M.Sc. (First Semester) Examination, 2015

Zoology

Paper: LZT-102

(Entomology and Fish Biology)

Model answer

Section A

Answer 1. (i) b (ii) b (iii) b (iv) b (v) d (vi) c (vii)d (viii) b (ix) a (x) c

Section B

Answer 2. Nervous system of Cockroach

In cockroach nervous system includes

a) Central nervous system

b) Peripheral nervous system

c) Visceral nervous system

Central nervous system

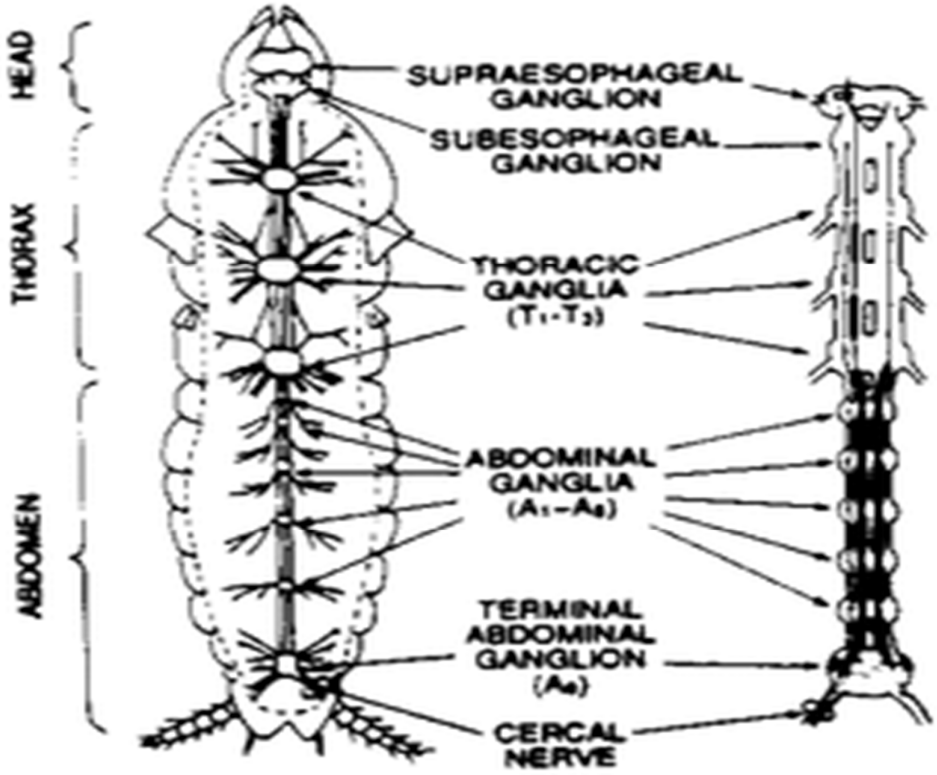
- ✓ It includes nerve ring, double ventral nerve cord and segmental ganglia.
- ✓ In cockroach nerve ring is present around the oesophagus.
- ✓ Nerve ring is formed by a pair of supra oesophageal ganglia, a pair of sub- oesophageal ganglia, a pair of circum oesophageal connectives which connect them.
- ✓ Supra oesophageal ganglia or brain is present on dorsal side of oesophagus. The brain is mainly a sensory and an endocrine center releasing hormones into the hacmolymph.
- ✓ A pair of subocsophageal ganglia that lies below the oesophagus. It is the motor center that controls the movements of mouth parts, legs, wings.
- ✓ A pair of circumocsophageal connectives that is present around the oesophagus, connecting the supraocsophageal ganglia with the subocsophageal ganglia.

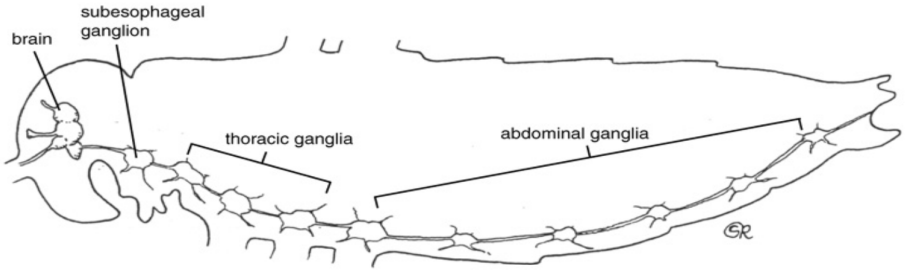
Ventral nerve cord

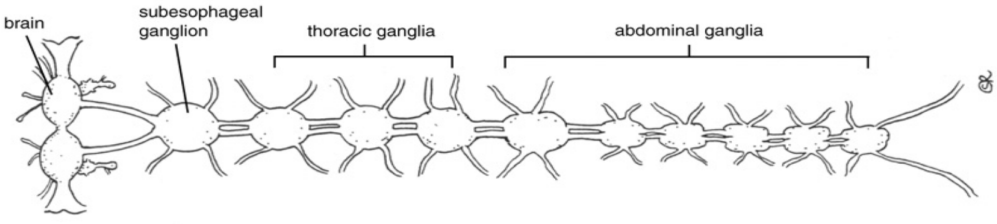
- ✓ It consists of two longitudinal nerves which are solid. Hence it is described as double solid ventral nerve cord.
- ✓ The nerve cord extends in between sub- oesophageal ganglia and the last abdominal ganglia present in the 7th segment.

Segmental ganglia

- ✓ Total no. of segmental ganglia in cockroach are 9. Among them 3 are present in thoracic region and 6 in the abdominal region.
- ✓ In cockroach abdominal ganglia are present in 1,2,3,4,6 and 7 segments.
- ✓ Abdominal ganglia are absent in 5, 8, 9 and 10 segments.
- ✓ The largest abdominal ganglion is 6th ganglion present in 7th abdominal segment.







b) Peripheral nervous system

- ✓ It includes nerves which arise from CNS and supply to the different parts of the body.
- ✓ From the brain 3 pairs of nerves arise and supply to compound eyes, antennae and labrum and also to frontal ganglion.
- ✓ Sub-oesophagcal ganglia gives off 3 pairs of nerves to mandibles, maxillae and labium.
- ✓ Thoracic ganglia supply nerves to legs and wings.
- ✓ Metathoracic ganglia send nerves to first abdominal segment. Nerves from each of the first five abdominal ganglia innervate all organs of each of the segments, two to six serially (1 to 4 ganglia innervate segments 2 to 5 respectively and 5'" ganglion innervates the 6'" segment).
- ✓ All organs present in 7lh to 10lh segments receive nerves from the last abdominal ganglion. The organs include the reproductive organs, copulatory appendages besides anal cerci.
- ✓ Abdominal ganglia supply nerves to body wall and other parts in those segments.
- ✓ The last abdominal ganglion supply neves to 7th, 8th, 9th and 10 th segments including anal cerci and anal styles in males.

c) Visceral nervous system

- ✓ Visceral is also called somatogastric nervous system.
- ✓ It includes 4 nerve ganglia and nerves which connect them and supply to visceral organs.
- ✓ The nerve ganglia are
- ✓ Frontal ganglion - present on pharynx, just infront of the brain.
- ✓ Occipital ganglion or Hypoccrebral ganglion - Present behind the brain above the oesophagus.
- ✓ Visceral ganglion - present on the wall of crop.
- ✓ Provenlricular ganglion: It is present on gizzard.
- ✓ Stomatogastric nervous system supply nerves to alimentary canal heart and other visceral organs. It regulates the functions of those organs hence it is called visceral nervous system.

