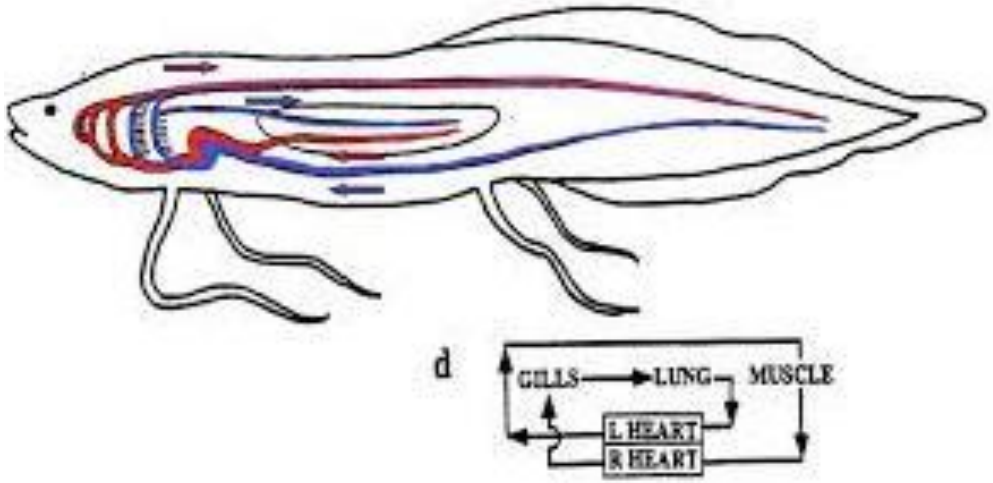
# Branchial Respiration, Integumentary Respiration and Dipnoi accessory respiratory modifications

**Lecture for MSc.**

**Course Chordates: Structure, function and Evolutionary significance (ZOOL 4007)**

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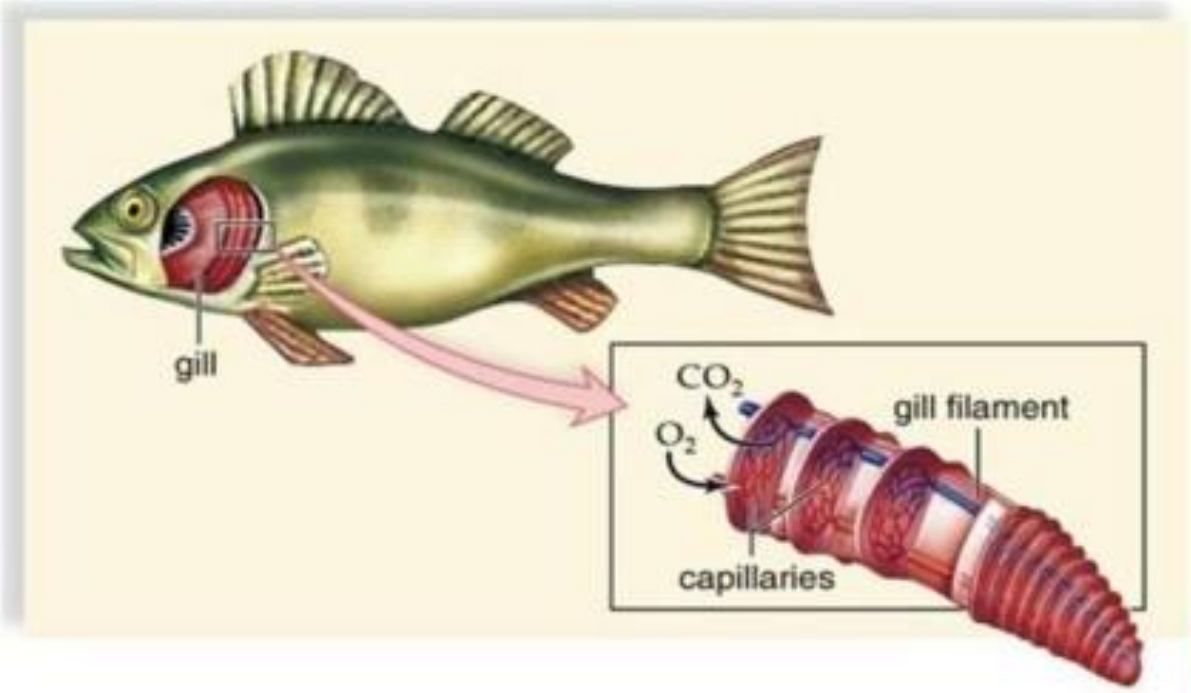
# Branchial respiration

Aquatic invertebrates (mollusks and crustacean) and vertebrates (fish) have specialized organs for gas exchange called **gills**.




