SECTION-A (Multiple choice questions)

Q. 1-Answer

(i) **d** (ii) **c** **(iii) c** **(iv) a** **(v) b** (vi) **b** **(vii) b**

(viii) b **(ix) b** **(x) a**

SECTION –B (Descriptive type questions)

Q. 2- Answer

Two different types of scales are present in fishes;

(A) Placoid scale & (B) Non placid scale: It is further divided into three types:

1. Cosmoid scale

2. Ganoid scale:

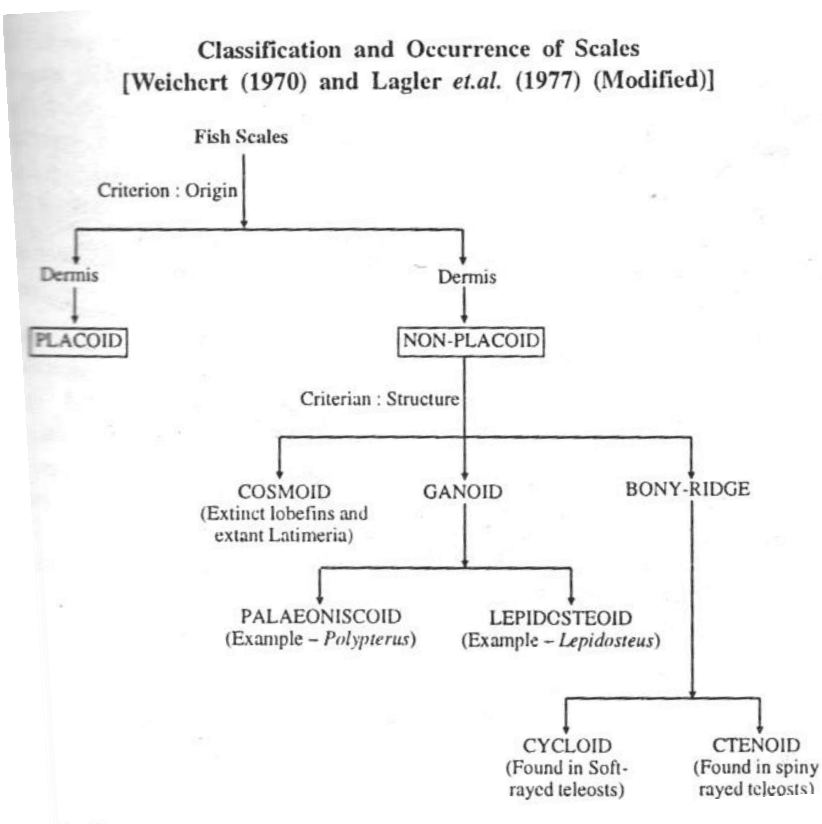
   (a)Palaeoniscoid

   (b)Lepidosteoid

3. Bony-Ridge scale:

   (a) Cycloid scale

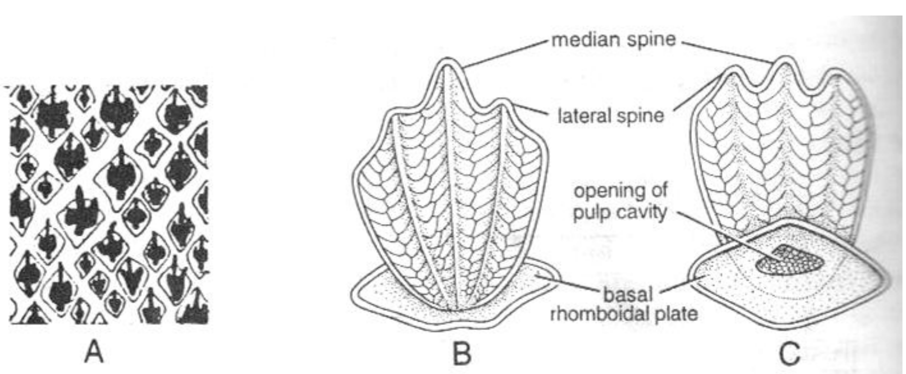
   (b) Ctenoid scale



(A) Placoid scale: These are also called as dermal denticles found in the sharks. In structure placoid scale resembes a tooth. Though the placoid scales are closely set but do not overlap each other.Each scale consists of two parts : (a) a rhomboidal basal plate embeded in the dermis and (b) a flat trident spine, projecting outward through the epidermis.

