host)

Properties of enzymes:

- Enzymes are protein in nature.
- They are in the form of colloid.
- They accelerate the speed of reactions
- When the temperature or p^H is altered, enzymes become denatured. So, their structure is charged and they lose their activity.
- The enzymes are responsible for various reactions that are going on in a system. But, the enzyme itself remain unchanged till the end of the reaction.
- Enzymes are required in very small quantities for any reaction.
- The enzymes can perform their function well in an optimum temperature only. When temperature is raised, the enzyme become denatured and inactivated. Generally 30^o – 40^oC is the optimum temperature for most enzymes.
- Enzymes show Reversible actions also.
- Each enzyme is specific in its activity. It can react with only one type of substrate or group of related substrates. This is called enzyme specificity.
- It may be absolute specificity or optical specificity or group specificity.

Mechanism of enzyme action:

Each enzyme can act on a specific substrate only. So, it forms an Enzyme – substrate complex. (Michaelis complex)

After the completion of the reaction, the enzyme dissociates from the end product.

Now it is ready to combine with another molecule of substrate.

Regarding the mechanism of enzyme-substrate complex formation, two hypothesis are formed. They are,

Lock and key hypothesis and Induced

fit hypothesis.

Lock and key hypothesis:

This hypothesis was proposed by Emilfisher (1914).

According to this hypothesis the enzyme molecule has one or more specific regions called active sites.

These sites are rigid and with proper configuration.

Already we know that each enzyme is highly specific for its substrate.

So, when the enzyme comes in contact with its substrate, the active site of the enzyme get fits into the substrate to form enzyme substrate complex, like lock and key.

(fig).1

Induced fit hypothesis:

This was proposed by Koshland in 1963.

According to this the active site of enzyme molecule does not possess a rigid and proper configuration. It seems to be flexible.

When the enzyme comes in contact with the substrate, the substrate induces the active site, to develop a conformational change.

Due to the change, the enzyme and substrate are attracted toward each other and thus the enzyme-substrate complex is formed.

After the completion of reaction, the substrate is split into end product and thus the enzyme is released.

(fig).2

ENZYME INHIBITION

Sometimes the enzymes become inactivated by some substances. So, the enzyme action is

inhibited. Such substances are called enzyme inhibition.

Three types of enzyme inhibition are seen. They are,

1. Competitive inhibition
2. Non-competitive inhibition and
3. Allosteric inhibition.

1) Competitive inhibition:

The competitive inhibitor closely resembles the substrate of the specific enzyme.

So, the enzyme molecule combines with the substrate through its active site. Thus enzyme-inhibitor complex is formed.

It occurs due to the,

- ❖ Inability of the enzyme to find out the absolute specificity of the substrate.
- ❖ Structural similarity of the substrate and the enzyme inhibitor.
- ❖ Enzyme has more affinity towards the inhibitor than its substrate.
- ❖ This sort of inhibition can be reversed by increasing the substrate concentration.

(fig).3

2) Non competitive inhibitor:

The non-competitive inhibition of enzyme is irreversible.

Here, the inhibitor has little or no structural similarity with the substrate.

The inhibitor binds with the non-active site of enzyme molecule. So, deformity of the enzyme occurs.

The binding is very strong.

The non-competitive inhibitor can react either with the free enzyme or with the enzyme-substrate complex.

(fig).4

3) Allosteric inhibition:

In allosteric inhibition, the inactivation of enzyme can be reversible by an inhibitor attached to other regions of the enzyme than its active sites. In allosteric inhibition, the end product is the inhibition of the reaction.

So, it produces reversible reaction.

FACTORS AFFECTING ENZYME ACTIVITY

A number of factors like temperature, p^H, enzyme concentration and substrate concentration which affecting the enzyme activity.

Effect of temperature on enzyme activity:

When we increase the temperature gradually during an enzyme action, the rate of reaction increases according by upto 40^oC. At that time the enzyme shows its maximum activity. It is called the optimum temperature. At low temperature and at high temperature, the enzyme is inactive and ineffective.

At high temperature, the enzymes become denatured. It proves that, the enzymes show liability towards temperature changes. This is called thermolabile nature of enzymes.

(fig).5

Effect of p^H on enzyme activity:

Too low and too high p^H make enzyme inactive.

Most of the enzyme shows their highest activity in p^H range for most enzymes.

Effect of enzyme concentration:

An enzyme can act even when it is present in very low quantity. When an increase in enzyme concentration is observed, it shows an increase in the velocity of the reaction.

The velocity of reaction is (V) proportional to the concentration of enzyme. (E)

(fig).6

Effect of substrate concentration:

When the concentration of substrate is increased, a rapid increase in the velocity of reaction is seen.

If the substrate concentration increases continuously, the velocity of reaction seems to be slowdown.

No further increase in velocity is seen.

Thus, the velocity of reaction can be increased upto a certain concentration increase of the

substrate but not a continuous increase of it. **(fig).7**

Biological functions of enzymes:

- Enzymes act as catalysts in all biological reactions.
- Enzymes help for the breakdown of complex food materials into their simplest forms during digestion.
- All metabolic reactions are under the control of enzymes only.
- Enzymes like pepsin are used clinically to correct digestive disorders.
- Enzyme like urokinase is used to dissolve blood clots in the brain. The enzyme is isolated from urine.
- Trypsin is used in cataract surgery.
- Pepsin digests the gelatin. So, it is used in photographic films to recover silver.

Spefic coenzymes:

A coenzyme is a non-protein organic substance. It is loosely attached to the enzyme. It can be separated by dialysis. It is essential for enzyme action.

Some important co enzymes are NAD, NADP, ATP, UDP, COA, TPP, ubiquinone Q etc.

The coenzymes are heat-stable. They accelerate the rate of reaction of the enzyme co-enzymes exist in the Free State in the solution. Co-enzymes act as intermediate carriers of hydrogen atoms in the biological oxidation reduction reactions.

Isoenzymes: (isozymes)

Some enzymes exist in two or more forms. They show the same function. They differ physically, chemically, immunologically and electrophoretically. Such enzymes are called isoenzymes. (Eg). LDH, esterase's etc.

RESPIRATION

Respiration is the process of biological oxidation where oxygen is utilized and carbn-di-oxide is left out. Living organisms cannot survive without respiration. Respiration may be aerobic or anaerobic or External or internal.

Animal that take up oxygen from the environment are called aerobic forms.

Animals that respire in the absentee of atmospheric air or as parasites are called anaerobic forms.

The external respiration requires a system. If also includes two steps namely inspiration and expiratory organs. In lower animals, skin, trachea ect, are the respiratory structures. Internal respiration takes place in the cellular level. So,

it is called cellular respiration.

Respiratory pigments:

The respiratory pigments play a vital role in transporting the O1 and CO2

They are present in the blood. They are

coloured pigments.

Various respiratory pigments are there in various animals. They are,

Hemoglobin

Haemocyanin

Chlorocruvanin

Haemoerthrin

Pinnaglobin Vanadium

Echinochrome Molpadein

Hemoglobin:

It is respiratory pigment. It is present in the blood. It is

red in colour

It is composed of a protein component and iron component The protein part is the globin

The iron (non-protein) is the lame

Each hemoglobin molecule is formed of four polypeptide chains. Out of which, two are a chains and two are B chains.

α- Chain is formed of 141 amino acids. β- Chain is formed of 146

amino acids.

The haemoglobin combines with O2 to form OXYhaemoglobin. It low pressure it leaves O2

and reduced as haemoglobin.

Thus it plays a major role in oxygen carrying work in the blood.

Haemoglobin has affinity towards O2. It is the respiratory pigment of higher vertebrates.

Haemocyanin:

This respiratory pigment is blue in colour. It has protein and

copper as its components. It absirds Uvrays.

It is used in the transport of gases and storage.

It is found in the blood plasma of Arthropods and in mollusks. (Eg) limulus, sepia, octopus.

Haemoerythrin:

This respiratory pigment is found in lingula, siphungulus etc., It is reddish- violet in colour.

It has less O_2 carring capacity than haemoglobin.

Chlorocrvanin:

This respiratory pigment is found in annelids. It is green in colour.

It resembles haemoglobin and cytochromes. It has affinity towarts O_2.

It helps in respiration.

Pinnaglobin:

It is found in pinna only.