ZANICHELLI

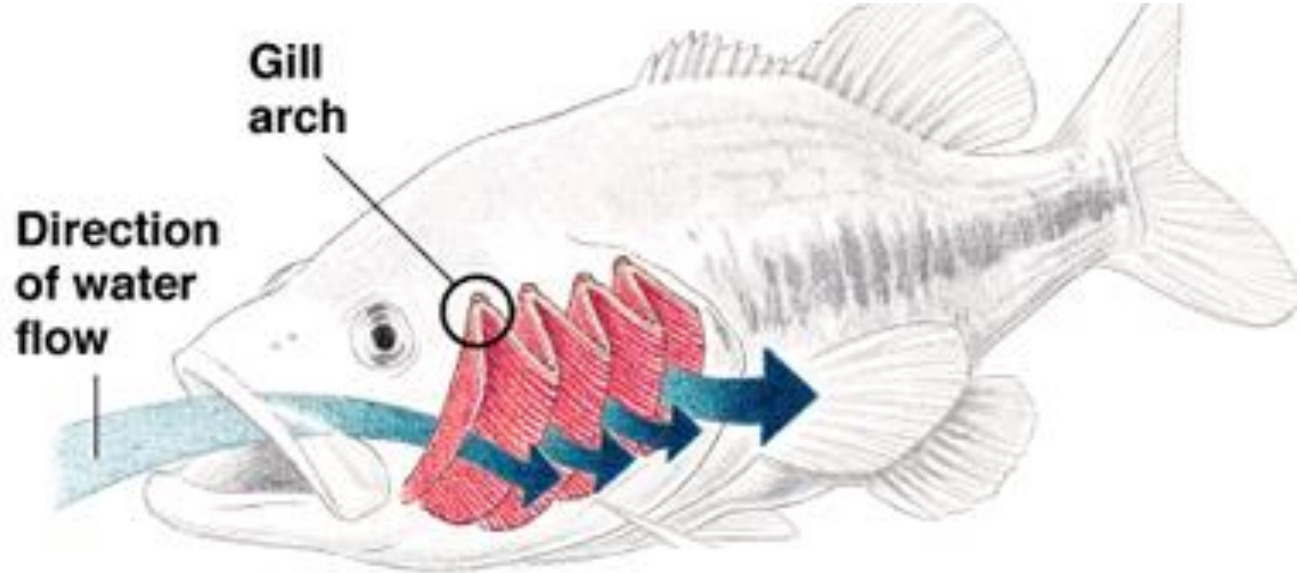
❖Fish respire with the help of gills. By opening and closing of the mouth water flows from the oral cavity and flows constantly over the gills.

❖ The water flows out through external gill apertures. The gills are richly supplied with blood vessels.

❖As the water flows over gills, oxygen is absorbed from water and CO2 is expelled into the water flowing out of gills. Thus the exchange of gases takes place.

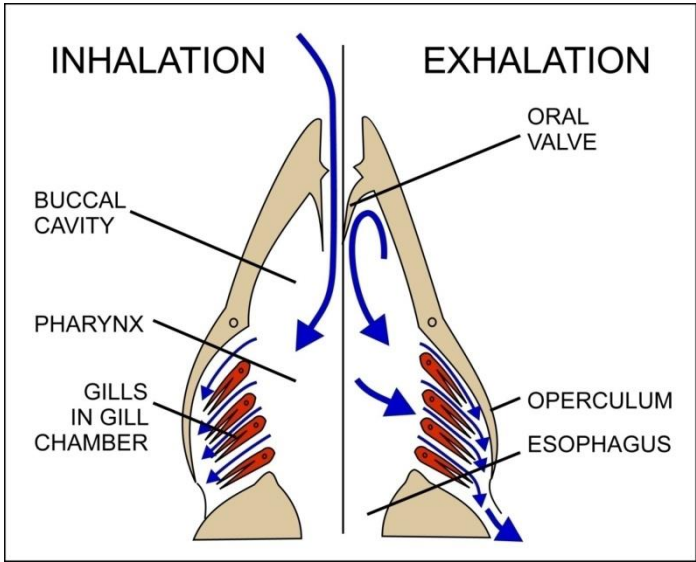
# Gills

- Mediate gas exchange
- Located at the side of the head
- Made up of gill filaments, feather structures that provide a large surface for gas exchange




Adult fish have a pair of gills. Each gill is covered by a boney lid. A fish draws in water by closing the lid over its gills and opening its mouth. When the fish closes its mouth and opens the gill lid the water is forced out and over the respiratory surfaces of the gill filaments.

- Fish opens its mouth.
- The floor of oral cavity is lowered.
- Water enters oral cavity.
- Fish closes mouth.
- Floor of oral cavity rises.
- Water enters the gill pouches through the internal brachial apertures.
- Lamella bathed in water perform the exchange of $O_2$ and $CO_2$
- The water from gill pouches passes out through the external brachial