The basal plates consist 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 fibers called Sharpley' fibres.

The trident spines are curved and directed posteriorly there by minimizing water friction. Each spine consist 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 nervs enter the pulp- cavity. The pulp contains many odontoblast .Fine canaliculi arise from the pulp cavity and reach the dentine. Placoid scales found in elasmobranches are very much similar to the dentine o ostracoderms.



(B) Non- placoid scales:

(1) Cosmoid scales: These scale where abundantly found in primitive members of sarcopterygii, cross pterygii and the dipnoi. The only living members with cosmoid scale are represented by the genus Latimeria. Cosmod scales are regarded as the precursor of the ganoid and the bony scales of the modern teleostes. Each cosmoid scale consists of following three layers:

1. Isopedine: This is the inner layer consisting of layer bone. It is pierced by cannels for blood vessels.

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

3. Cosmine: This is the outer layer made of dentine containing pulp cavity.

(2) Gonoid scale: These are of two following types:

1. Palaeoniscoid ganoid scale: Such scale where ound on primitive and extinct actinopterygians and on extant controsteans, the polypterus. In this type;

(1) The layered bone isopedine is present.

(2) The spongy bone is absent.

(3) The cosmine layer is reduce.

(4)Above the cosmine layer is the hard multilayered ganoine, which land the lustrous sheen to the scale.

2. Lepisosteoid ganoid scale:Such scale are found on more recent chondrostean, viz. Lepisosteus. In this type, spongy bone and cosmoid layer both are absent the ganoin contain many tubules.Such scale arrenged closely together, like tiles on a floor in diagonal rows.

3. Bony Ridge Scale

The cycloid and ctenoid scales are the two types of bony ridge scales. They are present in majority of the teleostean fishes and are thin, flexible, transparent structures due to the absence of the first and the middle layers of other types. These scales exhibit characteristic ridges alternating with grooves and generally the ridges are in the form of concentric rings. The central part of the scale is called the focus and is the first part to develop. In many species, oblique grooves or radii run from the focus towards the margin of the scale.

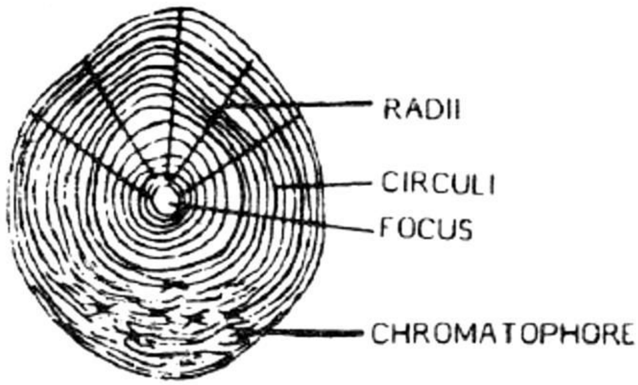


Fig. Cycloid scale

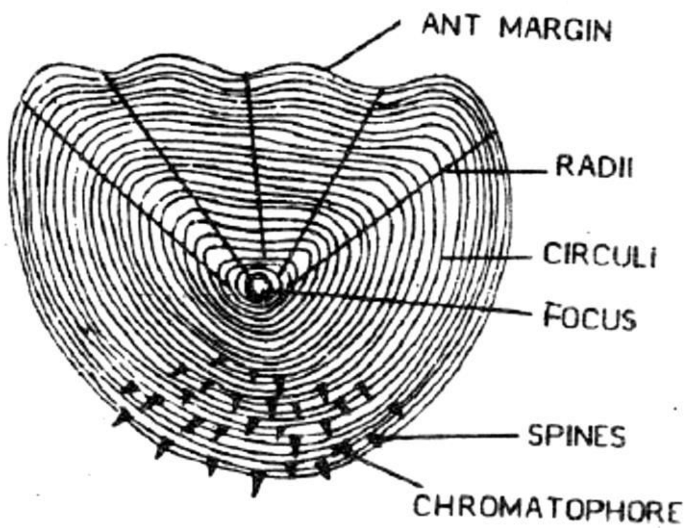


Fig. Ctenoid scale

The origin and development of both these types of scales are similar. The cycloid scales are thin and roughly, rounded in shape, being thicker in the centre and thining out towards the margin. They are found in a large number of teleostean fishes having soft rayed fins. They form a protective covering over the skin and project diagonally in an imbricating pattern. The ctenoid scales are also circular and can be distinguished from the cycloid by having a more or less serrated free edge. Moreover, several spines are present on the surface of the posterior area of the scale. These scales are found in a large number of fishes with spiny rayed fins.