It is a brown colour pigment.

Vanadium:

It is found in Ascidians.

Echinochrome:

It is present in sea urchins fluid. It is red in colour.

Molpadin:

Is found in malpadia.

Functions of respiratory pigments:

Respiratory pigments are responsible for the transport of respiratory gases in animals.

They contain a protein part and non-protein part. They are coloured pigments.

Role of respiratory pigments in the transport of O_2 and CO_2 in man: In man haemoglobin is the respiratory pigment.

It is found in the RBCs of blood.

During respiration O_2 enters into the lungs, and thenit is diffused into

the blood.

The O_2 is the then transport to the tissues.

The arterial blood contains 20ml/100ml of blood The venous blood contains 15ml O_2/100ml of blood.

The haemoglobin loosely attaches with the O_2 to form oxy haemoglobin, when the O_2 pressure is high in the blood.

It dissociates when the 0**2** pressure is low in the blood. In lungs the alveoli are surrounded by capillaries.

The 02 that enter into the lungs reach the alveolar capillaries. So, the alveolar blood has high pressure and loaded with 02.

Then the oxygenated blood enters into the heart. From the heart the oxygenated blood is pumped out to different parts of the body/tissues/organs The cells present in the tissues are continuously utilize 02 for their functions.

So, the O_2 pressure in the cell/tissues/organs seems to be low.

When the oxygenated blood passes through them, auto matically the oxyhaemoglobin looses its O_2 and leave it the tissues. Then it enters into the blood as haemoglobin and move to carry 02 further.

Oxygen dissociation curve:

Generally the Hb has an affinity towarts 02 and combines with it to form Hb02 (oxyhaemoglobin)

Many factors like,

02 pressure, C02

pH

Temperature etc, affect the O_2 carrying capacity of Hb

When the pressure of is low, then the oxygen carrying capacity of Hb is also low.

When 02 pressure is increased, the oxygen carrying capacity of Hb also increase.

So, when we draw a grap by marking the O_2 tension in the X axis and oxy hemoglobin in the y axis, the curve seems to be like the letter ‘S”

But above 100 mm Hg pressure, the curve shows only a slight increase.

Factors observed in

Formation of oxyhaemoglobin	Dissociation of oxyhaemoglobin
-High O_2 tension	-low O_2 tension
-Low Co_2 tension	-High Co_2 tension
-O_2 Tension in arterial blood is100mmHg and	-Co_2 tension in venow blood is 46
Co_2 tension is 40 mm Hg	mm Hg
-PH is 7.4	-Slighty acidic ph
-Temperature in tissues is low	-Temperature in tissues in high

Bohr effect:

The tissues are continuously utilize O_2 for various functions. After the cellular reaction they release more Co_2

So, the tissues /cells have high concentration of Co_2 in them.

When the oxygenated blood with oxyhaemoglobin passes througe the tissues, They unload O_2 to the tissues and get separated as Hb. Thus the increase in Co_2 helps to unload O_2 from HbO_2 This phenomenon is called Bohr Effect

The following graph explain the phenomenon easily

CO_2 transport:

The cells produce Co_2 continuously.

When $C0_2$ gets accumulated in the tissues, it is toxic. So, the $C0_2$ has to be removed through blood

It is called $C0_2$ transport.

The blood plasma and RBC are responsible for this.

Nearly 67 of C02 is carried by blood plasma 33 is carried by RBC. The $C0_2$ is carried by 3 forms namely, Carbonic acids

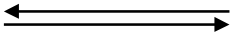
Carbamino compounds and Bicarbonates.

Removel of $C0_2$ as carbonic acid:

Nearly 5% of $C0_2$ dissolves in the plasma ot form carbonic acid ($H2C0_3$)

It is carried to the leangs through blood. There it is reversed to release

$C0_2$ Tissues



$C0_2$ +H2 $C0_3$

Lungs

As carbamino compounds:

About 10% of $C0_2$ is carried as carbamino compounds. These compounds reach lungs and undergo reversible reaction to release $C0_2$

Tissues

R- $NH2+C0_2$ R-NHCOOH

Lungs

As bicarbonates:

85% of $C0_2$ is transported as carbonates in the plasma and in the RBC. $C0_2$ from the tissues enter into RBC by simple diffusion.

In the RBC, the $C0_2$ comines with H_20 to from carbonic acid (H_2C0_3) Carbonic acid is unstable.

It immediately dissociates into H+ ions and bicarbonate ions ($HC0_3$)

Formation of oxyhaemoglobin	**Dissociation of oxyhaemoglobin**
-High O2 tension	-low O2 tension
-Low Co2 tension	-High Co2 tension
-O2 Tension in arterial blood is100mmHg and	-Co2 tension in venow blood is 46
Co2 tension is 40 mm Hg	mm Hg
-PH is 7.4	-Slighty acidic ph
-Temperature in tissues is low	-Temperature in tissues in high

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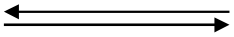
Nearly 5% of $C0_2$ dissolves in the plasma ot form carbonic acid (H_2C0_3)

It is carried to the leangs through blood. There it is reversed to release $C0_2$ Tissues



$C0_2 + H_2 C0_3$

Lungs

As carbamino compounds:

About 10% of $C0_2$ is carried as carbamino compounds. These compounds reach lungs

and undergo reversible reaction to release C02

Tissues

R- NH2+C02 R-NHCOOH

Lungs

As bicarbonates:

85% of C02 is transported as carbonates in the plasma and in the RBC. C02 from the tissues enter into RBC by simple diffusion.

In the RBC, the C02 comines with H20 to from carbonic acid (H2C03) Carbonic acid is unstable.

It immediately dissociates into H+ ions and bicarbonate ions (HC03)

CIRCULATION

BLOOD COMPOSITION

Boold is the fluid tissue. It is formed of a fluid component and cellular components. Plasma is the fluid components.

The cellular elements are, ed blood corpuscles, White blood corpuscles and blood platelets.

Plasma: (fluid component)

Plasma is the fluid somponent of blood It is light yellow in colour

It contain 90% water and 10% of organic and inorganic substances.

It contains proteins, glucose, nitrogenous wastes, enzymes hormones, minerals etc.

The plasma proteins are, serum albumin, serum globulin, fibrinogen and prothrombin.

Formed elements of Blood:

The RBC, WBC and platelets are the formed elements

RBC:

The Red Blood corpuscles are otherwise called erythrocytes. In man,

They generally non-nucleated cells.

They are biconcave disc like structures.

They contain heamoglobin. It is red in colour due to the presence of

haem a non-protein group and protein part of heamoglobin is globulin

Haemoglobin has affinity towards oxygen.

So, it plays a vital role in respiration

It combines with 0_2 to from oxyhaemoglobn, which is transported to various parts of the body through blood vessels.

Each RBC is provided with a plasmmembrane and storma. The storma is spongy mesh. The haemoglobin lies indies the meshes of storma. When haemoglobin is treated with glacial acetic acid., it forms haemin crystals.

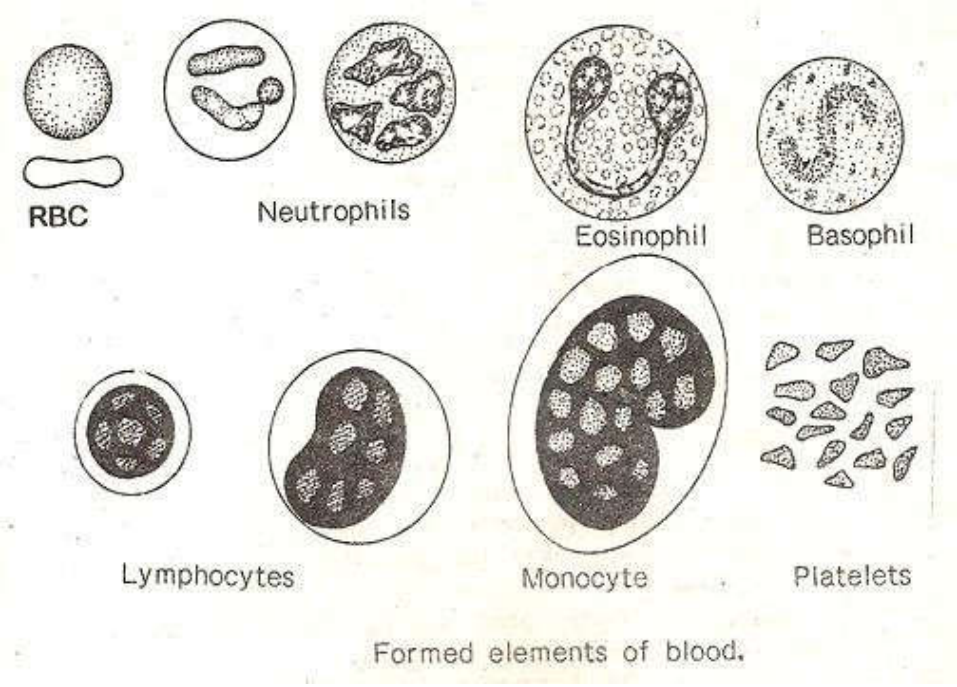
The RBCs develop from the bone marrow (cradle of RBC). The life span of RBC in human is 120 days. The old RBCs are disintegrated in the spleen. So, the spleen is called graveyard of RBC. The degradation of haemoglobin leads to the production of globn and iron. Iron is stored in the liver. It is used in the formation of fresh haemoglobin. The globin part is converted into bilivirdin. They give colour to the bile.