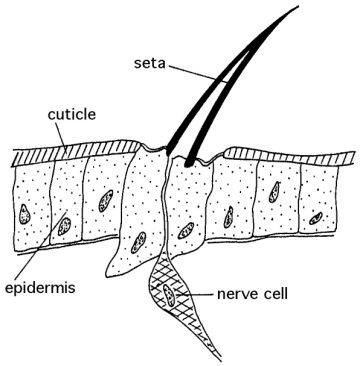
Answer 3. A mechanoreceptor is a sensory receptor that responds to mechanical pressure or distortion.

Insect mechanoreceptors can be found almost anywhere on the surface of an insect's body.They may act as tactile receptors, detecting movement of objects in the environment, or they may

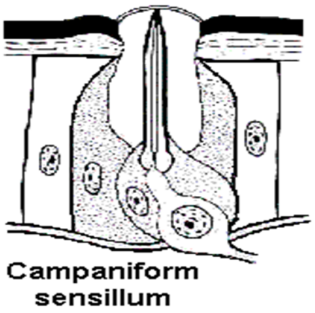
provide proprioceptive cues (sensory input about the position or orientation of the body and its appendages).

These receptors are innervated by one or more sensory neurons that fire in response to stretching, bending, compression, vibration, or other mechanical disturbance.

Trichoform sensilla are the simplest mechanoreceptors. These are tactile hairs (setae) that are innervated by a sensory neuron. Dendrites of the neuron attach near the base of the hair and generate a nerve impulse whenever they detect movement. Hair beds (clusters of tactile setae) are often found behind the head, on the legs, or near joints where they respond to movements of the body.



Trichoform sensillum



Campaniform sensilla are flattened oval discs that usually serve as flex receptors in the exoskeleton. They respond whenever mechanical stress causes the exoskeleton to bend. Campaniform sensilla are found throughout the body -- especially on the legs, near the base of the wings, and along sutures where two sclerites of the exoskeleton meet.

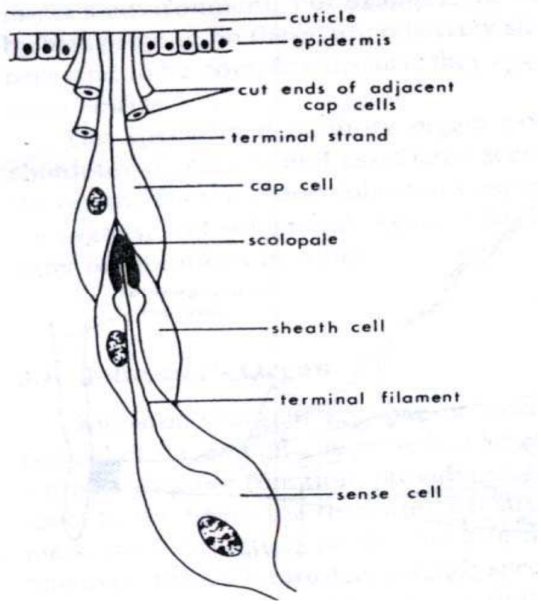
Chordotonal organ- It consists of single unit or group of similar unit is called scolopidia. They are sub-cuticular and are attached to the cuticle at one or both end often no sign of their presence. Each scolopidia consists of three cells:

a. Neuron

b. Scolopale cell or enveloping cell

c. Cap cell

The chordotonal organs occur in legs at femoral, distal tibial and tibio-tarsal regions, in abdomen and wing base. They are stimulated by passive movement of segments, tension of muscles, internal pressure changed due to blood and tracheae.



Chordotonal organ

Q4. Describe the endocrine system and hormonal regulation in insect

Endocrine system-Is involved in the integration and coordination of long-term events through chemicals called hormones. Endocrine system of insect consiste of following glands

i. Neurosecretory cells
ii. Carpora cardiaca
iii. Carpora allata
iv. Prothoracic gland

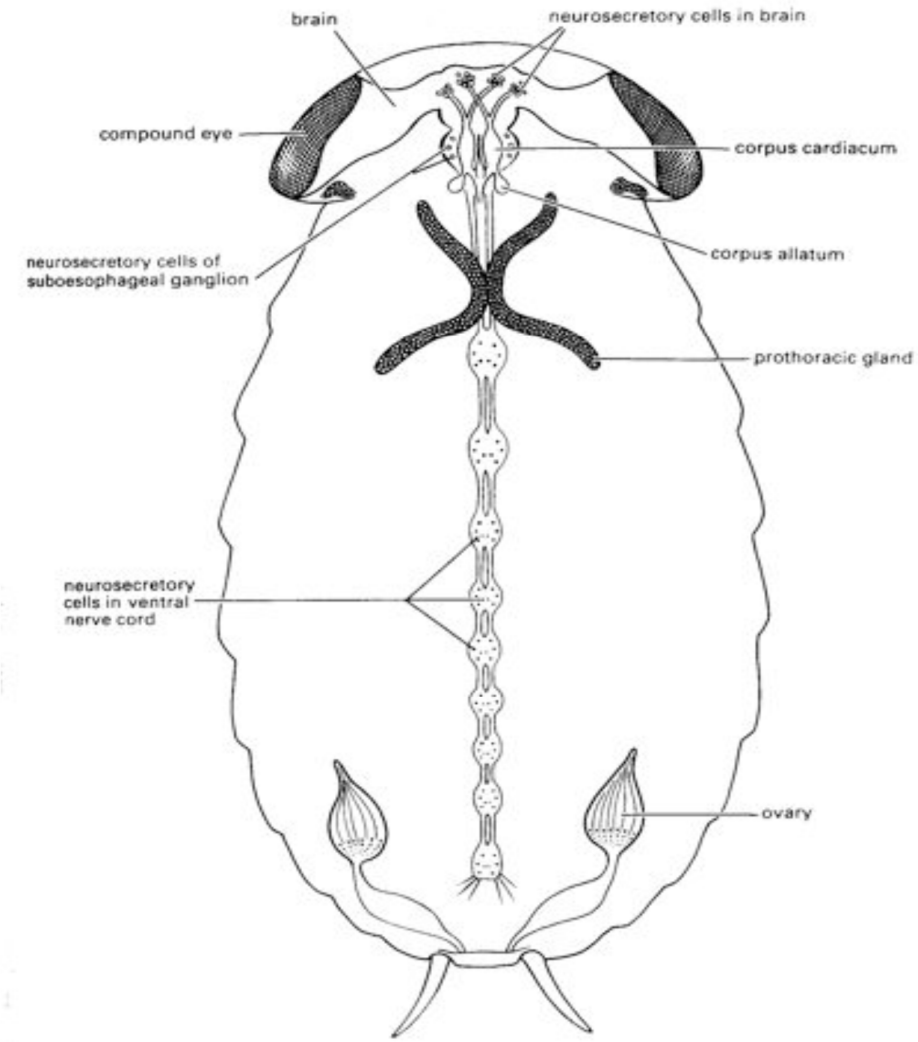
Neurosecretory cells (NSC): specialized nerve cells that secrete brain hormones(BH)