❖Bony fishes Usually have 5 gill slits

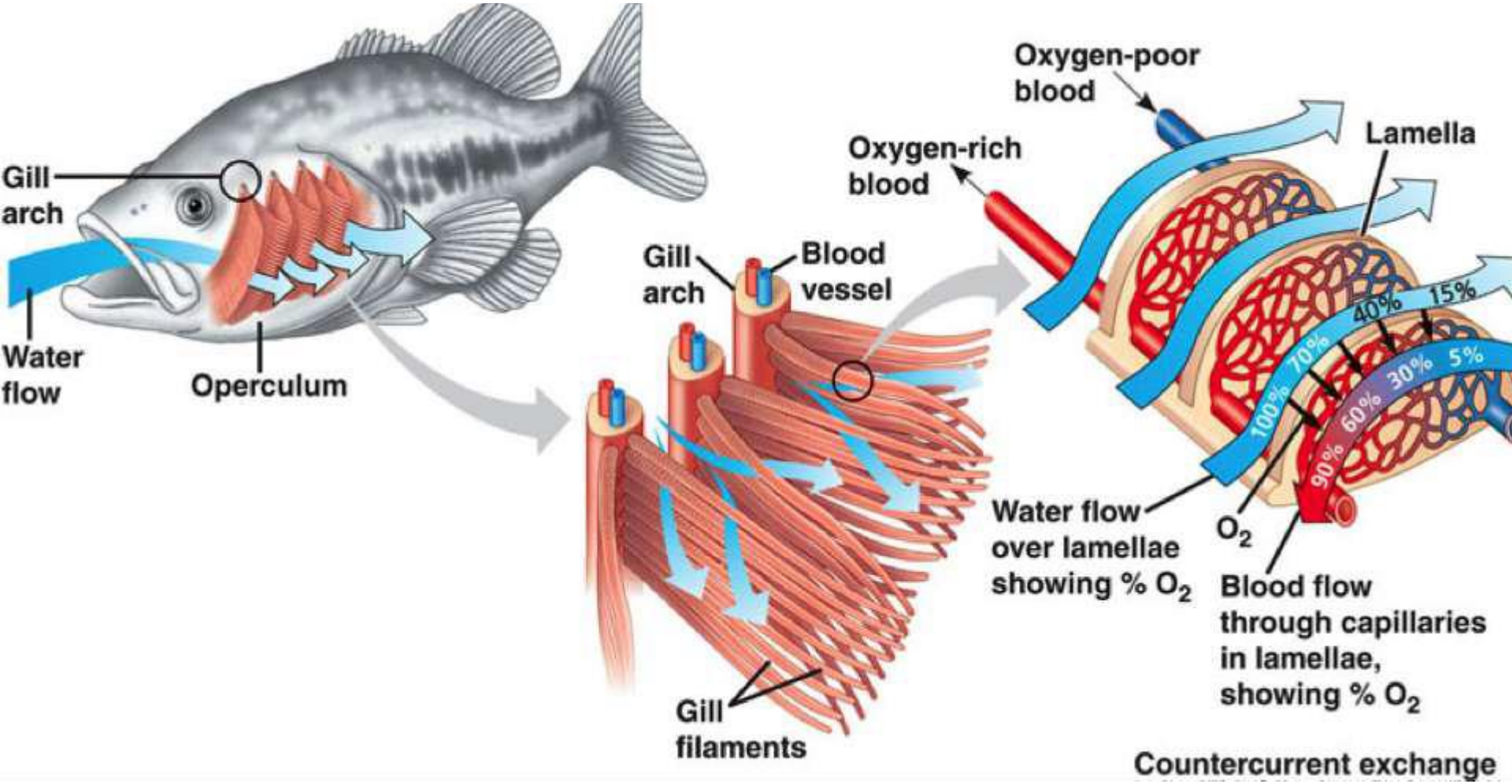
❖Operculum projects backward over gill chambers

❖ Interbranchial septa are very short or absent

❖ Lamellae are made of extremely thin membranes (1 cell thick) and are primary sites of gas exchange.

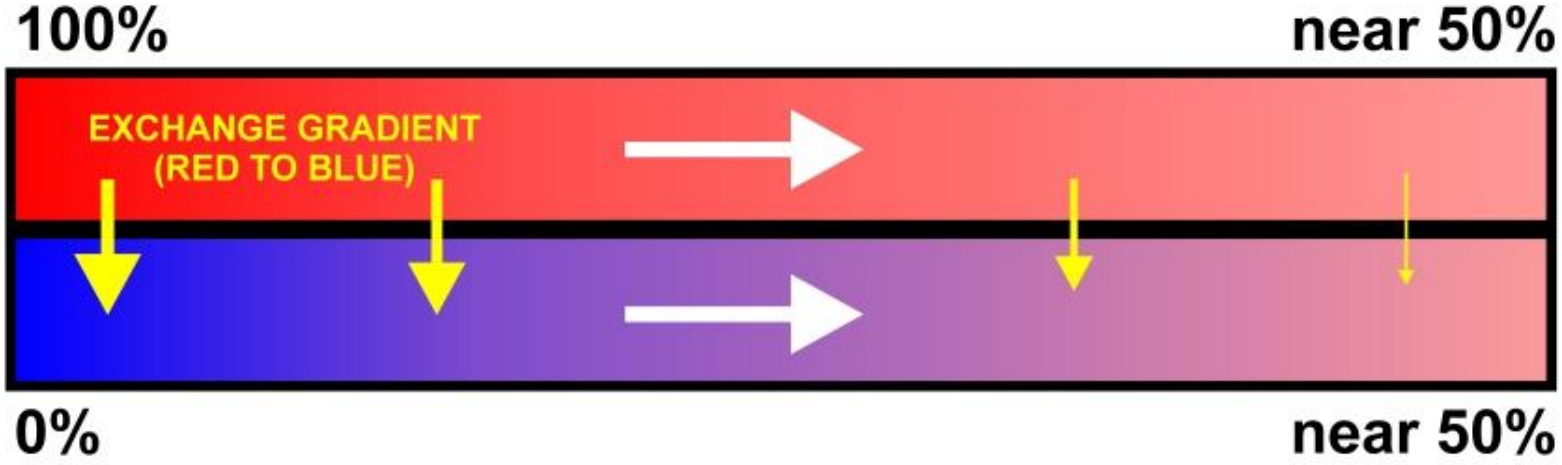
❖ Water flows across the gill filaments and oxygen is removed and passes into the blood by diffusion.