WBC:

The white blood corpuscles are colourless. Hence they are called leucocytes.

Leucocytes are called phagocytes, when they attack the invading foreign substances through phagocytosis.

Leucocytes fall under two groups namely, Granulocytes and Agaranulocytes,



Formed elements of blood.

Granulocytes:

The cytoplasm contains granules. Nucleus is lobed.

These granulocytes are, neutrophils, oesinophils and basophils.

If the number of granulocytes are more in blood, it is called granulocytosis. When they are in reduced number, the condition is called granulocytopenia.

If no granulocyte was observed in blood, it is known as agranulocytosis.

Neutrophils:

They constitute nearly 79% of the total WBC count. The cytoplasm shows granules.

The nucleus has 3 or 4 lobes or 7 lobes. The exhibit amoeboid movement.

They engulf the invading foreign bodies through phagocytosis. They can pass out through blood capillaries by diapedesis.

Because they attack the intruded unwanted cells, they are called scavenger cells.

Eoesinophils:

They constitute nearly 1-4% of the total leucocytes count. They

absorb the stain eosin.

Nucleus has 2 or 3 lobes.

The number of oesinophils get increased during allergic conditions. They are amoeboid.

These cells bring about destruction and detoxification of toxins of protein origin.

Basophils:

They constitute 0-4% of the total WBC count. Nucleus is lobed.

Cytoplasm is granular. They absorb basic stains.

They participate in local auticoagulation.

Agranulocytes:

Leucocytes which have no granules in their cytoplasm are know as agranulocytes.

They are produced in the lymph nodes and spleen.

The lymphocytes and monocytes fall under this category.

The lymphocytes may be small lymphocytes or large lymphocytes. They constitute nearly 25-30% of the total leucocyte count.

The nucleus is large in size.

Monocyte

They form 5-10% of the total leucocyte count. The nucles is horse-shoe shaped.

They are motile in nature. They engulf bacteria.

Blood platelets or thrombocytes:

The blood platelets are smaller in size. They may be oval or spherical in shape. They have 2-3 mm diameter.

The number of platelets vary from 2,50,000-4,50,000 per cu-mm of blood.

They have a life span of 5-9 days.They are produced in the bone marrow and destroyed in the spleen. Functions of platelets:

Participate in blood clothing. Repair capillary endothelium.

Based upon the number of platelets, the speed of blood clotting occurs. They are responsible for varo

constriction of blood vessels.

Functions of blood:

Transport of o2 and co2.

Transport of digested food to the tissues.

Transport of waste materials from the tissues to the concerned excretory

organs.

Transport of hormones.

Maintenance of ph in blood. Maintenance of

body temperature. Protect body from

infection.

Prevent blood loss by a process called clotting.

TYPES OF HEART

The heart is an organ, which transports or circulates blood to various parts of the body through blood vessels.

Among animals two types of circulatory systems are found. They are, Open

type and

Closed type.

In open type of circulatory system, the blood comes out of the blood vessels.

The internal organs are bathed in blood. Thus the

organism show haemocoel. (eg). Annelids,

arthropoes, ascidians etc., In closed type of

circulatory system,

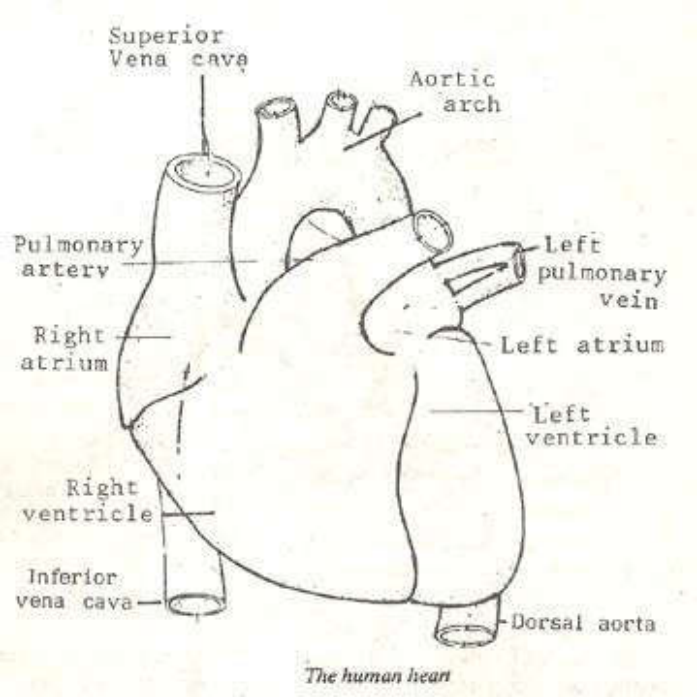
The heart is connected with blood vessels. (eg).

Cephalopods, mollusks & higher animals.

CIRCULATORY ORGANS

The heart and blood vessels constitute circulatory organs.

Heart:



The human heart

It is the major pumping organ.

Among animals various types of heart are seen. They are,

Pulsatile hearts – found in annelids.

The blood vessels exhibit rhythmic pulsating contractions.

Tubular hearts are found in balanoglossus and ascidians. These are tube like structures. They lie within the pericardium.

Higher animals have chambered hearts. Chambered hearts have auricles and ventricles.

Two auricles and one ventricle is seen in amphibians.

In birds and in mammals two auricles and two ventricles are present. **Accessory heart** are found in cephalopods, insects, fishes etc., These are nothing but dilated portions of blood vessels.

They act as Booster pumps.

Myogenic heart:

In myogenic hearts, the heart beat starts from the cardiac muscle. (eg).
Heart of moluscus & vertebrates

Neurogenic heart:

The heart beat orginates from the ganglion cells.(eg) crustaceans, insects etc.,

ORIGIN AND CONDUCTION OF HEART BEAT IN MAN

The heart is the pumping organ of the body. It pumps the blood through blood vessels to the entire body.

The rhythmic contraction and relaxation of the heart while pumping the blood is called heart beat.

The normal heart beat is called heart beat The contraction phase is called systole.

The relaxation phase is called diastole.

Origin of heart beat:

The heart beat originates in two ways namely neurogenic and myogenic origin.

Neurogenic origin is found in annelids and arthropods. The myogenic origin is found in vertebrates, mollusks etc., In man, the heart beat originates from auricle-ventricular node, it is otherwise called pace maker or heart of hearts.

For the contraction of heart, the stimulus is received form chemical changes that occur in the since auricular node.

The route of conduction of heart beat is auriculo-ventricular node, Bundle of His and
Purkinjii fibres.

The impulse arises from the since auricular node by the chemical changes. The impulse is picked up by auriculo ventricular node.

This node lise at the inter auricular septum at its right border.

The impulse is then transmitted to the bundle of then moves to the purkingii fibres through out heart.

The bundle of His lise at the auriculo ventricular node.

