PENANG SANGAM HIGH SCHOOL
P.O.BOX 44, RAKIRAKI
LESSON NOTES

Year/Level: 12C/D week 19 **Subject:** Biology

Strand	1 structure & life processes
Sub Strand	1.4 comparative form and function in plants and animals
Content Learning Outcome	Describe the gas exchange in fish and amphibians

Gas Exchange in Vertebrates

- Vertebrate animals tend to be quite active hence, all vertebrates have specialised respiratory organs and a pumped transport system to meet the energy demand of their body processes.
- Vertebrates actively pump or suck the surrounding air (or water, in the case of fish) to get oxygen into their food quickly by the process of breathing or inhalation.
- Vertebrates are capable of adjusting the speed of gas exchange to the rate of their cells'respiration.
- For example, your breathing rate increases when you run because active muscles cells need plenty of energy and your breathing rate decreases when you are sleeping because resting cells do not need much oxygen.
- Transport of gases to and from gas exchange surfaces uses blood or the circulatory system in most animals (except for insects), therefore, gas exchange and transport systems are in close contact.
- Therefore, for effective gas exchange, vertebrate respiratory surfaces must;
  be well supplied with blood capillaries
  be thin and moist at all times
  have a large surface area.

Gas Exchange in Fish

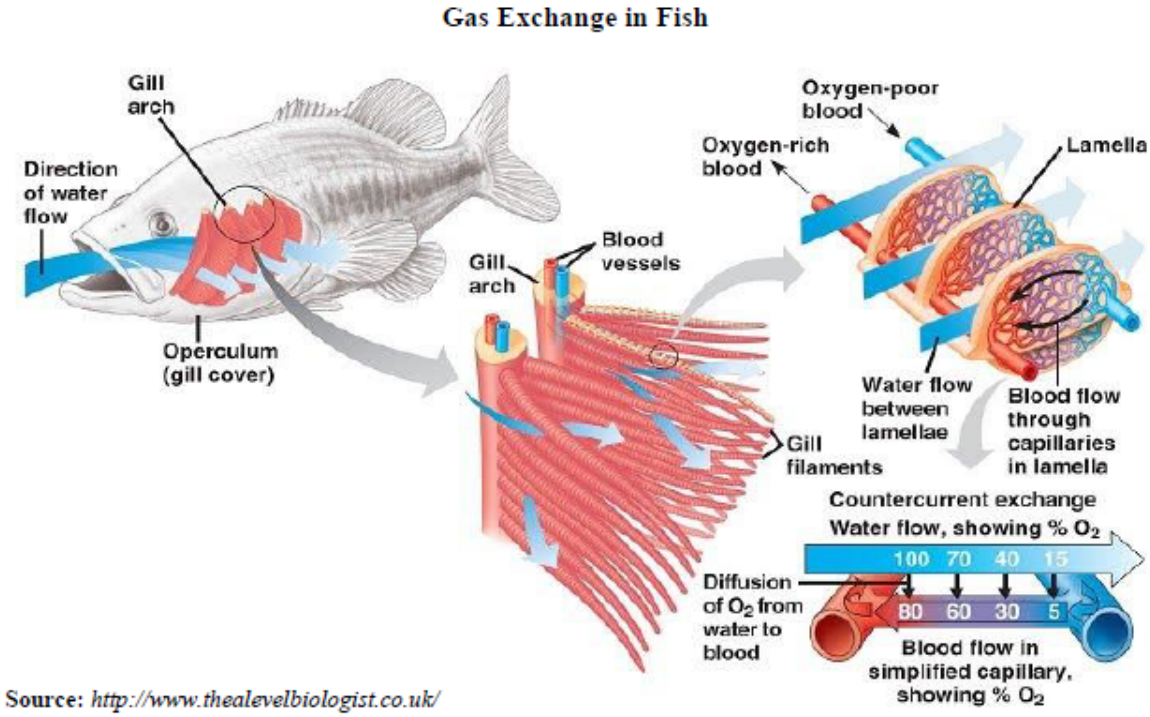
- Fish have internal **gills** to exchange gases with water while in tadpoles the gills are located externally.
- Gills rest outside a fish's body, though they are protected under gill covers.
- Exchanging gases with water is more difficult than exchanging with air because;
  - Water contains less oxygen than air.
  - Water is harder to pump over the respiratory surface because it is denser.
- Fish have several adaptations for overcoming these problems