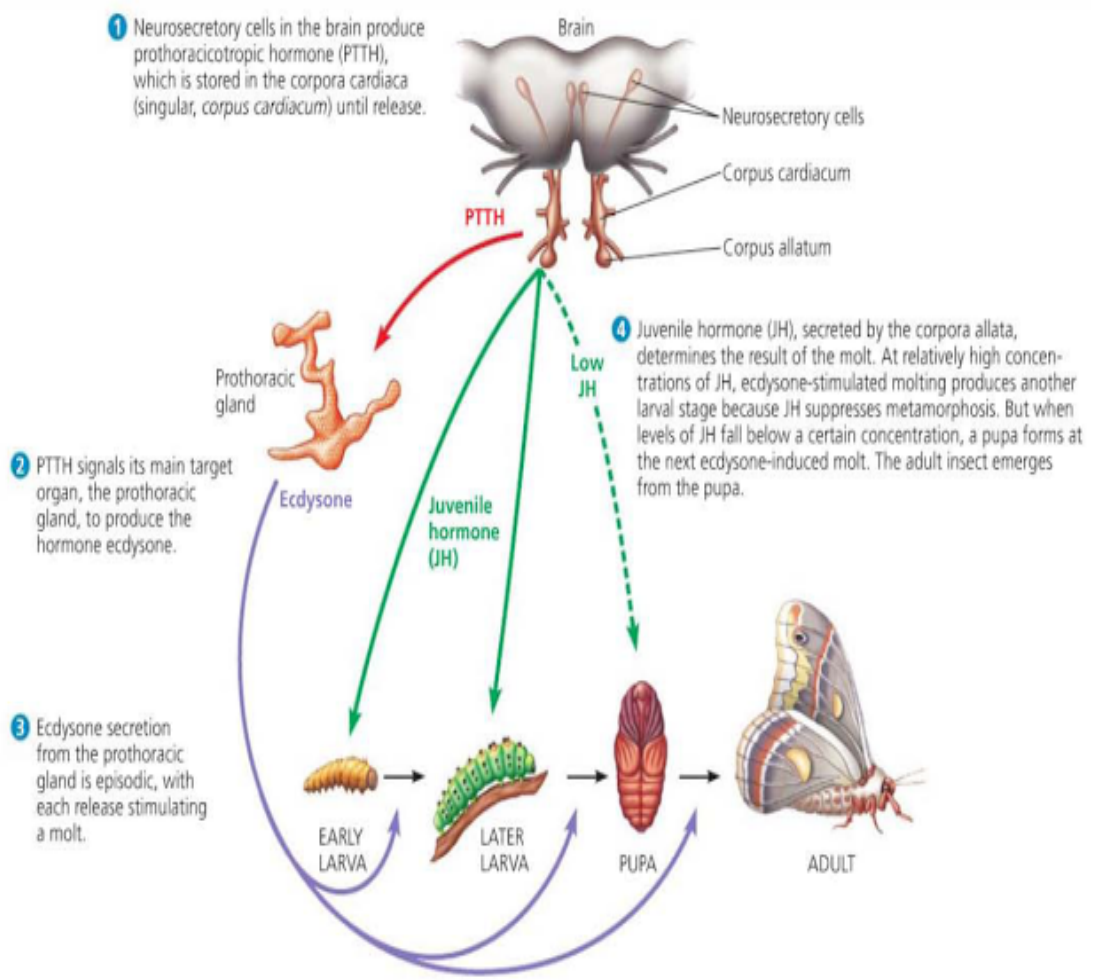
•NSC is found in pars intercerebralis of protocerebrum and other parts of brain and ventral nerve cord

- Ganglion: a whole ganglion become a hormone synthesis / releasing organ:

Corpora cardiac and corpora allata

Prothoracic gland(PTG): It located in the prothorax and secrets ecdysone that regulate molting


brain
neurosecretory cells in brain
compound eye
corpus cardiacum
corpus allatum
neurosecretory cells of
suboesophageal ganglion
prothoracic gland
neurosecretory
cells in ventral
nerve cord
ovary

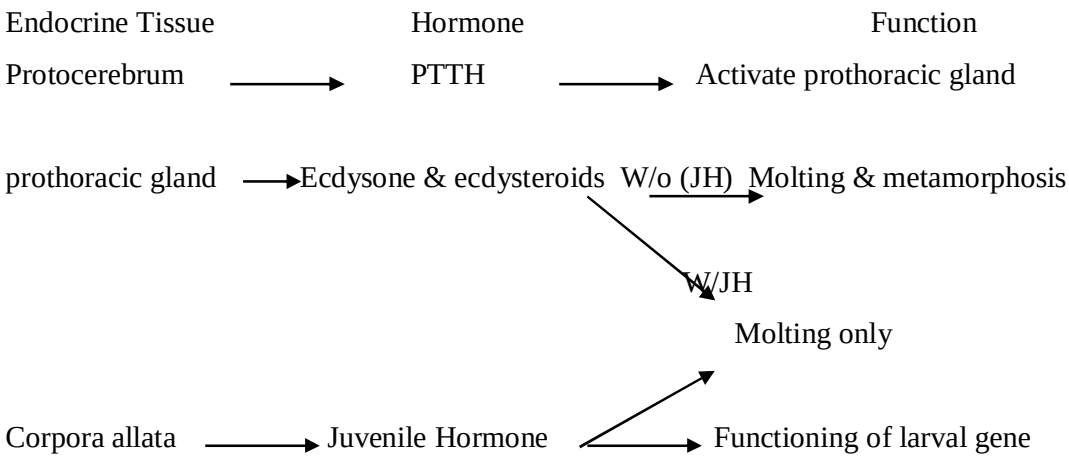


i) Brain Hormone- Produced by the neurosecretory cell of brain. This hormone serve to activate the corpora cardiaca, a component of retro cerebral complex of visceral nervous system

ii) PTTH(Prothoracicotropic hormone)-This hormone is secreted by corpora cardiaca which stimulate the prothoracic gland to release ecdysone hormone

iii) Ecdysone – Produced by prothoracic glands. It controls epidermal cells expression of new exoskeleton and molting fluid.

iv) Juvenile Hormone – produced by corpora allata controls modification and expression of the molt (and other functions). It inhibits metamorphosis.

