VIVEKANANDA COLLEGE
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NAAC ACCREDITED 'A' GRADE

Topic: Respiratory System: Brief account of swim bladder

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Swim bladder

Swim bladder is a characteristic sac-like structure present between the gut and kidneys of most bony fishes. This structure is also named as gas bladder or air bladder and is filled with gases derived directly or indirectly from the atmosphere (Oxygen, Nitrogen, Carbon dioxide). Swim bladder arises from the dorsal wall of the gut and gets blood supply usually from the dorsal aorta.

Differences between swim bladder and lung

1. The swim bladder arises from the dorsal wall of the gut, whereas the vertebrate lung originates from the ventral wall of the pharynx.
2. Swim bladder gets blood supply usually from the dorsal aorta, while the lung receives blood from the sixth aortic arch.
3. Swim bladders are single, whereas lungs are usually paired.
4. Swim bladder usually functions as a hydrostatic organ, while the lung is mainly involved with respiration and gaseous exchange.

Structure:

1. It is essentially a sac-like structure with an overlying capillary network.
2. It generally consists of two air-filled chambers.
3. The wall of the anterior part of swim bladder consists of the following histological layers from outside to inside:
    a. Tunica externa made of dense collagenous fibrous material.
    b. Submucosa made of loose connective tissue
    c. Muscularis mucosa made of a thick layer of smooth muscle fibres.
    d. Lamina propria formed of a thin layer of connective tissue.
    e. Innermost layer of epithelial cells,
4. In the posterior chamber, there is a glandular layer outside the muscularis mucosa. This layer is richly supplied with blood capillaries forming the rete mirabile.
5. In physoclistous type of swim bladder there is an anteroventral secretory gas gland containing rete mirabile and a posterodorsal gas absorbing region called the *oval.*

6. The swim bladder may or may not retain connection with the oesophagus by a pneumatic duct (*ductus pneumaticus*).

Rete mirabile: (= net + marvellous). Rete mirabile is a network of as many as tens of thousands of uniquely long afferent capillaries, all oriented in the same direction, among which pass a like number of efferent capillaries.

Types:

Swim bladders may be of two broad types, depending upon the presence or absence of a duct (*ductus pneumaticus*) between the swim bladder and the oesophagus.

1. Physostomous type: When the ductus pneumaticus is present between the swim bladder and the oesophagus, it is physostomous condition. Air volume in such fishes can be controlled if a fish gulps in more air or releases extra through the pneumatic duct. It is found in bony fishes and soft-rayed teleosts.
2. Physoclistous type: When the ductus pneumaticus is either lost or atrophied, it is physoclistous condition. It is observed in spiny-rayed fishes. Here, there is an anteroventral secretory gas gland containing rete mirabile and a posterodorsal gas absorbing region called the *oval* (developing out of the degenerating ductus pneumaticus). [Gas gland and rete mirabile together are called a *red body*.]. Air volume and buoyancy is controlled if more gas is released into the bladder at the rete mirabile or if some is removed at the oval.

   Transitional condition: It is an intermediate stage when a physostomous condition is on the verge of transformation into the physoclistous stage. It is generally present in eels where the ductus pneumaticus is retained as an enlarged separate chamber containing the oval.

Functions:

1. Swim bladder primarily functions as an hydrostatic organ. It helps to keep the weight of the body equal to the volume of water displaced by the fish. It also maintains equilibrium with the surrounding medium by increasing or decreasing the volume of gas content.

2. It also acts as an adjustable float by enabling the fish to swim at any depth with the least effort. When a fish sinks, specific gravity of body is increased. When it ascends, the bladder is distended and specific gravity decreases.
3. Helps to maintain a proper centre of gravity by shifting the contained gas from one part to another.
4. It performs a respiratory role in fish living in water containing low oxygen. Here the oxygen in the bladder may serve as source of oxygen.
5. In some species the swim bladder is interconnected with the inner ear of the fish by four bones called the Weberian ossicles to form the Weberian apparatus. Here it can intensify sound vibration and transmit these to the ear through the Weberian ossicles, and thereby act as a resonator.
6. Circulation of air contained in the bladder of some fishes causes vibration of incomplete septa on the inner wall of the bladder and helps in production of sound.

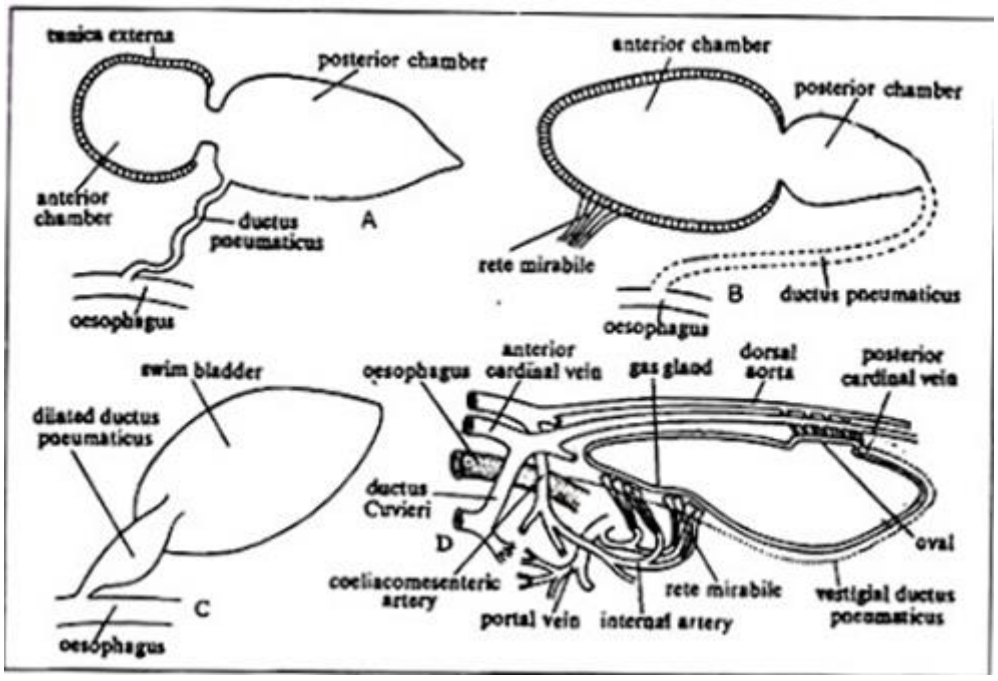

Fig: Different types of swim bladders

A: Physostomous swim bladder

B: Physoclistous swim bladder with anterior and posterior chambers

C: Transitional swim bladder in eel

D: Physoclistous swim bladder showing gas gland and oval

Probable questions:

1. What is swim bladder?
2. State the functions of swim bladder.
3. Give an account of the different types of swim bladders.
4. Differentiate between physostomous and physoclistous swim bladder.
5. What is rete mirabile?