Q. 3-Answer

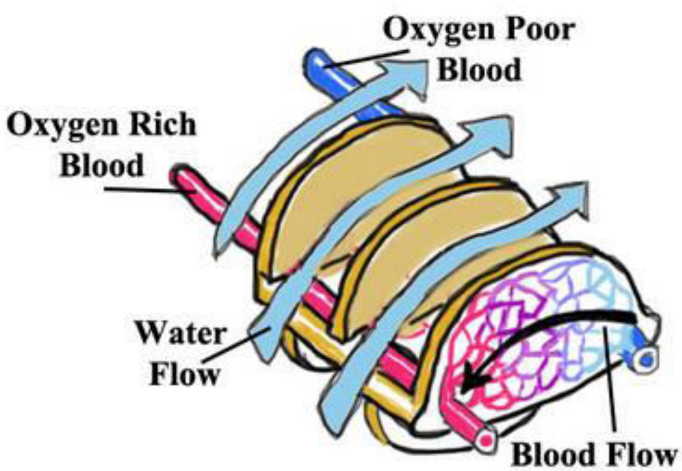
(a) Counter current mechanism:

The structure of the gill in teleost is such that water brought inclose contact with the secondary lamellae through which exchange of gases take place. Functionally the gills are very efficient and utilized about 52-80% of oxygen present in water . The teleostean gill is supposed to be more efficient then an elasmobanches gill due to great reduction of inter branchial septum. More over the arrangement of the afferent and the efferent branchial vesseles is such that the blood and the respiratory water flow in the opposite direction.This is called counter-current system,in which water containing oxygen flow from the oral to aboral side of the gills,and the blood in the lamillae flow from the aboral to oral side,thus providing maximum exchange of respiratory organ.

The efficiency of fish gills stems from a simple adaptation known as **countercurrent exchange**: The blood in the capillaries flows in the opposite direction from the water in the adjacent channels. Dissolved gases diffuse faster between fluids with a large difference in gas concentration (a high concentration gradient) than between fluids with only a small difference.

In the fish gill, low-oxygen blood enters the capillaries, encountering water at the end of its travel through the gills, which is thus relatively low in oxygen. As blood travels in the direction opposite to the water, it encounters "fresher" water with ever-higher oxygen concentrations. Thus, along the capillary, a steep diffusion gradient favors transfer of oxygen into the blood.

Gill efficiency is further increased by **ventilation**, the increase in flow of the respiratory medium over the respiratory surface. Fish ventilate by swimming and by opening and closing the flaps that cover the gills, the **opercula**. This draws fresh water into their mouths to pass over their gills and out their gill slits.



Counter current exchange in aquatic respiration (fish)

(b) Respiratory pump: Blood is oxygenated in teleost by rhythmical inhalation and exhalation of water through the bucco-pharyngeal cavity. This is effected by suction of water into the cavity and its subsequent expulsion through the gill slide, during which the water batches the highly vascular gill lamellae. The bucco-pharyngeal cavity, there for,applies both suction and pressure to propel water through the gills.

Foe respiration, the mouth is open and buccal cavity is enlarged by lateral expansion of its walls. For this, various muscle contract as well as the branchiostegal rays are spread and lowered an increase of the buccal cavity creat negative water pressure in it, so that water is sucked in.

When the oral cavity is filled with water, the mouth is closed and the operculum is abducted anteriorly to increas the opercular cavity, but the opercular opening is kept closed due to pressure of the external water. Next the buccal and the opercular cavity are reduced so as to exercise pressure on the water inside it. The oral valves prevent water from going out the mouth. The opercula after reaching the maximum abduction are quickly brought towards the body. The water is expelled through the external branchial aperture and is prevented from going back due to excess pressure in the buccal cavity as compared to the opercular cavity.