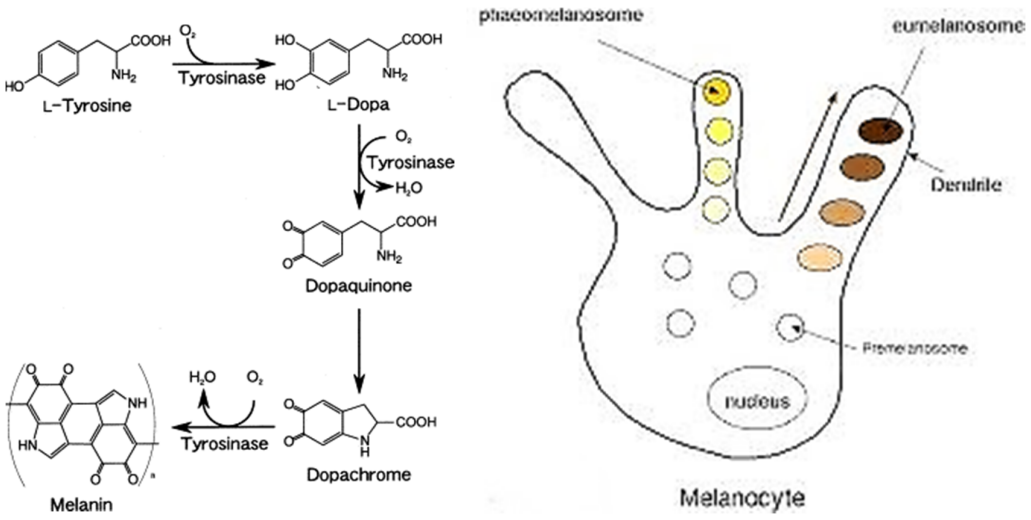


Hormones play a major role

1. Regulation of molting
2. Determination of form at metamorphosis
3. Effects on polymorphism
4. Regulation of diapause
5. Involvement in reproduction
6. Regulation of metabolic activities and general body functions
7. Regulation of behavior
8. Regulation of preprogrammed cell death

Answer 5. Chromatophores are branched connective tissue cells, which are located in the dermis either above or below the scales. They contain various kinds of pigment granules, which may be carotenoids (yellow-red), melanin (black), flavines (yellow) purines (white or silvery), pterins, porphyrins and bile pigments. Based upon the color of the pigments, the chromatophores are of the following types. .

a. Melanophores: In melanophores, the pigmentary material is black colored pigment called melanin. Melanin is formed from the amino acid tyrosine by a series of biochemical reactions in presence of enzyme tyrosinase that need copper as a cofactor. Melanin formed in this manner, associates with the cytoplasmic organelle called the melanosome. A brownish black pigment called eumelanin is also sometimes found within the melanophores.



b. Iridophores: Iridophores contain guanine as pigmentary material. Guanine is opaque, whitish or silvery. It is a waste product, which is deposited in the form of granules. These granules are opaque and possess great reflecting power, so that the iridocytes may also be called the minor cells. Tiny crystals of this pigment produce a white or silvery white appearance and against a background of melanophores, impart a blue color to the fish.

c. Xanthophores and Erythrophores: Here, the pigmentary material are carotenoids and pterins. These white, yellow, orange or red colored pigments are abundantly found in plants. As the fishes are incapable of synthesizing them, have to depend upon the plants for a dietary supply of the pigmentary material. The cellular organelle containing pteridines are known as pterinosome and the ultra-microscopic vesicles of cells containing carotenoid are called the carotenoid vesicles.

Color patterns of a majority of a fishes are due to the combined effects of chromatophores containing different kinds of pigmentary granules. Thus the black and yellow chromatophores, together develop green coloration. Likewise, yellow and black and orange and blue may combine separately to provide a brown appearance to the fish. Yellow mixed with black gives brown or blackish coloration in fishes.

Importance of minerals: (any four)

Calcium: Calcium is an essential component of bone, cartilage and the crustacean exoskeleton. Calcium is essential for the normal clotting of blood, by stimulating the release of thromboplastin from the blood platelets. Calcium is an activator for several key enzymes, including pancreatic lipase, acid phosphatase, cholinesterase, ATPases, and succinic dehydrogenase. Through its role in enzyme activation, calcium stimulates muscle contraction

(i.e. promotes muscle tone and normal heartbeat) and regulates the transmission of nerve impulses from one cell to another through its control over acetylcholine production. Calcium, in conjunction with phospholipids, plays a key role in the regulation of the permeability of cell membranes and consequently over the uptake of nutrients by the cell. Calcium is believed to be essential for the absorption of vitamin B12 from the gastrointestinal tract.

Phosphorus: Phosphorus is an essential component of bone, cartilage and the crustacean exoskeleton. Phosphorus is an essential component of phospholipids, nucleic acids, phosphoproteins (casein), high-energy phosphate esters (ATP), hexose phosphates, creatine phosphate, and several key enzymes. As a component of these important biological substances, phosphorus plays a central role in energy and cell metabolism. Inorganic phosphates serve as important buffers to regulate the normal acidbase balance (ie. pH) of animal body fluids.

Magnesium: Magnesium is an essential component of bone, cartilage and the crustacean exoskeleton. Magnesium is an activator of several key enzyme systems, including kinases, mutases (transphosphorylation reactions), muscle ATPases, and the enzymes cholinesterase, alkaline phosphatase, enolase, isocitric dehydrogenase, arginase (magnesium is a component of the arginase molecule), deoxyribonuclease, and glutaminase. Through its role in enzyme activation, magnesium (like calcium) stimulates muscle and nerve irritability (contraction), is involved in the regulation of intracellular acid-base balance, and plays an important role in carbohydrate, protein and lipid metabolism.

Sodium, Potassium and Chlorine

Sodium, potassium, and chlorine occur almost entirely in the fluids and soft tissues of the body, sodium and chlorine being found mainly in the body fluids, and potassium occuring mainly in the cells. They serve a vital function in controlling osmotic pressures and acid-base equilibrium. They also play important roles in water metabolism. Sodium is the main monovalent ion of extracellular fluids; sodium ions constituting 93% of the ions (bases) found in the blood stream. Although the principal role of sodium in the animal is connected with the regulation of osmotic pressure and the maintenance of acid-base balance, sodium also has an effect on muscle irritability, and plays a specific role in the absorption of carbohydrate.