❖ To increase the efficiency of oxygen uptake a countercurrent method is used; blood flows through the lamellae in a direction opposite to the water flow through the gill filaments. Countercurrent flow ensures a steady oxygen.

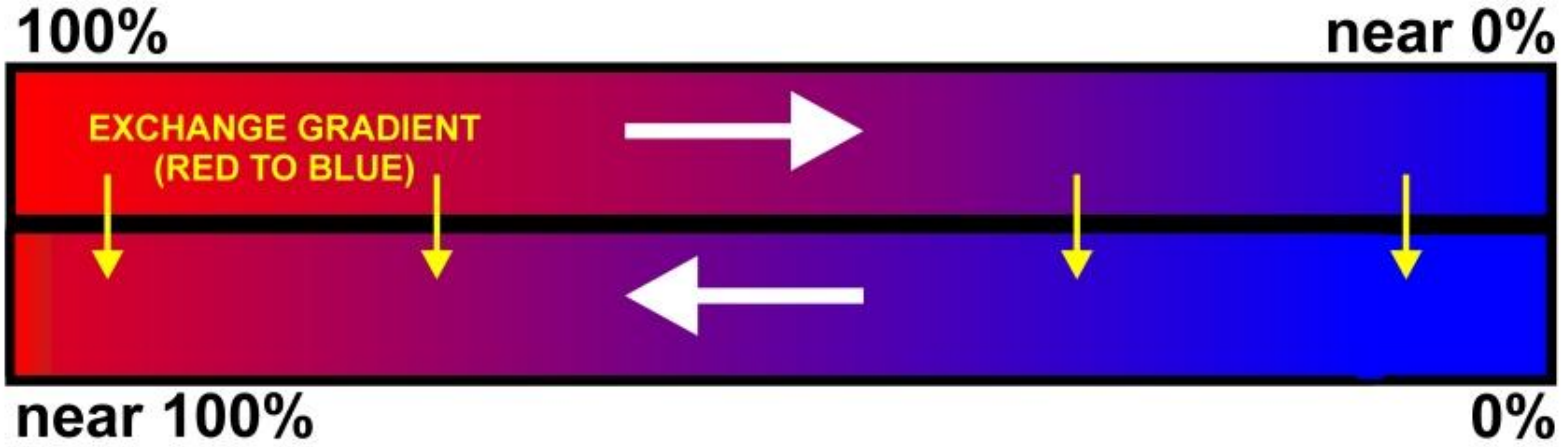



Countercurrent exchange

## COCURRENT FLOW




## COUNTERCURRENT FLOW



# Cutaneous (Integumentary) Respiration By Skin

❖Simplest Form Of Aerial Respiration.

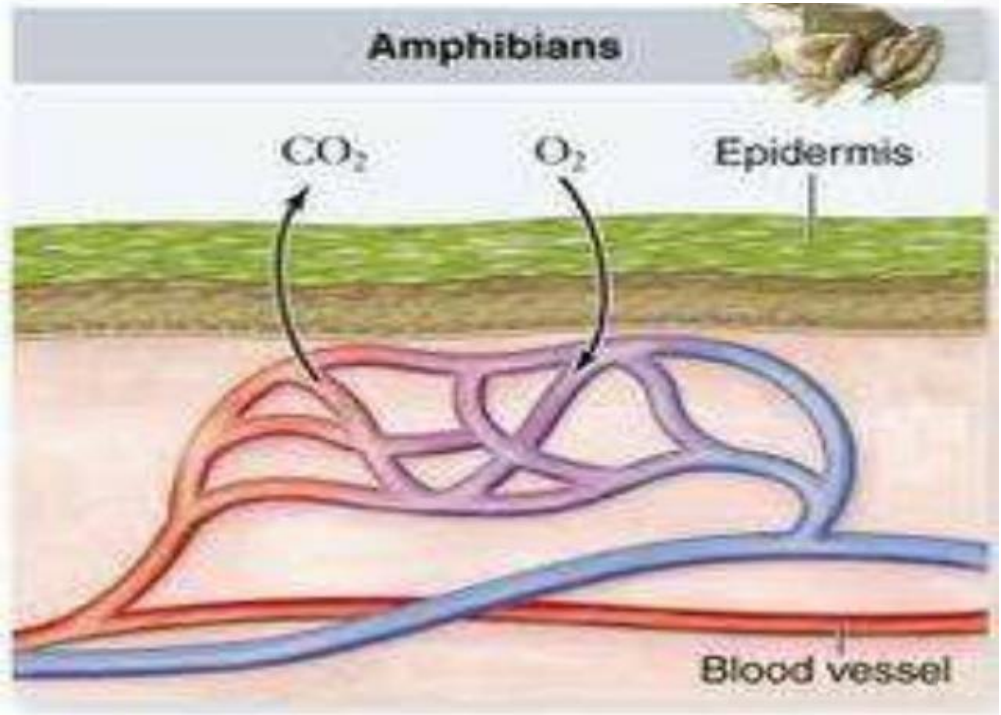
❖ In this case the skin is thin , moist , glandular and richly vascular.