Then it divides into two branches and reach the ventricular walls branches. These branches are called

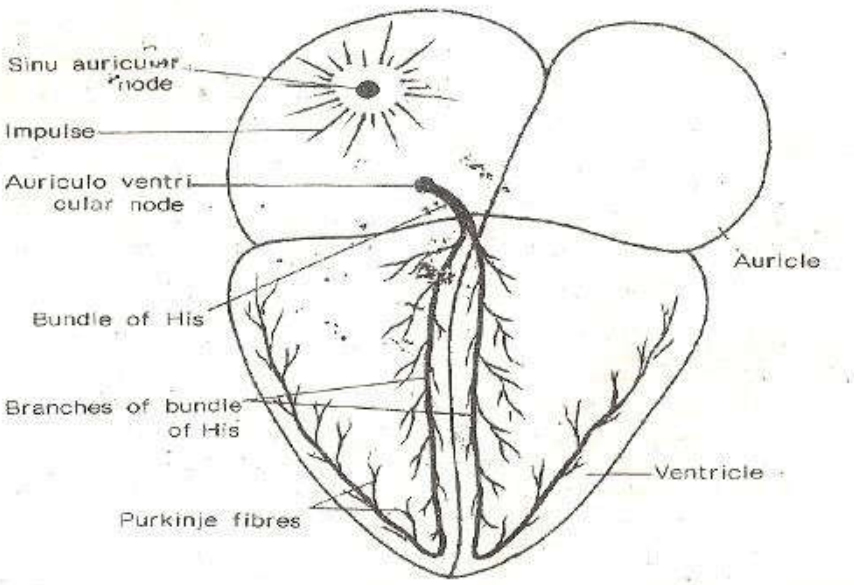
purkingii fibres out the heart.

The bundle of this lies at the acriculo ventricular node.

Then it divides into two branches and reach the ventricular walls branches. These branches are called purkingii fibres.

During contraction phase,

The auricles contact first. Then the ventricles contract.



Origin and Conduction of heart beat.

Regulation of heart beat:

The regulation of heart beat is regulated by nervous system, hormones, temperature and $p^{H.}$

Nervous regulation of heart beat:

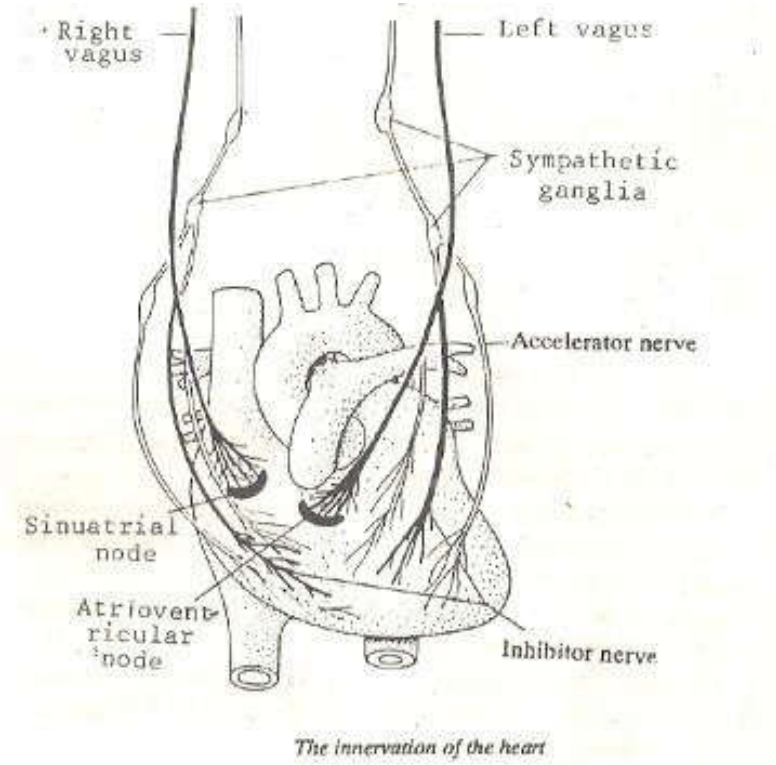
The heart receives branches of nerves from the vegus nerves and syspathetic nerve branches form the spinal card.

The vagus nerves are cardiac inhibitory in function. They are controlled by cardio inhibitory centers of medulla.

The inhibitory action of vagus nerves, occurs as follows.

- The heart rate is slowed down.
- The Bundle of his dose not receives any stimulus.
- Contraction force is slowed down.
- Systolic duration is reduced.

- Length of refractory period reduced.
- Excitability of heart is reduced.



The innervation of the heart

Sympathetic nerves:

The sympathetic nerves are acceleratory in function. They innervate the since auricular node, Auriculo. Ventricular node, and also the heart mudulla. The sympathetic nerves are controlled by cardio accelerator centre of medulla. The stimulation of sympathetic nerves causes the following events.

Frequency of heart beat is increased.

Force of heart contraction is increased.

The excitability of heart is increases. The irritability of hearts is increased.

The conductivity of heart muscle and bundle of His is also accelerated.

Hormonal control of heart beat:

Aderenlin, thyroxine and sex hormones are responsible for accerlerating reduces the heart beat rate.

Temperature:

Increased temperature accelerates heart beat and decreased temperature reduces the heart beat rate.

P^+:

Low P^H increases heart beat.

BLOOD PRESSURE

The blood pressure is a condition in which the lateral pressure that the blood exerts against its walls of blood vessels.

The cause for blood pressure are,

- Contriction of ventricles.
- Peripheral resistance to the path of blood vessels9arteries)

For clinical purposes, the blood pressure is measured from the large arteries of arm.

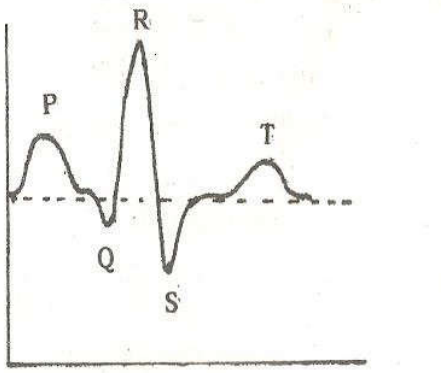
Normal man has the systolic pressure 120mm Hg and diastolic pressure 80mm Hg.

Blood pressure is measured by mercury manometer or by sphygmomanometer.

ECGC (Electro Cardio Gram)

The electric impulse originated from the heart is recorded by a machine called electrocardiograph. It is placed on the body opposite to the heart. The record of electric impulse generated by the heart is called Electro Cardio Gram.

The electro cardio gram of man shows a series of waves.



Electrocardiogram showing normal heartbeat

Each ECG has 5 consicutive waves., of which three are upward deflections and two are downward waves. They are named as PQRST.

PQR are upward deflections. S and T are downward waves.

The upward and downward waves are alternately arranged.

There are two iso electric points.

Between P and Q there is a shorter isoelectric period.

The longer one is present between S and T.

P- is the first upward deflection.

It is a small wave.

The top is round.

It is formed when the impulse spreeds over the atrial chambers. The duration is about 0.1 second.

It originates frim the atrium. So, it is called atrial complex.

QRST are caused by ventricular activity.

So, they are altogether called ventricular complex.

The average duration of this complex is about 0.43 second. Q- it is the first downward curve.

The impulse reach inter ventricular septum.

So,the septum contracts. It accurs due to the activity of the septum.

R- It is the second upward deflection.

It is with tallest amplitude.

It represents the activity of right ventricle.

S- It is the second downward wave.

It represents the activity of left ventricle.

T- It is the third upward deflection.

It has a broad, smooth round deflection. The time is about 0-27 second.

It occurs due to the current, owing to the contration of basal part the ventricle.

It the repolarzrion wave of the ventricle.

P and Q Period:

It is an isoelectric period, where the curve is flat. It is the time taken for the impulse to travel

over atrium to auriculo ventricular node along the conducting tissues to the ventricular muscles.

S and period:

It is the second isoelectric period. It is a long period.

Abnormal ECG is seen when any defect in heart is found. So, it is of clinical importance. Abnormatty in activity is reflected in P wave. If the auricle has fibrillation P wave is absent.

In a trial hypertrophy, the P wave is large and notched. In nodal rhythm, the direction of P wave is reversed.

Serious myocardial damage are seen in T wave.

The shape, size and direction and duration will be abnormal.

It is associated with cardiac hypoxia. Thus abnormal ECG shows the defects of heart and its functioning condition.