Potassium is the major cation of intracellular fluid, and regulates intracellular osmotic pressue and acid-base balance. Like sodium, potassium has a stimulating effect on muscle irritability.

Potassium is also required for glycogen and protein sysnthesis, and the metabolic breakdown of glucose.

Chlorine is the main monovalent anion of extracellular fluids; chlorine ions constituting about 65% of the total anions of blood plasma and other extracellular fluids within the body (ie. Gastric juice). Chlorine is therefore essential for the regulation of osmotic pressure and acid-base balance. Chlorine also plays a specific role in the transport of oxygen and carbon dioxide in the blood, and the maintenance of digestive juice pH.

Sulphur: Sulphur is an essential component of several key amino acids (methionine and cystine), vitamins (thiamine and biotin), the hormone insulin, and the crustacean exoskeleton. As the sulphate, sulphur is an essential component of heparin, chondroitin, fibrinogen and taurine. Several key enzyme systems such as coenzyme A and glutathione depend for their activity on free sulphydryl (SH) groups. Sulphur is believed to be involved in the detoxification of aromatic compounds within the animal body.

Iron: Iron is an essential component of the respiratory pigments haemoglobin and myoglobin. Iron is an essential component of various enzyme systems including the cytochromes, catalases, peroxidases, and the enzymes xanthine and aldehyde oxidase, and succinic dehydrogenase. As a component of the respiratory pigments and enzymes concerned in tissue oxidation, iron is essential for oxygen and electron transport within the body.

Zinc: Zinc is an essential component of more than 80 metalloenzymes, including carbonic anhydrase (required for the transport of carbon dioxide by the blood and for the secretion of HCI in the stomach), glutamic dehydrogenase, alkaline phosphatase, pyridine nucleotide dehydrogenase, alcohol dehydrogenase, superoxide dismutase, pancreatic carboxypeptidase, and tryptophan desmolase. Zinc serves as a cofactor in many enzyme systems, including arginase, enolase, several peptidases, and oxalacetic decarboxylase. As an active component or cofactor for many important enzyme systems zinc plays a vital role in lipid, protein, and carbohydrate metabolism; being particularly active in the synthesis and metabolism of nucleic acids (RNA) and proteins. Although not proven, it has been suggested that zinc plays a role in the action of hormones such as insulin, glucagon, corticotrophin, FSH and LH. Zinc is believed to play a positive role in wound healing.

Manganese: Manganese functions in the body as an enzyme activator for those enzymes that mediate phosphate group transfer (ie. phosphate transferases and phosphate dehydrogenases), particularly those concerned with the citric acid cycle including arginase,

alkaline phosphatase and hexokinase. Manganese is an essential component of the enzyme pyruvate carboxylase. As a cofactor or component of several key enzyme systems, manganese is essential for bone formation (re. mucopolysaccharide synthesis), the regeneration of red blood cells, carbohydrate metabolism, and the reproductive cycle.

Copper: Copper is an essential component of numerous oxidation-reduction enzyme systems. For example, copper is a component of the enzymes cytochrome oxidase, uricase, tyrosinase, superoxide dismutase, amine oxidase, lysyl oxidase, and caeruloplasmin. As a component of the enzyme caeruloplasmin (ferroxidase), copper is intimately involved with iron metabolism, and therefore haemoglobin synthesis and red blood cell production and maintenance. Copper is also believed to be necessary for the formation of the pigment melanin and consequently skin pigmentation, for the formation of bone and connective tissue, and for maintaining the integrity of the myelin sheath of nerve fibres.

Cobalt: Cobalt is an integral component of cyanocobalamin (vitamin B12), and as such is essential for red blood cell formation and the maintenance of nerve tissue. Although not confirmed, cobalt may also function as an activating agent for various enzyme systems.

Iodine: Iodine is an integral component of the thyroid hormones, thyroxine and triiodo-thyronine, and as such is essential for regulating the metabolic rate of all body processes.

Selenium: Selenium is an essential component of the enzyme glutathione peroxidase, and as such (together with the tocopherols - vitamin E) serves to protect cellular tissues and membranes against oxidative damage. It has also been suggested that selenium participates in the biosynthesis of ubiquinone (coenzyme Q; involved in cellular electron transport) and influences the absorption and retention of vitamin E.

Chromium: Trivalent chromium is an integral component of the glucose tolerance factor (GTF; a low molecular weight compound with trivalent chromium coordinated to two nicotinic acid molecules with the remaining coordinates protected by amino acids) and acts as a cofactor for the hormone insulin. Apart from its vital role in carbohydrate metabolism (ie. glucose tolerance and glycogen synthesis), trivalent chromium is also believed to play an important role in cholesterol and amino acid metabolism.

Answer 6. Fishes are used by human beings in different forms. Millions of human beings suffer from hunger and malnutrition, and fishes form a rich source of food and provide good stable food to tide over the nutritional need of man. Most of the captured fishes are utilized as food, while others are distasteful and considered unsuitable for human consumption. Similarly, the material discarded during fish

processing also becomes a waste. Such fishes and discarded materials become an important source of raw materials to fish bye product industries and are used to produce several useful bye-products.

Fish is rightly considered as the "poor man's diet'.

(a) Fish liver oil: Chemical composition of fish liver oil is as follows:

Fat 55-75%

Proteins 5-10%

Water 20-36%

Cholesterol..... 0.46-1.32%

Vitamins .....A and D

Iodine 158.7-166.6%

Vitamin A, vitamin D and also vitamin E, constitute the most important part of the fish liver oil. Their quantities may vary from fish to fish and from season to season. Cod liver oil, for example, is rich in fat but poor in vitamin A. Halibut and Tuna are rich in vitamin A contents, but poor in fat. The livers of sharks generally have the highest contents of vitamin A and fat. Vitamin E present in fish liver oil exerts a protective action against vitamin A oxidation. Shark and Cod (*Gadus callarius*) liver oil are well known in pharmaceutical industries. In fact, the prime value of sharks and rays lies in their liver oil. As food fishes, they rank lower than bony fishes on account of their 'urea' flavor. For commercial purposes, the larger the sharks, the better their livers, which yield more oil.

Depending upon extraction from fresh or stale livers, oil is grouped into 3 types:

(I) Pale cod liver oil.

(2) Light brown oil.

(3) Brown oil.

Pale cod liver oil is obtained from liver of the fishes that are brought alive to the shore. They are sacrificed and their livers are separated and heated by steaming in jacketted vessels (under 2 kg/sq. cm of pressure). During heating, the cell membranes of liver cells burst and exuded, oil is collected. This oil possesses highest medicinal value. Vitamin D is independent of vitamin A. In general, the less the oil content of the liver, the greater is the vitamin D content.

Light brown liver oil is procured from disintegrated livers of fishes. Like pale oil, it is also used for medicinal purposes in pharmacy.