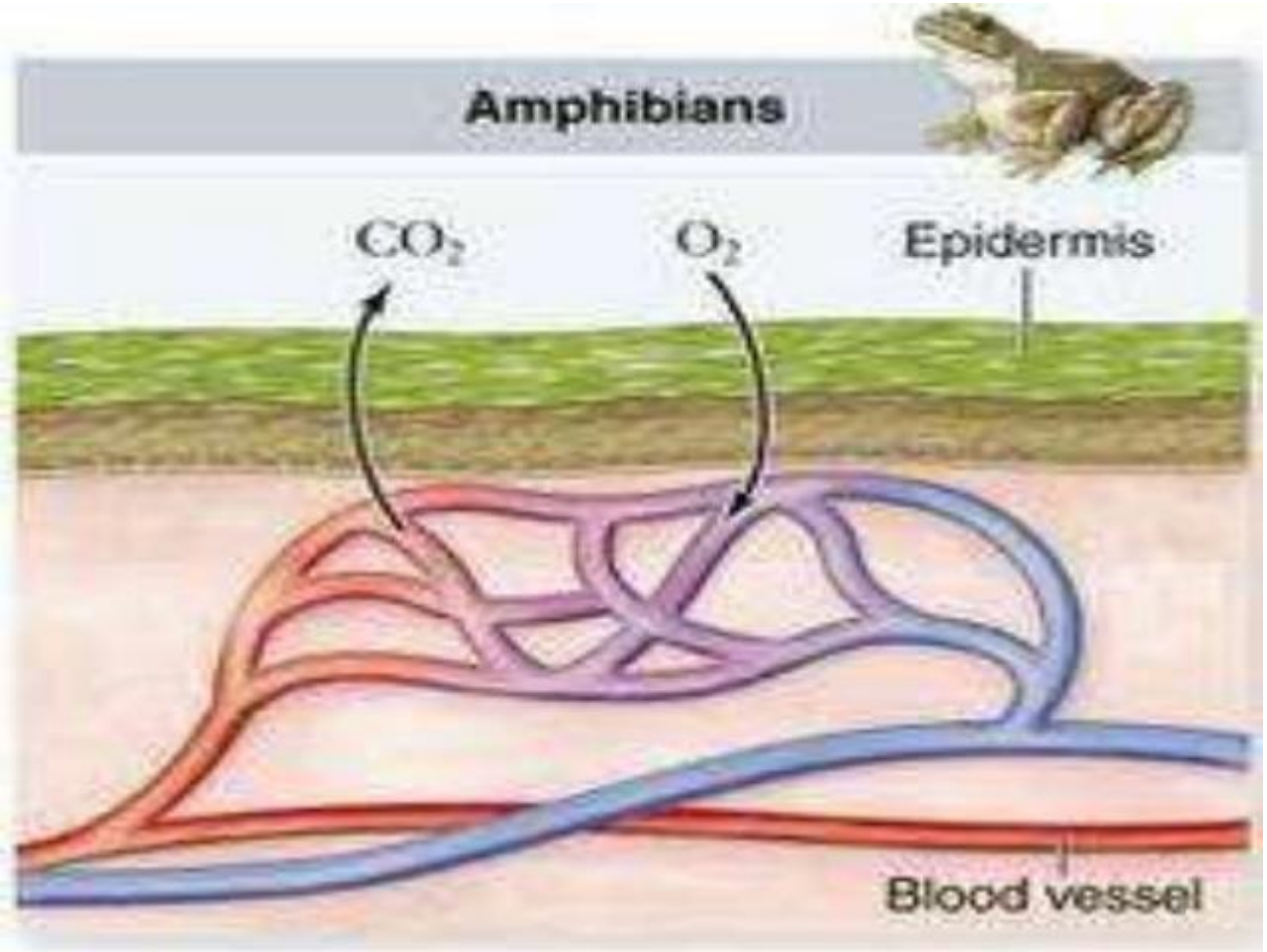
❖The embryos and larvae of many fishes breathe by skin , until gills become functional.