BLOOD COAGULATION

When the blood is exposed to atmospheric air due to any wound or cut or accient, it forms a semi-solid structure called clot. The formation of clot is called coagulation.

Blood clotting is of biological importance- because it prevents blood loss from the animals.

Mechanism of blood clotting:

The mechanism of blood clotting was explained by Morawitz.

When blood oozes out, the blood platlets disintegrate and liberate thromboplastin.

The thromboplastin converts prothrombin into active thrombin.

Ca^{++}ions participate in this conversion.

The thrombin interacts with fibrinogen to form fibrin.

Thus the clot is formed.

Thromboplastin+prothrombin $=Ca^{++}$ $\longrightarrow$ thrombin.

Thrombin+fibrinogen $\longrightarrow$ fibrin(clot).

The mechanism of blood clotting is explained by

(i) Best and Taylor's theory.

(ii) Howells theory.

(iii) Fuld and spiro's theory and

(iv) Enzyme cascade Hypothesis.

Best and Taylor's theory

According to this theory, four substances participate in the coagulation process.

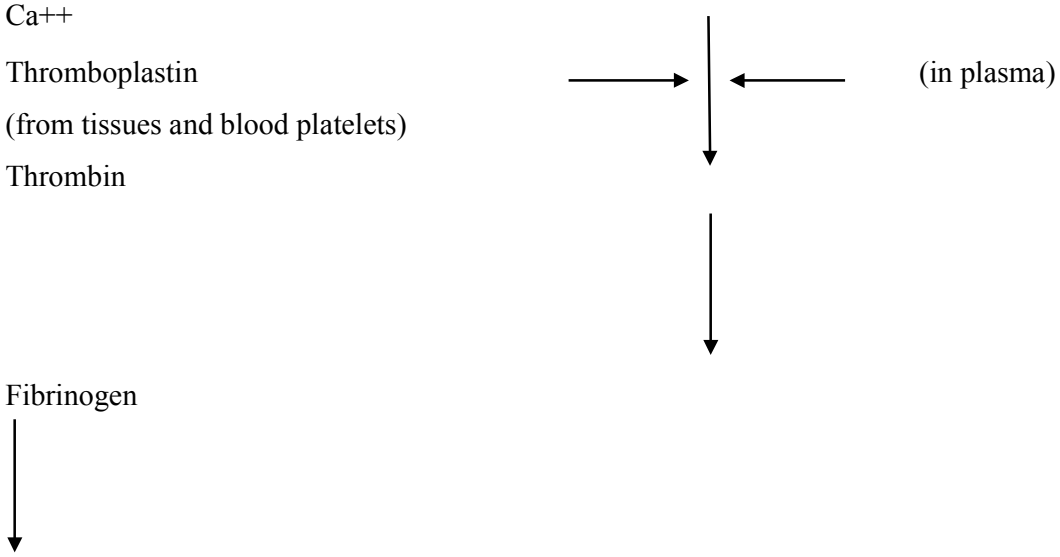
They are prothrombin, calcium, thromboplastin and fibrinogen.

The prothrombin is produced in the liver. It is found in blood plasma.

Thromboplastin is present in the tissues.

Calcium is also present in the plasma in dissolved state.

When blood comes out from the injury, the thromboplastin is liberated from the tissues. The prothrombin is converted into thrombin in the presence Ca^{++}ions.



(ii) Howell's Theory

According to this theory, the prothrombin is prevented from its activity due to the presence of anti thrombin in the blood.

During injury, the formed elements of blood relese cephalin.

The cephalin neutralizes the acitivity of anti thrombin. So, it permits Ca to react with prothrombin. Thus prothrombin is conversted into thrombin.

This thrombin reacts with fibrinogen to from the fibrin (clot)

Blood corpuscles

↓

Cephalin

↓

Antithrombin

prothrombin ↓ Ca^{++}

Thrombin

↓

fibrinogen

↓

Fibrin (clot)

(iii) Fuld and Spiro's theory

According to this theory, anenzyme thrombokinase is produced by the platelets.

This enzyme plays ans inmprtant role in cogulation

Blood platelets

↓

Thrombokinase Ca++

Prothrombin

↓

Thrombin Fibrinogen

↓

Fibrin (clot)

(iv) Enzyme Cascade Hypothesis

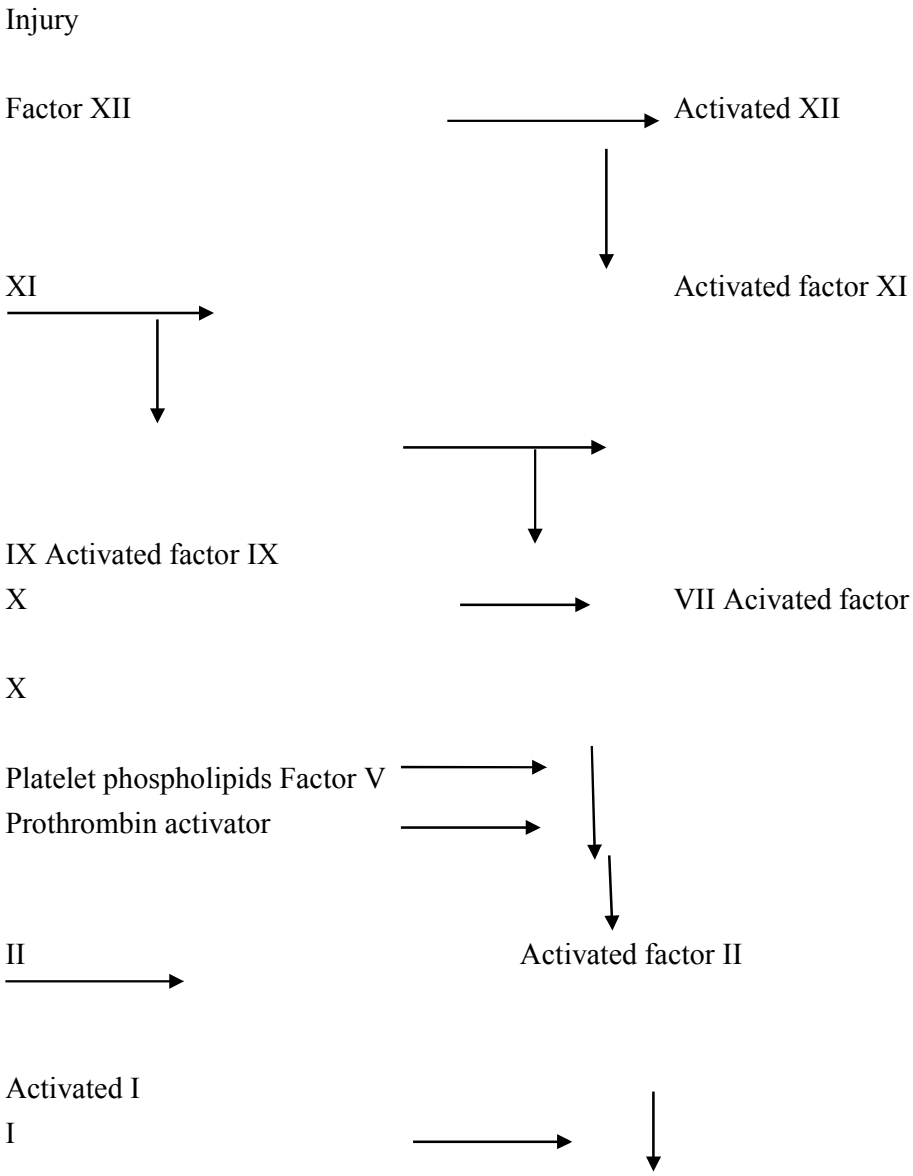
This hypothesisi was proposed by Biggs and Mac Fralane. According to this hypothesisi 13 factors are involved in the process of blood coagulation. They are I,II,III,IV,V,VI,VII,VIII,IX,X,XI,XII and XIII.

These factors act as enzymes and proenzymes. A sequence of reaction are formed in which these enzymes activate next and finally the fibrin is formed.

The steps involved are,

1. Formation fo injury or would
2. Alteration of factor XII and converts it into active factor XII.
3. The activated XII converts the factor XI to activated factor XI.