(c) Gill filament- Each gill arch bears two row of gill filaments or primary gill lamellae towards the outside of the buccopharyngeal cavity in most teleost, the inter branchial septum between the two row of lamellae is short so that the lamellae of the two rows are free at their distal ends. However, in *Labeo rohita* and *Hilsa ilisha*, the septum extends half way down the primary lamellae. The shap, size and number of the primary lamellae vary in fishes with diverse habits. The gill lamellae belonging to the two hemibranchs are either alternately arranged with respect to each other or they may interdigitate. Usually the gill lamellae of each row are independent of one another, but in *L. rohita* , the neighbouring lamellae are fused at the tip as well as at the basis, so as to leave narrow slit like apertures between them. The praimary gill lamellas undergo division to give rise additional lamellae in several hill stream fishes. The lamellae may bifurcate in the middle or at the base to produce two branches. Some time three or four branches are formed or several branches may develop at one point giving a flower like appearance.

The primary gill lamellae are supported by gill rays which are partly bony or partly cartilaginous and are connected with the gill arch and with each other by fibous ligament. Each rays is bifurcated at its proximal end to provide a passage for the efferent branchial vessel. These lamellae covered by an epithelium usually called the primary epithelium or gill filament epithelium or consist of mucus secreating cells. Taste buds are also present which serve to ditect the nature of water.

Q. 4-Answer

The basic function of digestive system is to dissolve food by rendering them soluble so that they can be absorbed and utilized in the metabolic process of the fish this system may also function to remove potentially dangerous toxic properties of certain food substance the food stuffs and undigested remains move downwards as in higher vertebrates by peristaltic waves of muscular contraction. In the interior part, the movement is voluntary while in the posterior part it is in voluntary due to the involvement of smooth muscle. Many predatory fishes may vomit large and unwanted food itoms quite easily owing to the grater development striated muscle in the walls of the oesophage extending o the stomach.

Protein digestion:

In adition to mucus gland, gastric gland occur in the stomach at least in predaceous fishes they secrete HCL and pepsinogen , effective in combination to split large protein molecule. In typically carnivorous fishes like *Esox lucius*, gastric cavity (pH -2.4-3.6) have been measured .stomach enzyme other than peptidase are not clearly known. Some minnows lack gastric gland and consequently a true stomach like gizzard does not have digestive gland. Pyloric caeca when present, may have digestive or absorptive or both function.

Enzyme from bile, pancreas and small intestine work best at a pH ranging from neutral to alkaline. the stomach intestinal mucosa, pancreas and pyloric coeca are source of protein digesting enzyme in fishes. Different proteases affecting terminal and inner bonds uniting the amino acid of protein are secreted either from the intestinal mucosa or from the pancreases. Intestinal enzyme secreted in an in active form as zymogens a general term for inactive enzyme before chemical changes in the lumen of the intestine makes them active in digestion. Thans changes are brought about by other enzyme such as enterokinase.

Carbohydrate digestion:

Various enzymes like sucrose, maltase, lactase and amylase that digest respective carbohydrate have been found in the intestine as well as in the pancreatic juice and pyloric caeca of fishes. There is no evidence that fishes have bacterial flora fauna for the breakdown of cellose plant material.

AI-Hussaini observed that the concentration of carbohydrase is highest in predominantly herbivorous fishes like *Ciprinus* and lowest in the Carnivorus fishes like *gobids*, while the concentration of protease was just opposite.

Lipid digestion:

Secretion of gall bladder is bile which contain the fat emulsifying bile salt along with other pigment, biliverdin and bilirubin that originate from the breakdown of R.B.C. and Hemoglobin. The bile salt may not only help to hydrolyse fat but also to adjust the digestive juices of the intestine to the proper alkalinity for the action of digestive enzyme.

According to Greene (1913), fats are absorbed through the epithelium of all portion of the alimentary tract of the king salmon. The primary function of the numerous pyloric caeca is fat absorption. Fat is digested into fatty acid and glycerol by lipase secreted from pyloric caeca and intestinal mucosa.

Q. 5- Answer

Generally, the gas bladder or swim bladder opens into the oesophagus by a duct called penumaticus duct which is short and wide in the lower teleosts (Chondrostei and Holstei) but longer and narrow in others. The pneumatic duct is present in the form of an open tube in several orders of teleosts as Cluppeiformes, Esociformes, Anguiliformes and Cyprininformes, but absent in Gasterosteiformes, Mugiliformes, Notacanthiformes and the Acanthopterygii. Hence, the teleosts were formerly divided into the **Physostomi** with an open duct and **Physoclisti** with a closed bladder.