# Integumentary(Cutaneous) respiration

- Amphibians derive up to 100% of their gas exchange through cutaneous respiration.
- The simplest and most ancestral respiratory surface is the skin.
- It occurs in hibernation and in water.
- The skin of amphibians are very thin and is rich with blood capillaries.
- The water carries oxygen which diffuses into the capillaries and the carbon dioxide in the blood diffuses out.

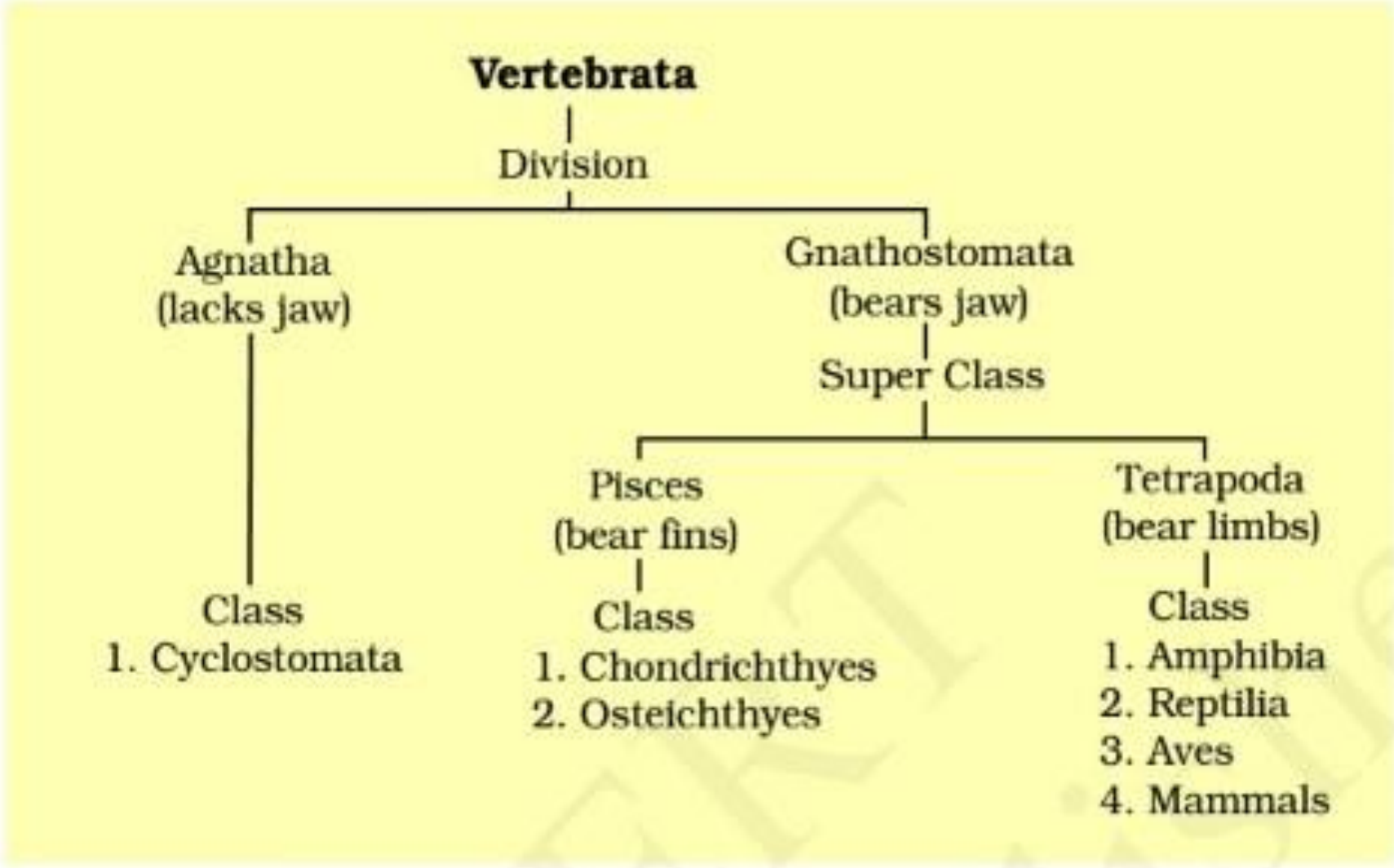
# Integumentary Respiration


Amphibians
$CO_2$
$O_2$
Epidermis
Blood vessel

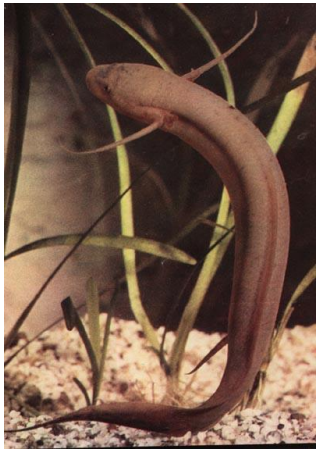
# Dipnoi and accessory respiratory modification