- Activated factor XI acts on IX and it is converted into activated IX.
- The activated factor IX acts on factor on factor X along eith factor VIII.
- Thus activated factor X is formed.
- This activated factor X combines with factor V and from parthrombin activator
- This splits prothrombin into thrombin (activator factor II)
- Thrombin converts fibrinogen (factor I) into fibrin.



CORONARY ANGIOPLASTY

Coronary angioplasty is an operation done to clear flow of blood ehen the coronary arteries are narrowed or blocked by fattydeposits with the help of a balloon catheter. Under local anesthesia, a guide wire is inserted through the femoral artery in the groin and up into the affected coronary artery. A balloon

catheter is oassed up the wire and balloon is implanted in the narrowed area to widen it. Sometimes, a metal tube called stent is inserted after wards. It keeps the artery open.

CORONARY BY PASS SURGERY

Coronary by a pass surgery is an operation to circumvent (or) blocked coronary arteries by grafting additional blood vessels to transmit blood flow. During this procedure the heart is temporarily stopped and blood circulation and oxygenation is taken over by a heart lung machine

Angiogram

Angiogram is a special contrast X ray and can be used to detect an abnormality in a blood vessel such as a narrowing of a large diseased artery.

Coronary angiography

Coronary angiography is used to image the arteries that supply the heart muscle with blood. Angiography can image narrowed or blocked coronary arteries, which are not visible on a and a fine flexible catheter is passed within the femoral artery, through the arorta and into a coronary artery. A contrast dye is injected through the catheter and a series of X reys taked. The procedure is painless.

EXCRETION

1. Definition
2. Types of nitrogenous wastes
3. Structure f mammalian kidney.
4. Urine formation
5. Rena
6. Kidney stone
7. Kidney transplantation

1. Definition

During metabolism some by products and end products are formed. They are to the tissues if they accumulate in the body. thus excretion is a process by which the separation and elimination of metabolic waste occer in the

body. The organs that excrete these toxic waste products are called excretory organs. The excretory organs may be contractile vacuoles, flame cells, organ of Bojanus, malpighian, Lobules, protonephric, metanephric or metanephric kindneys.

2. Types of nitrogenous wastes

Among animals based upton their living habits three types of nitrogenous waste products are formed. They ammonia, uric acid and urea. Based upton the nature of the waste, the animals are classified as

Ammonotelic, Uricotelic

and Ureotelic forms

Ammonotelic forms:

The ammonotelic forms excrete ammonia as their excretory product These forms are aquatic in nature

The ammonia can easily diffuses into the surrounding water (eg) protozons, & crustaceans, annelids, amphibians atc.,

Uricotelic forms:

These forms excreate uric acid as their excretory product. uric acid is a semi solid form

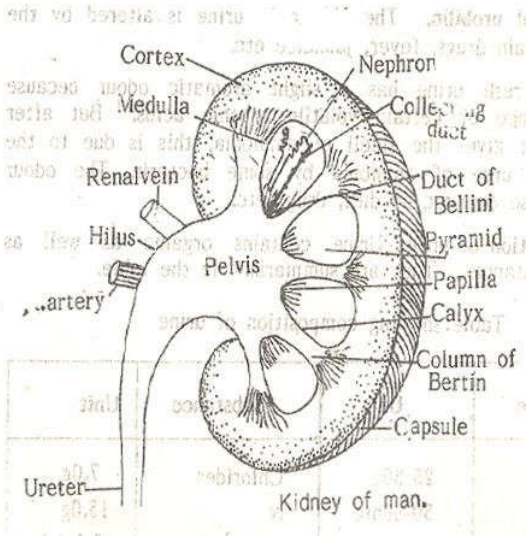
(eg) Birds

Uretelic forms:

The ureotelic forms are animals that excreate urea as their excretory product.

(eg) man.

3. Structure of mammalian kindney (man)



In man, a pair of kidney are present. They lie one on either side of the vertebral column.

They are metamorphic kidneys.

They lie one on either side of the vertebral column. They are metamorphic kidneys.

In man, the right kidney is slightly lower than the left kidney, becaue of the presence of liver at the rifht sideof the abdomen.

Each kidney is bean- shaped.

The convex surface is the outher side. The convex surface is the inner

side The kidney is dark red in colour

The peripheral area is called cortex The inner area is the medulla

From the inner surface of the kidney arises the ureter. The place where the ureter enters in the kidney is called hilus.

The expanted prtaion of ureter at the hilus is called pelvis. From the pelvis arises the cup-

like clyces

Each calyx is provided with a cavity

The cavity is occupied by the pyramid

The papillae projects into the cavity of the calyx

Nearly 10-15 pyramids are seen in each kindney pyramids are separated by renal columns of Bertin. Each pyramid has thousands of minute tubules called uriniferous tubules or nephrons.

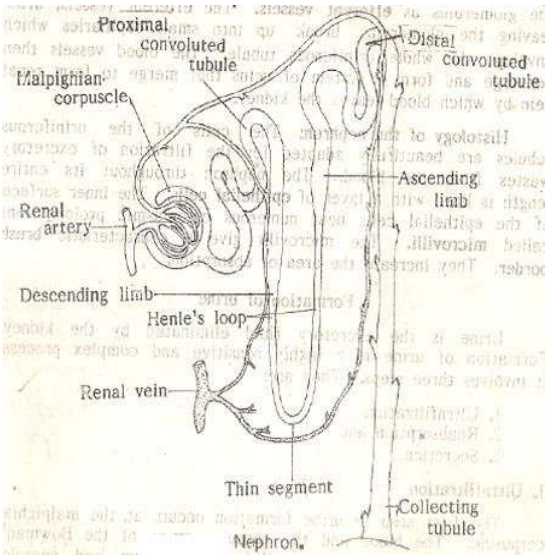
The urini ferous tubules form collecting duct of Bellini, which opents at the tip of the pyramid.

The tip of the pyramid has numerous minute pores.

Through these pores, the duct of Bellini pore the secretions into the

pelvis.

From the pelvis it reaches the ureter.



Structure of a nephron:

The nephron is the basic structure and functionsl unit of kidney.

Each nephron is caoiled tubule. Each tubule consists of Bowman's

capsule,

Proximal convoluted tubule Henle's

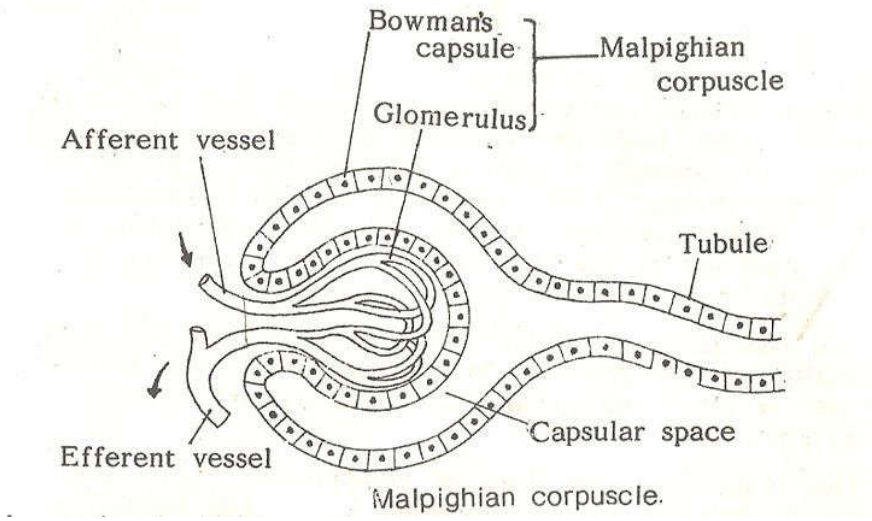
loop

Distal concoluted tubule and

Collecting duct, which opens into the pyramid

The Bowman's capsule is a double-wlled cup like structure. The space between the two walls is the capsular space.

Inside the cup lies a net work of capillaries called glomerulus



The afferent arterioles supply blood to glomerules. The efferent arterioles leave out from the glomerulus

The glomerulus and the Bowman's capsule together constitute the malpighian capsule.

The Bowmans capsule leads to proximal convoluted tubule. This tubule leads to the 'U' shaped Hanles loop .

The Henle's loop has 3 regions namely, A proximal descending limb,

A middle thin sement and A distal ascending limb

The ascending limb leads to the distal convoluted tubule, which opens into the collecting duct.