Brown oil is not usually preferred in pharmacy because of its extraction, which is done from liver of stale fishes. The use of brown oil for various other purposes is, however, noteworthy. Besides vitamin A, D, and E, other important component of fish liver oil is cholesterol or the crude form of the liver oil is used

for tanning leather, tempering steel, preparation of soaps, etc. Practically, no cod liver oil is produced in India, but shark liver oil is frequently produced. The following sharks are exploited for their liver oils: *Carcharhinus melanopterus*, *C. gangaticus, C. Iimbatus, Sphyrna blochii, Pristis cuspidatus, Scoliodon walbeehrni*, etc.

(b) Fish manure

Surplus fishes or those unfit for human consumption or when the fishes get rotten due to bad preservation are used as fertilizers for coffee, tea, tobacco, and rubber plantation because it is rich in nitrogen and phosphates. During peak season, when there is a large supply of fishes or they are landed in spoiled conditions, they are sun dried by spreading them on the beach. The dried fishes are ground and converted into manure. Fish manure prepared from the dried and putrid fishes are of three kinds viz, the fish manure, prawn manure and the fish guano. Fish manure is prepared by mixing ash with the dried fishes. The resulting mixture contains about 5-7% nitrogen and phosphate. It is considered ideal for manuring plants. Prawn manure is also prepared in the same manner from the leftouts of prawn (e.g. head, tail and body exoskeletons). It contains about 5-6% of nitrogen, 3-4% of phosphate and a small amount of lime. Fish guano is prepared from the fish materials left after the extraction of oil. It contains 7-10% of nitrogen and phosphates and is considered a rich nutrient for the plants.

(c) Isinglass:

Isinglass is a pure gelatinous substance which is obtained from the inner lining of the swim bladder (air-bladders) of fishes like catfish, carps, eels, polynemids, sciaenoids, sea bass, etc. It is a high-grade collagen product. Isinglass is made in various parts of the world form the swim bladders of diverse fishes such as the Sturgeons, Carps, Catfishes, Cod, Ling, Hake, Squeteagues, Drums, and Thread Fins. From the fish selected, the bladders are first removed and the blood and adhering materials are scraped off. Following this, they are cut open and washed thoroughly in running water. Then, the outer black membrane is removed by scrapping and the bladders are cut into pieces. The pieces are dried in an artificial drier or in open sky, i.e. given sun exposure. After all these processing, the product (Isinglass) is stored in suitable containers. It has many uses. The most common use is in clarifying beverages like bear, wine and vinegar; for making jellies, etc. and in the preparation of certain cements. Isinglass is also effective in the reduction of the suspended solids in beer and increase rate of filtration form 3,000 to 11,000 liters. Other uses of this product are as an adhesive base in confectionary products, Indian ink-work manufacture and also as an efficient adhesive for glass, pottery and leather products manufacture. Nevertheless, isinglass products having moisture content less than 8% find preference for industrial purposes.

(d) Fish meal (food for cattle): Fishmeal is prepared from wastes fishes left over after extracting oil from the fish. It is also prepared from non-edible fishes of both , the small and large sizes. Fishes are chopped and boiled to extract the oil. They are then covered with canvas and screw-pressed to form the cakes, that are then dried. Dried cakes with canvas and screw-pressed to form the cakes that are then dried. Dried cakes are sometimes pressed in hydraulic presses to recover oil and are redried in steam, before being sterilized and packed for marketing. The chief fishes used in this process include sardines, mackerels, sharks, rays and the silver bellies. Fishmeal is considered a valuable source of food for pig, poultry, and the cattle. Some good quality of fishmeal is mixed with maize flour to form fish flour to be used by human beings especially in biscuits and cakes making factories. Fish meal is rich in fat soluble vitamins like A, D, and K along with water soluble vitamins B1 & B12.

(e) Fish hydrolyzed protein: Flesh of certain fish is not preferred by humans for consumption. These fishes are used to prepare an easily digestible fish protein by following procedure.

- Fish flesh is minced , washed and boiled with dilute CH_3COOCH at 80^0C.
- A through washing of boiled flesh is made to remove the acetic acid.
- Washed flesjh is dried, pressed and treated with petroleum to remove the fat contents.
- Fat free flesh is hydrolysed with 10% caustic soda at 50^0C and the liquid so formed is neutralized with 85% acetic acid.

(f) Fish glue: Fish glue is a sticky substance and is prepared from different wastes (e.g. bones, scales and fins, etc.) discarded during processing. These are washed, grounded and cooked acetic acid in steam. Liquid is separated and condensed to form glue. It is used as a strong adhesive for layers, files, wood, leathers and glass. Glue is chiefly obtained from cods and sturgeons.

(g) Fish leather: skin of some fishes, particularly those of sharks and rays are sometimes used by mankind, is popularly called "shagreen". The skin of these fishes are used for making polishing and smoothing materials in place of sand paper. Specially colored shagreen is used for covering jewel boxes or for other ornamental coverings. The dried and treated skin is also used for preparing ladies shoes, money bags, belts, suitcase, etc. dried and spiny skins of globe fishes are used as a war helmet by natives of some islands in south seas. Scoliodon skin is a good source of shagreen. Greeland sharks (*Sonniosus microcephalus)* are killed because their skin is used for bookbinding.

(h) Fish pearl: the material obtained by scraping the silvery coating of the scales of certain cyprinid fishes like alburnus and gold fish is used for polishing the hollow glass beads. These beads are then filled with wax and marketed as artificial fish pearls used in jewelry.

(i) Fish soap: the fins of sharks aredried and exported especially to China where they are used for making soaps.

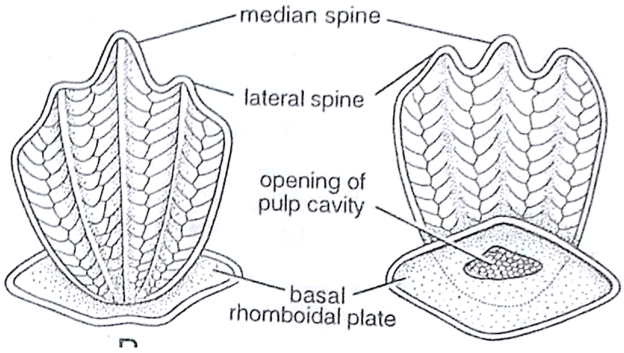
(j) Fish insulin: large sized fishes are dissected so as to remove the pancreas for obtaining insulin. Pancreas of the sharks is rich in insulin.

(k) Aesthetic value: some beautiful colored fishes are cultured in aquaria for decoration of houses. For example: gold fish (*Carassius auratus*), Angel fish (*Pterophyllus*), Molluscs fish (*Macropodus*), etc.