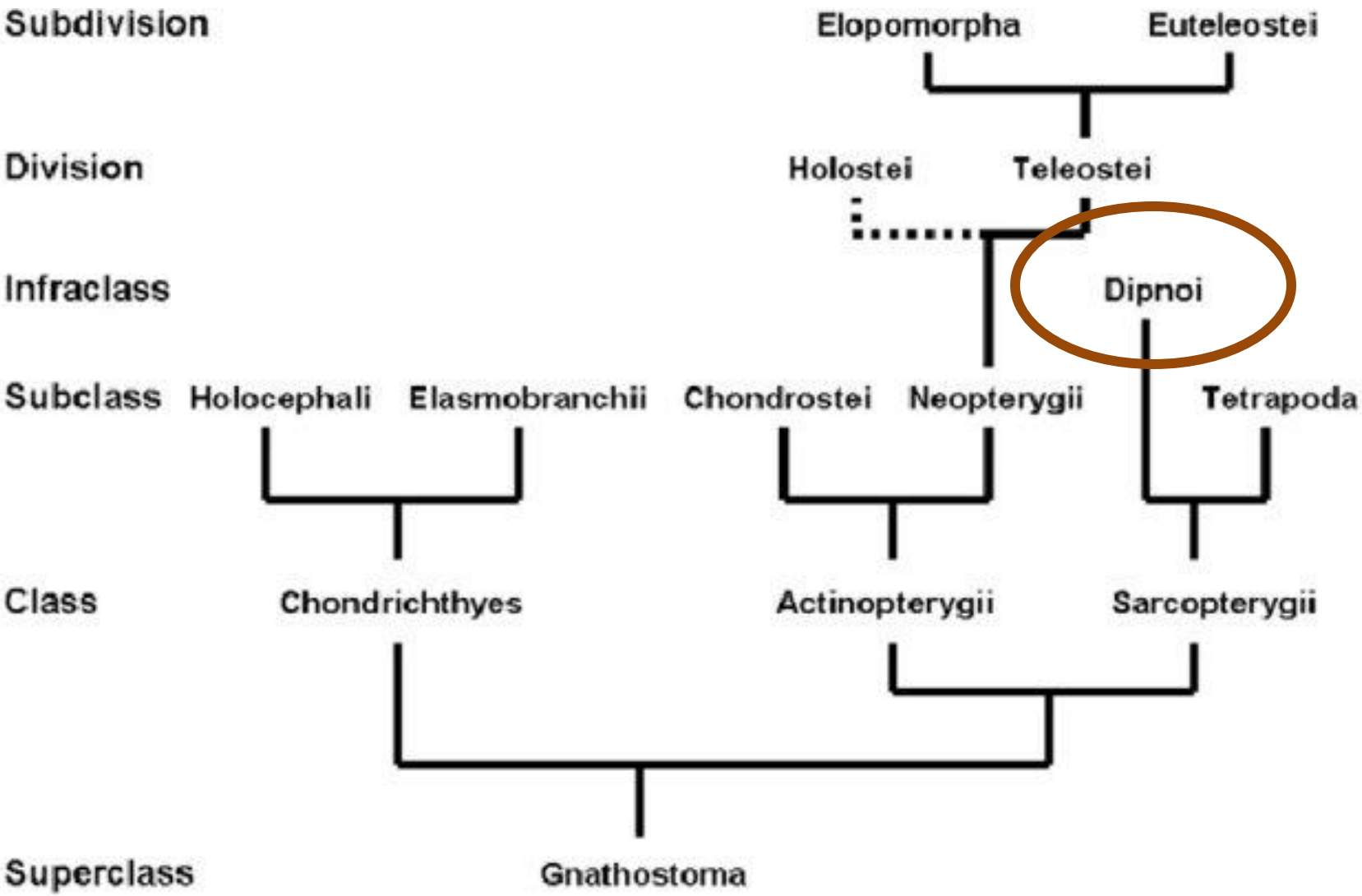
The subphylum Vertebrata is further divided as follows:



# Superclass Gnathostoma: Jawed Fish

- Class Chondrichthyes
  - Sharks, rays
  - cartilaginous skeletons
- Class Osteichthyes
  - bony fish (bone skeletons)
  - Subclass Actinopterygii
    - Ray-finned fish
  - Subclass Sarcopterygii
    - Lobe-finned fish




Subdivision
Elopomorpha
Euteleostei
Division
Holostei
Teleostei
Infraclass
Dipnoi
Subclass
Holocephali
Elasmobranchii
Chondrostei
Neopterygii
Tetrapoda
Class
Chondrichthyes
Actinopterygii
Sarcopterygii
Superclass
Gnathostoma

# Dipnoi

A group of sarcopterygiian fish, commonly known as the lungfish.

Their "lung" is a modified swim bladder, which in most fish is used for buoyancy in swimming, but in the lungfish also absorbs oxygen and removes wastes.

## Respiratory System of Dipnoi:

❖Both gill and pulmonary respiration take place in the lung-fishes. Although the dipnoans possess the gills as well as lungs, they use mostly the lungs.