Gas secretion in swim bladder

The anterior part of the swim bladder, whether open or closed, is specialized for gas secretion, while absorption of gas into the blood takes place in the posterior region of the physoclistous forms. In more specialised physoclisti, such as the Mugil, Balistes and gadus, the posterior region becomes converted into an 'oval' whose opening is guarded sphincter and dilated by muscles. A small area in the anterior region becomes specialized for secreting gas and is called the red body or red gland.

In several species belonging to the Syngnathidae, Gadiidae, Labridae and Triglidae, the gas bladder is closed and divided into two chambers by a constriction. In these fishes gas gland for secreting gas is found in the anterior chamber, while the posterior chamber becomes thin walled for gas diffusion. But in the Cyprinidae, the gas bladder is divided into two chambers and has pneumatic duct. Here, the gas gland is confined to the posterior chamber.

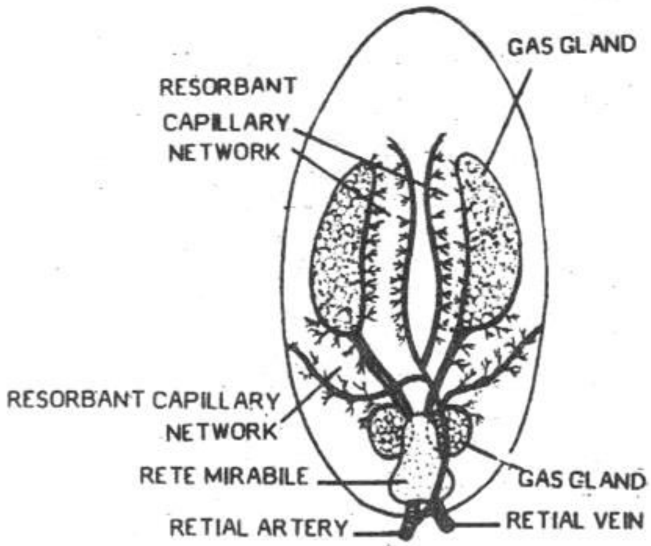


Fig: Swim bladder of a deep sea fish showing gas secreting complex.

Q. 6- Answer

Closed circulatory systems have the blood closed at all times within vessels of different size and wall thickness. In this type of system, blood is pumped by a heart through vessels, and does not normally fill body cavities. Example: Vertebrates, and a few invertebrates, have a closed circulatory system.

The open circulatory system is common to molluscs and arthropods. Open circulatory systems (evolved in crustaceans, insects, mollusks and other invertebrates) pump blood into a hemocoel with the blood diffusing back to the circulatory system between cells. Blood is pumped by a heart into the body cavities, where tissues are surrounded by the blood.

Working of heart in Teleost:

The venous blood flowing continuously towards heart reaches the sinuses and passes into auricle by pushing apart the semilunar valves. During this, the pockets of the valves also become full of the blood and pressure due to contraction of the auricle cause the valves to swell and adhere with each other, thus preventing the backward flow of blood. The blood now flows from auricle to ventricle by pushing apart the four auriculo-ventriculer valves. As soon as the ventricular cavity is full, the valves also received the blood, so that they bulge out and adhere with each other so as to effectively close the opening and thus, prevent the backward flow of the blood. The blood, now, pushes aside the ventriculo bulber valves, to enter the bulbus. Here again, the increased pressure inside the bulbus causes the valves to swell and close the passage, preventing backward flow of the blood, which passes forward into the ventral aorta. A schematic diagram of heart of a carp (Tor tor) showing blood flow is given below:

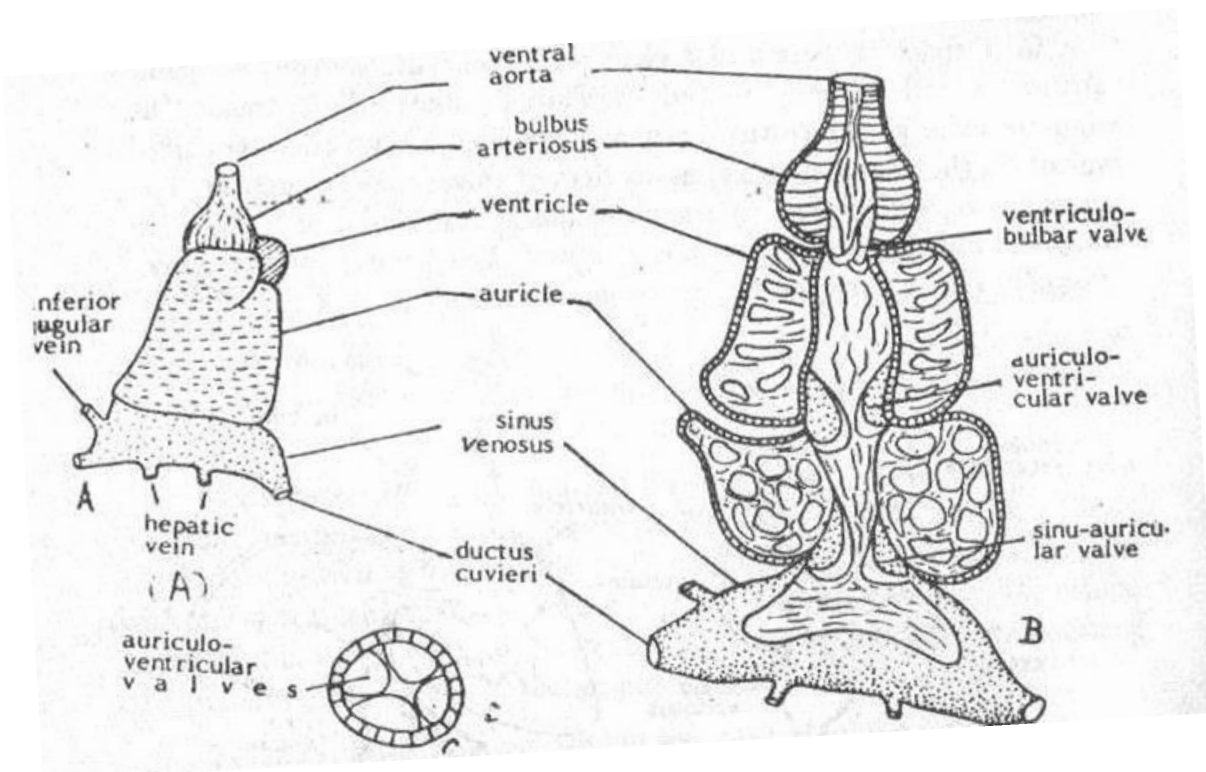


Fig: (A) Heart of a carp (Tor tor) (B) The same dissected to show internal structure and working of heart.

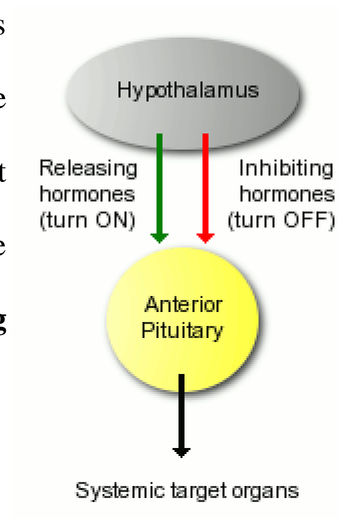
Q. 7- Answer

Pituitary gland or hypophysis has been referred as the 'master gland' as it controls various metabolic activities of the animal through its hormones. But the secretion of various hormones of the pituitary gland is regulated by the hypothalamus of the brain. Extensive investigations have been conducted on the hypothalamic nuclei, of which nucleus preopticus (NPO) and nucleus lateralis tuberis (NLT) are more important. The **hypothalamo-hypophyseal system** is thus a collection of neurons, tracts of nerve fibers, endocrine tissue, and blood vessels in the hypothalamus and the pituitary gland. The hypothalamo-hypophyseal portal circulation provides the mechanism for hypothalamic neuroendocrine (hypothalamic hormones) regulation of pituitary function and the release of various pituitary hormones into the systemic circulation to maintain homeostasis.

Hypothalamic control of pituitary gland:

The pituitary gland is often portrayed as the "master gland" of the body. Such praise is justified in the sense that the anterior and posterior pituitary secrete a battery of hormones that collectively influence all cells and affect virtually all physiologic processes.

The pituitary gland may be king, but the power behind the throne is clearly the hypothalamus. Some of the neurons within the hypothalamus - neurosecretory neurons - secrete hormones that strictly control secretion of hormones from the anterior pituitary. The hypothalamic hormones are referred to as **releasing**



hormones and **inhibiting hormones**, reflecting their influence on anterior pituitary hormones.