(l) Fishes in relation to public health (Larvicidal and scavenger fishes): Several species of fishes are known as larvicidal in nature and feed upon their larvae viz. mosquito larvae. They are helpful in biological control of many vector borne diseases like malaria and filarial. Young forms of almost all fishes found in plains eat mosquito larvae. Fishes are cheaper and non-toxic as against chemical for control of mosquitoes.

Answer 7. The scales are one of the most complex derivatives of the integument. They are derived from the mesenchymal cells of dermis and represent an exoskeleton that cover the skin in most of the fishes. Only a few fishes such as the electric rays, catfishes and cyclostomes are naked having no scales on the body. A few species like the *Polyodon* and *Acipensor* exhibit an intermediate condition, having scales or plates only at some localised regions of the body. In scaleless teleosts the analogue of scales appears, but only in embryos.

1. Placoid Scales: Placoid scales are found in the sharks and also known as dermal denticles. Structurally, placoid scale resembles a tooth. Though, the placoid scales are closely set but do not overlap each other. Each scale consists of two parts:



(i) Basal plate - It is embedded in the dermis and rhomboidal in shape. The basal plate consists of calcified tissue. According to Weichert (1970), it is a bony plate, which indicates the relic of ancestral bony armour. It is anchored into the dermis by connective tissue fibres called Sharpley's fibres.

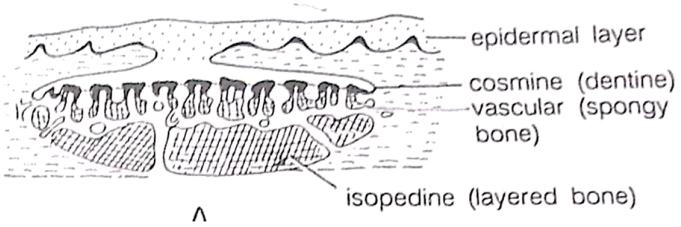
(ii) Trident spine- It is a flat trident and projects outward through the epidermis. The trident spines are curved and directed posteriorly thereby minimizing water friction. Each spine consists of dentine covered with a hard layer of vitrodentine. The dentine encloses a pulp-cavity, which opens below through the basal plate. Through this opening, blood vessels and

nerves enter the pulp-cavity. The pulp contains many odontoblasts (dentine forming cells). Fine canaliculi arise from the pulp cavity and reach the dentine. Placoid scales found in elasmobranchs.

2. Cosmoid Scales: These scales were abundantly found in primitive members of Sarcopterygii, Crossopterygii and the Dipnioi. The only living member with cosmoid scales is represented by the genus *Latimeria*. Cosmoid scales are regarded as the precursor of the ganoid, placoid and the bony scales of the modern teleosts. Each cosmoid scale consists of following three layers :

a. Isopedine. This is the inner (basal) layer consisting of layered bone. It is pierced by channels for blood vessels.

b. Vascular layer. This is the middle layer consisting of spongy bone and contains numerous vascular spaces.

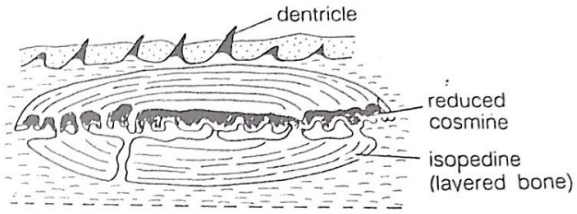


c. Cosmine. This is the outer layer made of dentine containing pulp cavities.

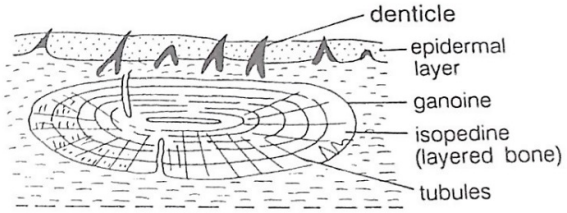
3. Ganoid Scales: These are of two following types:

[I] Palaeoniscoid ganoid scale: Such scales were found on primitive and extinct actinopterygians and on extant chondrosteans, the Polypterus. Features:

- Layered bone isopedine is present.
- Spongy bone is absent.
- Cosmine layer is reduced.
- Above the cosmine layer is the hard-multilayered ganoine, which lends the lustrous sheen (shining) to the scale.



Palaeoniscoid Ganoid Scale



Lepisosteoid Ganoid Scale

[II] Lepisosteoid ganoid scales

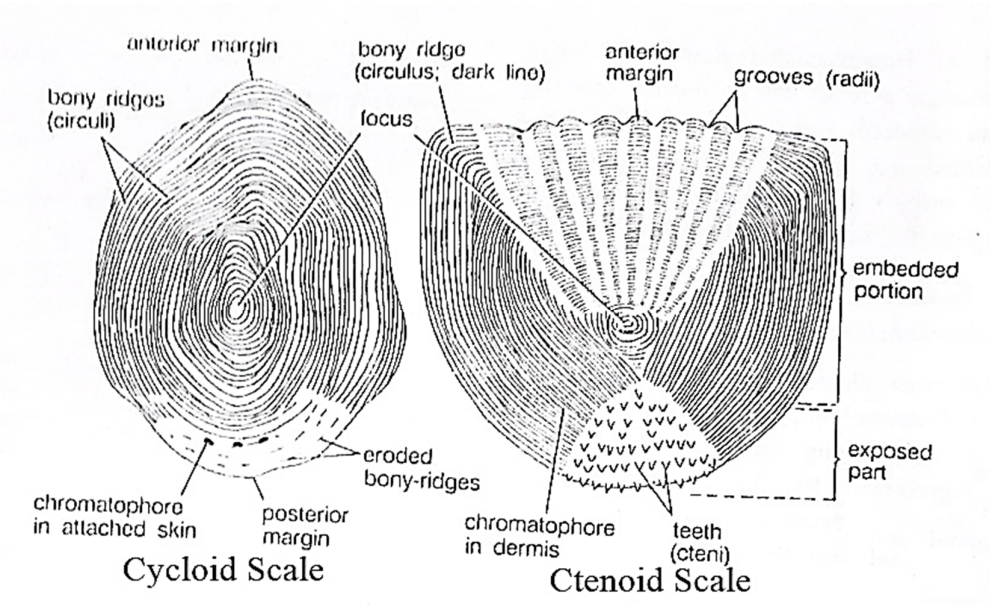
Such scales are found on more recent chondrostean, viz. *Lepisosteus* (gars). Feature:

- Spongy bone is absent;
- Cosmine layer is absent.
- Ganoine contains many tubules.

- Scales are arranged closely together, like tiles on a floor in diagonal rows.

4. Bony-Ridge Scales: These are of two types: Cycloid and Ctenoid scales.

Cycloid scales are characteristic of soft-rayed teleosts and modern lobe-finned fishes whereas ctenoid scales are present in most of the spiny-rayed teleosts. The ctenoid scale differs from the cycloid in having comb-like teeth or cteni in its posterior margin. These scales are composed of two layers only: isopedine layer and an inner dense fibrous layer. The scales are arranged in an overlapping fashion, like the tiles on a roof of a house. These show the following features:



1. Focus. This is the central zone or nucleus of cycloid and ctenoid scale and is the first part to develop. In some scales, focus may be away from the centre.