The nostrils help in aerial respiration. The external nostrils lie at the margin of the mouth and the internal nostrils open into the buccal cavity.

❖A slit-like glottis is present in the floor of the oesophagus which opens into a short trachea. The trachea passes into the lungs around the right side of the oesophagus. The glottis is provided with a fibro cartilaginous plate which resembles the epiglottis.

❖The swim-bladder is modified into the ‘lung’.

❖The lung is placed dorsal to the gut while in the tetrapods it is ventral. The dorsal position of the lung in the dipnoans is regarded to be the result of shifting from its original ventral to the dorsal side.

❖The walls of the lungs contain muscle fibres and the internal cavity produces numerous alveoli which lead into minute alveolar sacs.

❖Aquatic respiration takes place through the gills. The gill-structure is similar in many respects to that of other crossopterygians except the absence of mandibular pseudo-branch and having only a vestigial mandibular pouch.

❖In the lung-fishes which depend more on the aerial respiration, the gills help in the excretion of carbon-dioxide.

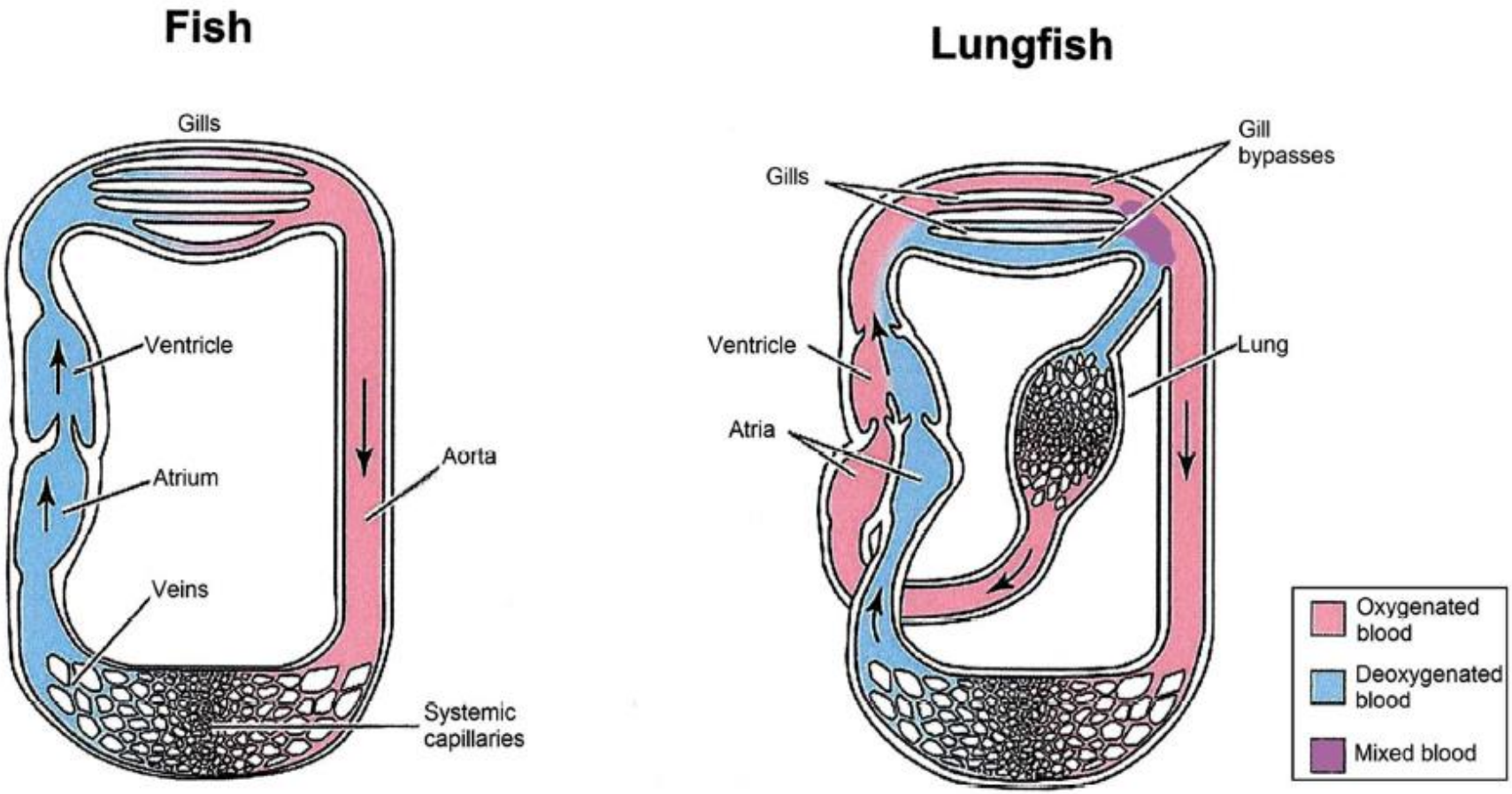



**Fig. (1).** Blood flow in oxygenation system in fish and lungfish.

# References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Thank
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