Several nephroi open into the collecting duct

The collecting duct in turn opens into the pyramid

The renal artery supply blood to the kidney The renal vein leaves out from the kidney The renal vein leaves out from kidney.

Histology of nephron:

The inner surface of each nephron is lined with a single layer of pthelial cells.

The inner surface of the cells are provided with micro villi. So, they give characteirstic brush border appearance.

Thus they increase the absorptive area.

4. Formation of urine

In the idneys, the urine formation occurs In involvesthree steps. They are,

Ultra filtrations Reabsorption and Secretion

Ultra filteration

The malpighian capsule is the place whereurine formation starts. The arterial blood flows in the glomerulus's

The blood is filtered by the Bowman's capsule.

Then it enters into the capsular space is called glomerular filtrate It

resembles blood in all aspects except its proteins and cells.

The glomerular filtration is nearly 180 liters/day The filtration is facilitated by two factors.

(1) The glomerular capillaries have thin walls and many minute pores. They allow the blood to pass through it. But it will not permit the proteins and blood cells to pass through it.

(2) The driving force of the moving fluid into Bowman,s capsule is the blood pressure in the capillaries.

(3) The pressure in the glomerules is higher than that of Bowman's capsule.

(4) So, the fluid moves toward the capsular space. Then the filtrate passes into convoluted tubule.

Reabsorption:

Normally the glomerular filtrate formed in a man per day is 180 litres. But about 1% of this filtrate is excreated in the from of urine.

The remaining 99% is reabsorbed into the blood through the capillaries found around the uriniferous tubules.

During reabsorptin

The initial glomerular filtrate has similar composition like that of plasma. So, it is isotonic to blood plasma. When it passen through the proximal convoluter tubule, nearly 85% of water, sodium ions, chloride ions, all glucose, vitamins and amino acids are reabsorbes by the capillaries. Now the glomerular fitrate is called renal fluid. In the proximal tubule reabsorption requires enery in the from of ATP- this energy is obtained from the mitochondria locater in theepithelial cells of the tubule.

From the proximal tubule the nenal fluid moves to the henles loop.

The Henle's loop has 3 regions namely, descending limb, thin segment and ascending limb.

The ascending limb has thick wall and impermeable to water. It pumps out Naions actively into the surrounding tissue fluid.some of the Na ions from the tissue fluid enter into the descending limb.

Thus there is a circulation of Na ions between the ascending limband descending limb.

The concentration of Nacl is highest in the medulla and lowest in the cortex.

Because the walls of ascending limb of Henle's loop is impermeable to water Na ions alone will leave ut from this region.

So, the filtrate in the reaches the loop of Henle loses much of its sodium.

Thus, when the renal fluid reaches the distal convoluted tubule, it

contains less salt than that of glomerular fitrate.

In the collecting duct the water is reabsorbed. So, the renal fluid become concentrated.

When the renal fluid moves to the collecting duct from the digital convoluted renal fluid become isotonic with the digital convoluted tubule. Water moves slowly by osmosis and reach the intertubular fluid. So, the renal fluid become isotonic with the fluid surrounding the duct

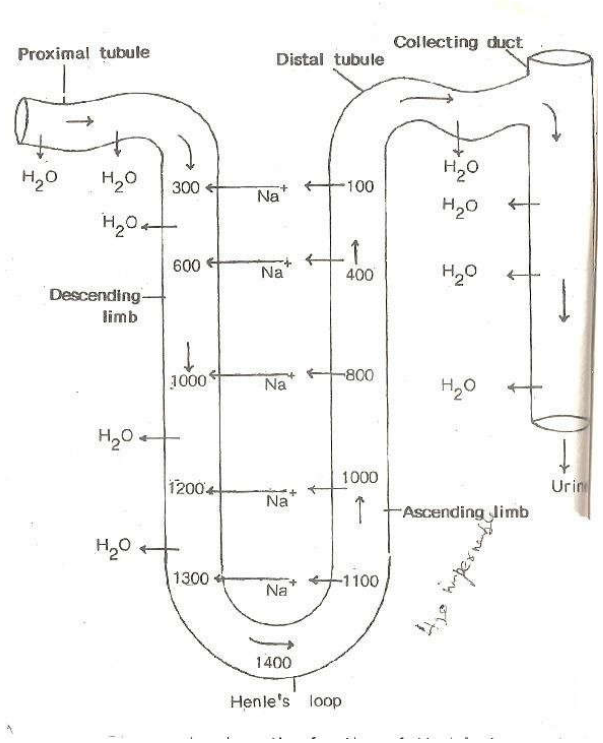
Now, this fluid is called urine

The substances reabsorbed are, amino acids, glucose, protein and phosphate (proximal tubule)

Potassium, sodium chloride and bicarbonates are absorbed in the proximal and distal tubules.

Water reabsorption occurs in the distal tubule and collecting tubule. Sodium is reabsorbed from the ascending limb.

Counter current Machanism:



The formation of concentrated urine was explained by WIRZ (1951) and Bray (1960). By the

counter current mechanism theory.

The Na^+ ions present in the ascending limb of Henle's loop are actively pumped out into the medullary tissues.

So, the medullary tissues become concentred.

Because of this water diffuse out from the desending limb until the fluid in the medullary tissues and descending limb ecome isotonic.

Thus, when the fluid moves toward the ascending limb, it become gradually concentrated.

So, the hair pin curve region of handle loop has maximum concentration 1400 mill:osmoles/litre.

At the same time Nat ions present in the tissue fluids enter into the descending limb by diffusion.

Thus the concentration of renal fluid is progressively concentrated in the descending limb and progressively diluted in the ascending limb.

The distal convolted tubule is permeable to water so, water diffuses out and the renal fluid become isotonic.

From the collecting duct water diffuses out and the renal fluid become concentrated to from urine.

The urine is then released out through the renal tubules and pelvis.

This is collected in the urinary bladder and expelled out periodically.

Secretion:

The final urine contain certain substances in more concentration and some additional substances while are nor found in the glomerular filtrate2.

It is evident that the urinary epithelium secreted some substances into the lumen of urinary tubule. It occurs mainly in the convoluted tubules.

Besides K+ and Na+ ions some foreign substances are introduced into the body for various diagnostic purposes. They are also removed from the plasma by the tubular epithelium. Thus urine is helpful for diagnostic purpose.

Kidney Transplantation

Kidney transplantation refers to an operation in which a diseased kidney is replaced by a transplanted healthy kidney, either from a living donor (or) from a person who has just died (cadaver). One healthy donor kidney is sufficient to maintain the health of the recipient.

Factors in improving the results of transplants surgery are.

1) To prevent rejection, effective immune suppressant drug treatment is given.
2) Tissue typing in necessary to help in matching recipient and donor tissue for transplant surgery thus minimizing the risk of rejection of a donor organ by the recipient's immune system.
3) After removal of organ from the donor it should be washed with an oxygenated fluid and cooled. This reduces the risk of damage.

CRUSTACEANS

4) Among animals body fluids contain a lot of ions and molecules in various proportion. The regulation of these ionic and molecular substance in the living system is called osmoregulation.
5) Osmoregulation is an adaptaion by which the animals can live successfully in their environment.
6) Generally three different media are there in which the animals survive. They are the isotonic medium, hypotonic medium and the hypertonic medium.
7) When ionic or molecular substance are equally distributed between two solutions, they are called isotonic. Because there is no movement of water across the membrane. Sothere will be no osmotic pressure.
8) The animals that live in an isotonic medium need not wzchange the substance into the medium because the cytoplasm concentration us equal to that of the medium where they live. (eg) marine protozoa's body fluid has the same ironic concentration as sea water.
9) Hypotonic medium means the concentration of various substance in the medium is lesser than that of the concentration of cytoplasm of the organisms that live in it. (eg) body fluid of marine fishes has lesser solute concentration than sea water.
10) Hypertonic medium contains more number of soluble molecules.
11) **Osmoregulation:**
12) Osmoregulation requires energy. It is under the control of the animal. The animals are classified on the basis of osmoregulation as, poikilismotic and homoesmotic forms.
13) **Poiilosmotic forms** (osmocoformers)

14) The animals can change their body fluid concentration, as that of the external medium are repreented as poikilotherms.