Hypothalamic releasing and inhibiting hormones are carried directly to the anterior pituitary gland via **hypothalamic-hypophyseal portal veins.** Specific hypothalamic hormones bind to receptors on specific anterior pituitary cells, modulating the release of the hormone they produce.

As an example, thyroid-releasing hormone from the hypothalamus binds to receptors on anterior pituitary cells called thyrotrophs, stimulating them to secrete thyroid-stimulating hormone or TSH. The anterior pituitary hormones enter the systemic circulation and bind to their receptors on other target organs. In the case of TSH, the target organ is the thyroid gland.

Clearly, robust control systems must be in place to prevent over or under-secretion of hypothalamic and anterior pituitary hormones. A prominent mechanism for control of the releasing and inhibiting hormones is **negative feedback.**

Q. 8- Answer

There are two kinds of nerves, spinal and cranial. The former take their origin from spinal cord and are metamerically arranged i.e., their number corresponds with that of the vertebrae. Cranial nerves arise from the brain and ten pairs of them are typically present in a teleost. Cranial nerves relay information between the brain and parts of the body, primarily to and from regions of the head and neck. They are summarized below:

Name of the nerve	Origin	Branches	Distribution	Physiological Nature
I. OLFACTORY	Olfactory lobe.		Olfactory epithelium	Sensory

			of the nasal cavity.	
2. OPTIC	Optic lobe.		Retina of eye.	Sensory
3. OCULOMOTOR	Ventrolateral side ofthe midbrain.		Anterior rectus, superior rectus, inferior rectus and inferior oblique muscles of the eye. Superior oblique muscle of the eye	Motor Motor
4 TROCHLEAR	Dorsolateral aspect of the midbrain between the optic lobes and cerebrum.		Olfactory capsule and dorsal	Mixed
5 TRIGEMINAL	Dorsally from the side of medulla oblongata below the corpora restiformes.	(i) Opthalmic profundus (ii) Ophthalmicus superfi-cialis V (iii) Maxillaris V (a) Superior (b) Inferior (iv) Mandibularis	skin of the snout. Skin of the snout. Skin of upper jaw Posterior part of upper lip. Muscles of the lower jaw.	Mixed Motor Mixed
6. ABDUCENS	Midventrally from the floor of medulla oblongata		Posterior rectus muscle of the eye.	Mixed
7. FACIAL	From the side of medulla below the corpora restiformes in the form of a bundle.	(i) Opthalmicus super-ficialisVII (ii) Ramus buccalis (iii) Flyomandibularis (a) Mandibularis exte-rnus (b) Mandibularis inter-nus (c) Hyoidean (iv) Ramus palatinus	Sense organs; the lateral line system of snout. Infra-orbital lateral line canal and associated ampullae. Mandibular canal of lateral-line system. Mucous membrane of the floor of buccal cavity. Muscles of the roof of buccal cavity and pharynx. Roof of the pharyngeal and buccal cavity.	Mixed Mixed Mixed Mixed Mixed Sensory

8. AUDITORY	From the side of medulla close to the V and Vll cranial nerves.	(i) Vestibular (ii) Saccular	Membranous labyrinth of the internal ear	Sensory
9. GLOSSOPHARYNGEAL	From the ventro-lateral side of medulla. .	(i) Pre-trematic (ii) Post-trematic	Mucous membrane of the first gill-cleft and the pharynx. The muscles of the pharynx Gills.	Sensory Mixed Mixed
10. VAGUS	Side of Medulla.	(a) Branchialis (b) Visceralis (c) Lateralis	Viscera. Lateral-line system of the trunk.	Mixed Mixed Mixed