2. Circuli. These are a series of concentric bony-ridges around the focus also called lines of growth or "growth-rings".

3. Radii. These are the grooves that radiate from focus towards the margin of scales.

4. Annuli. These are annual (yearly) growth marks.

5. Anterior margin. This lies in the embedded part of the scale— (i) In ctenoid scales, the posterior margin is readily recognizable by the presence of comb-like teeth or cteni. (ii) In cycloid scales, it can be recognized by the presence of indistinct or eroded bony ridges (circuli).

Q8. Write short notes on* i) *Johnston's organs ii) ***Cuticle***

It found within the pedicel of each antenna. In some insects, they function as a proprioceptors, supplying information on position or orientation of the antennae. In mosquitoes and midges, they respond to certain frequencies of airborne sound by detecting resonant vibrations in antennal hairs. (Shorter hairs near the tip of the antennae resonate to higher frequencies than longer hairs near the base).

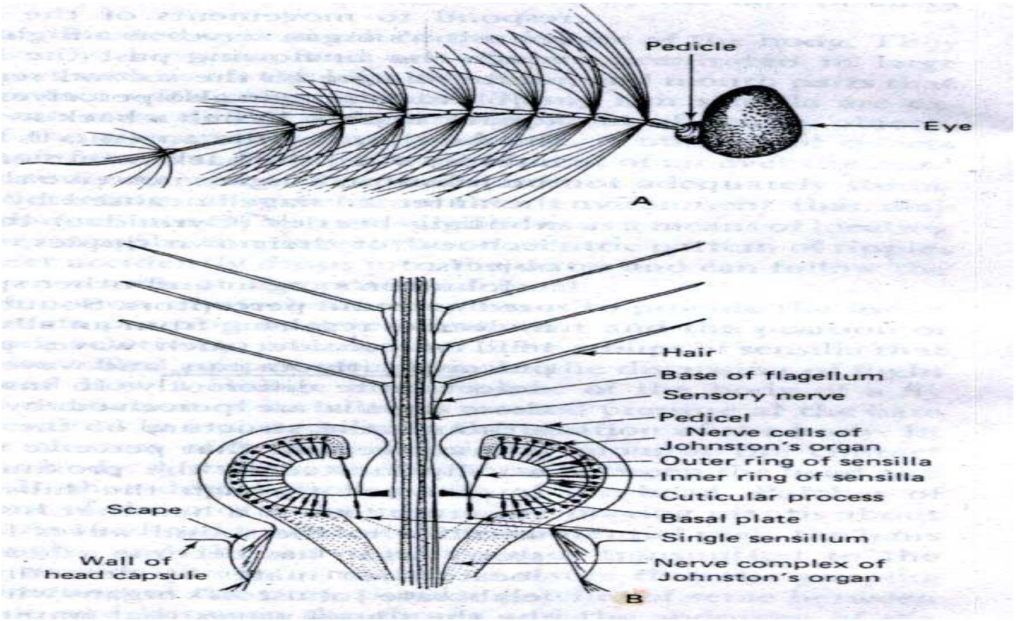


Fig.: Jhonston's organs. (A) Hairy antenna of a male mosquito showing a swollen pedicel that houses Jhonston's organ; (B) a diagrammatic section through Jhonston's organ

ii**) *Cuticle***

Insect body wall is called as Integument or Exoskeleton. It is the external covering of the body which is ectodermal in origin. It is rigid, flexible, lighter, stronger and variously modified in different body parts to suit different modes of life.

Structure

Body wall consists of an inner cellular layer (**Epidermis**) and an outer non cellular part (**Cuticle**).

Epidermis: It is an inner unicellular layer resting on basement membrane with the following function.

i. Cuticle secretion

ii. Digestion and absorption of old cuticle

iii. Wound repairing

iv. Gives surface look

Cuticle : It is an outer non cellular layer comprising of three sub layers.

It is an outer non cellular layer comprising of three sub layers.

i). **Epicuticle:** Outer most layer which is very thin. Pore canals present in the exocuticle helps in the deposition of epiculticle. This layer is differentiated into the following layers.

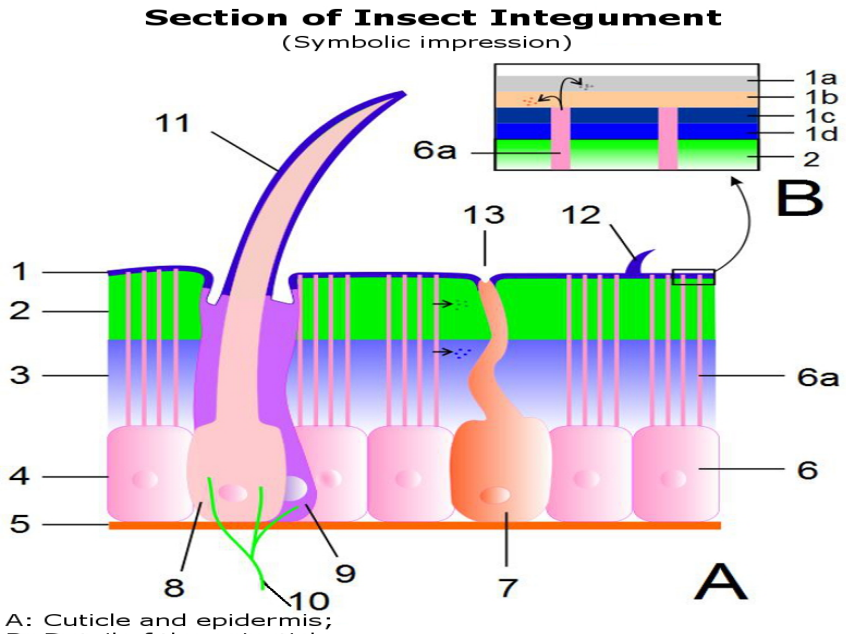
a. Inner epicuticle: It contains **wax filaments**

b. Outer epicuticle: It makes the contact with **cuticulin**

c. Cuticulin : Non chitinous polymerised lipoprotein layer.

d. Wax layer: It contains closely packed wax molecules which prevents desiccation.

e. Cement layer: Outer most layer formed by lipid and tanned protein. It protects wax layer.



ii). **Exocuticle**

Outer layer, much thicker with the composition of **Chitin** and **sclerotin**. This layer is dark in colour and rigid.

iii)**. Endocuticle**

Compared to others it is the inner and thickest layer. This layer is made up of **Chitin** and **arthropodin**. This layer is colourless, soft and flexible.

Resources: various internet websites and textbooks