15) (eg) Echinoderms, cephalopods etc.,

16) These animals are called osmoconformers because they cannot maintain the volume and concentration of their body fluid. So they are osmotic aly variable. These animals are further classified into,

17) Stenohaline and Euryhaline forms

18) Stenohaline forms:

19) These animals and plants are restricted to narrow of salinity. Even a slight change in salinity occurs, they annot survice.

20) Euryhaline forms:

21) These organisms can tolerate wide range variations in salinity. (Eg) mytilus, aplysia etc.,

22) **Homoesosmotic forms** (osmorgulators)

23) These animals can maintain a constant volume of internal body fluid irrespective of the variations found in the medium. So, they are called osmoregulators. These are osmotically stable.

24) (eg) Amoeba proteus, carcinus etc.,

25) Osmoregulation in teleost fishes:

26) Fishes are homostmotic forms.

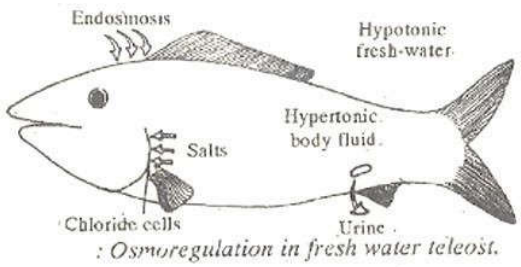
27) They are osmotically stable because they are osmoregulators. They can tolerate a wide range of variations in salinity.

28) Osmoregulation infreshwater releosts:

29) The body fluid of fresh water teleost contain hyperonic body fluid. So, there is possibility of endosmosisis enty water from the medium to the body. So, the volume if body fluid become increased.

30) It leads to the dilution of salts in body fluid ie they tend to remove excess water through urine.

31) When excess waer is removed as urine, along with it some amount of salr is also excteted. Thus bofy fluid has decreased salt content. The salt loss is compensated by absorbing them from the medium through chloride cells f gills



: Osmoregulation in fresh water teleost.

32) Osmoregulation in marine teleosts:

33) In marine teleosts the body fluid has lesser concentration than that of

34) the sea.

35) So, the water from the body of the fish tent to move out by exossmosis. While they drink sez water, the increase in salinity is found in their

36) body fluid.

37) The excess salt is secreted out bythe chloride calls of gills.

38) They excrete concentrated urine to prevent dehydration. The kidneys of marine teleosts are aglomerular.

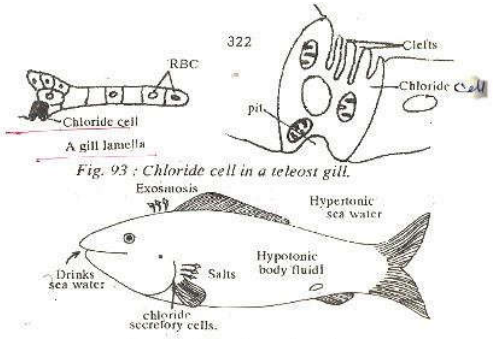


Fig. 93 : Chloride cell in a teleost gill.

39)

Osmoregulation in marine teleost.

40) Osmoregulation in crustaceans

41) The crustaceans are mrine and fresh water forms.

42) They are home osmotic and osmorgulators.
They are osmotically stable forms.

43) (Eg) Astacus, artemia salina, carcinus etc.,

44) Osmoregulation in astacus:

45) Astacus in the crayfish.

46) It lives in freshwater.

47) The body fliud of astacus is hypertonic while the medium is hypotonic to it. So, water enters into the body by endosmosis. The body fluid become diluted.

48) To equalize the water loss the animal drinks salt water.

49) While it drink salt water, the ionic concentration of body fluid get increased. The excess salt is removed by secreting by secreting them out through chloride calls of gills.

50) Carcinus:

51) Carcinus is a crab that lives in sea, where river flows in.

52) So, it is exposed to dilute water rainy seasons. Thus the medium is hypotonic to the body fluid of

carcinus.

53) So, the water enter into its body by endosmosis.

54) The excess water is removed by green glands in the from of urine. Along with urine large amount of salt also leaves out.

55) The slat loss is regained by the absorption of salt through chloride calls of gills. During summer the crab has to face a different circumstance.

56) Because there will be no rain during because there will be in rain during summer the medium become hypertonic. Thus the crab has to face a condition called dehydration by the loss, it body exosmosis.

57) To compensate water loss, it drink sea water which will lead to an increase in salt concentration in its body fluid. To overcome this situation it remove the excess salt by the chloride secreting cells. Thus carcinus can overcome bothconditions successfully.

Conduction of impulse through neuromuscular junction:

The neuromuscular junction is defined as the junction between a neuron and a muscle.

The axon loses its myelin sheath and divides into many fibres.

Each fibre ends in a bulged sole foot region. It contains mitochondria and synaptic vesicles with acetylcholine.

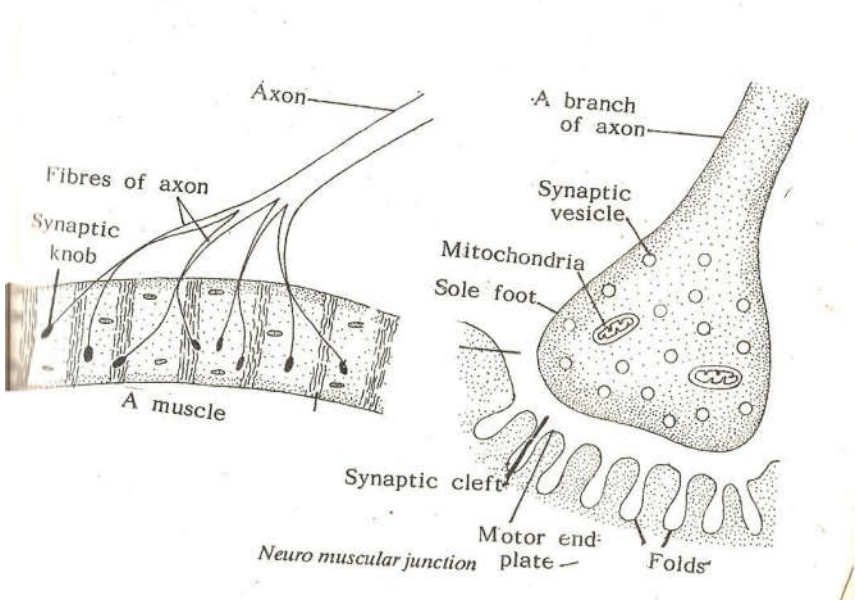
The membrane of the muscle fibre lying in close contact with the sole foot is called motor end plate. It has many folds and contains chemoreceptors.

The gap between sole foot and motor end plate is called synaptic cleft.

This is filled with a gelatinous substance.

When a nerve impulse reaches the sole foot.

Acetylcholine is liberated. It diffuses across the synaptic cleft. It reacts with chemoreceptor to form acetyl choline – receptor complex. It increases the permeability of sarcolemma to Na^+ and K^+ this complex causes depolarization of sarcolemma. Thus the impulse is transmitted through out the muscle fibre and causing contraction.



ENDOCRINE SYSTEM

The endocrine system is made up of discrete tissues or endocrine glands and also of scattered ells in other organs. The endocrine glands are called ductless glands.

They secrete hormones. The hormones are released directly into the blood stream. And reach the target organs through blood. The hormones are secreted in very small amounts. They are the messenger molecules.

Salient features of hormones:

- Hormones are biological catalysts.
- They are secreted in trace amounts.
- They act on specific target organs.
- They are liberated directly into the blood.
- They are water soluble substances.
- After their function is over they are destroyed or in cativated.
- Hormones are not species specific.
- Endocrine system is under the control of nerves.
- They are effective in extremely small amounts.

Mechanism of hormone action:

The hormones modify the physiological activity of a target cell or tissue.

Most of the hormones at by two mechanisms namely,

(i) Fixed – membrane receptor mechanisms namely,

(ii) Mobile – receptor – receptor mechanism.

(i)fixed – membrane receptor mechanism:

The water soluble hormones follow this mechanism. They are called "first messengers" – because they bind to specialized fixed receptors on the outer surface of the plasma membrane of the target cell.

So, they form a hormone – receptor complex (G- protein). The G – proteins have their link with the receptor on outside and with the enzyme Adenyl cyclase on the inner surface.

The activated aden.