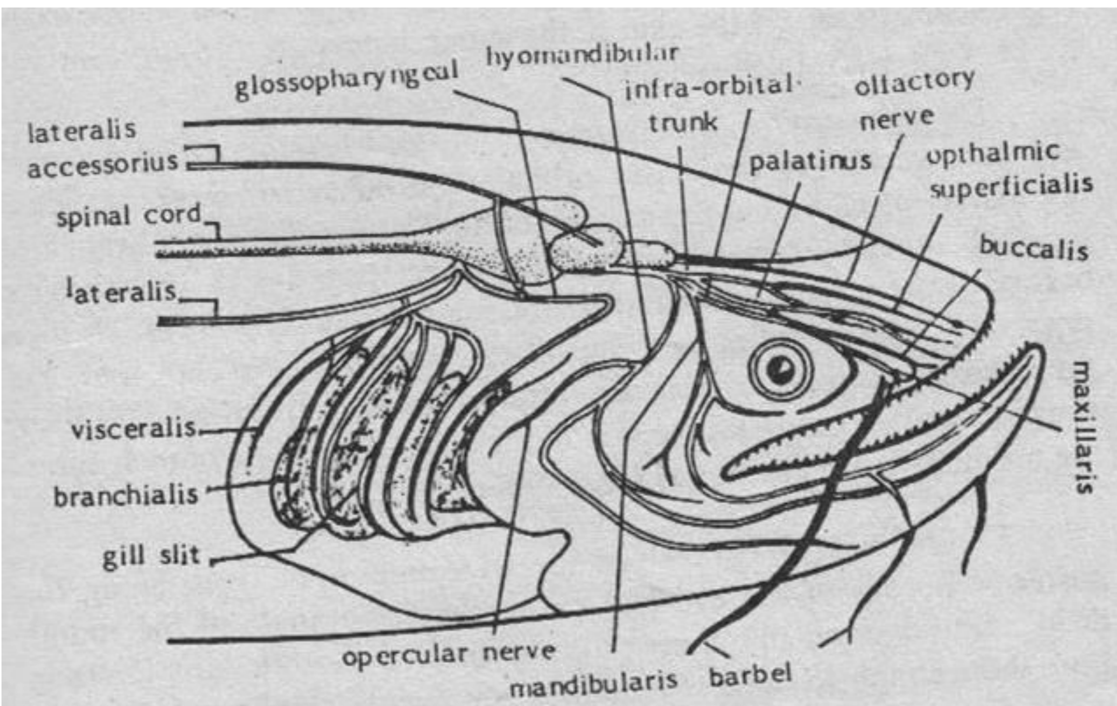


Fig: Cranial nerves of *Wallago attu*.

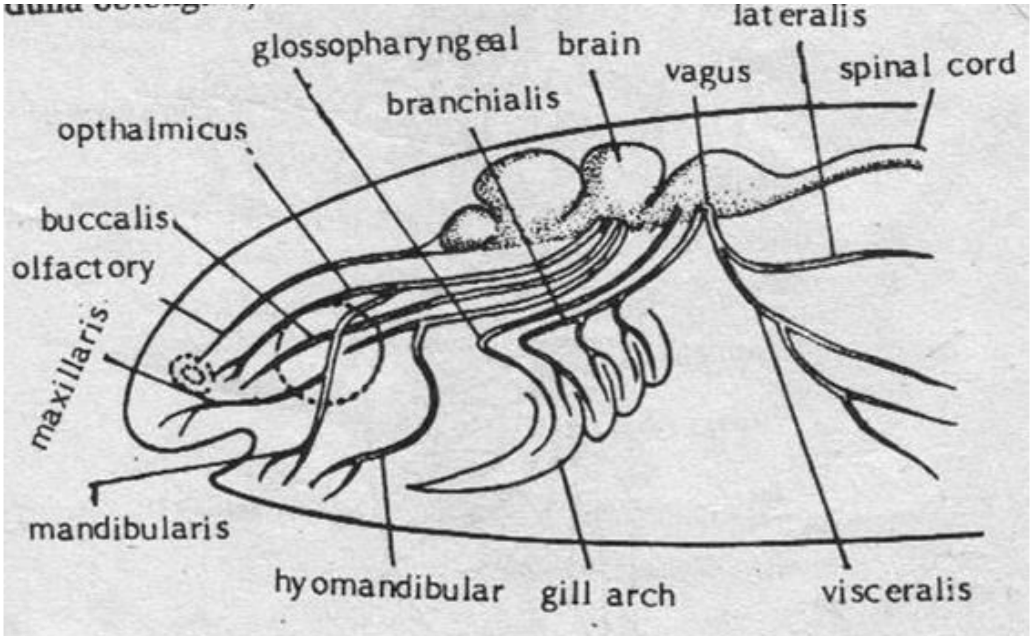


Fig: Cranial nerves of *Labeo*.