Fish Adaptations for Getting Oxygen from Water

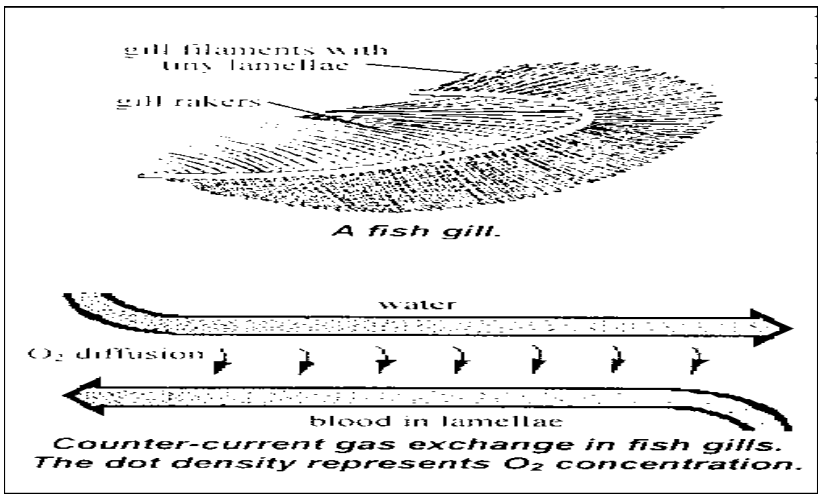
- Fish constantly pump fresh water over their gills using a muscular pharynx.
- Tiny ridges called **lamellae** on folds called **gill filaments** greatly increase gill surface area for gas exchange.
- Structures called *gill rakers* trap any bits of food.
- Gills dependent on the buoyancy of the water for support.

- Gills are packed with blood capillaries.

The direction of the blood flow in the gills is in the opposite direction to the flow of water on the gills. This ***counter current flow*** maximizes the concentration gradient thus maximizing the diffusion of O_2 from the water into the blood and CO_2 from the blood into the water.



Counter Current Gas Exchange System



- Water entering the gills has high concentration of oxygen.
- Blood entering the gills have low concentration of oxygen.
- A concentration gradient is created between the water and the blood.
- O_2 diffuses from water into blood.

- Blood leaving the gills have high concentration of O_2.
- Water leaving the gills has low concentration of O_2.
- Blood in the gill capillaries flows in the opposite direction to the flow of water (counter current system).
- This places blood with low concentration of O_2 with water with low concentration of O_2 and highest to highest.

Adaptive Value

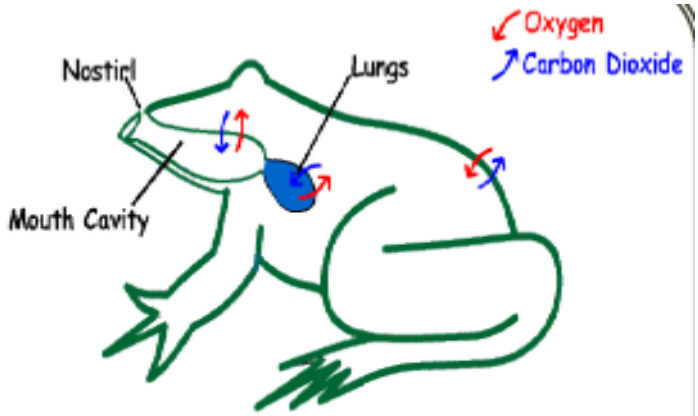
- Since all the fish are aquatic, their respiratory system is specially adapted for exchanging gases with water and would suffocate quickly out of water.
- Out of water, fish gill filaments stick together greatly reducing the surface area for gas exchange.
- The gills quickly dry up and then no longer able to dissolve gases for exchange.
- Fossil remains suggest that fish were the first vertebrates to evolve and have been around for approximately 400 million years longer than we humans.

Homework

1. Why do vertebrates need a particularly efficient method of exchanging gases?
   _____
   _____
   _____
2. Give two reasons why land animals cannot use gills for gas exchange?
   _____
   _____
   _____
   _____
3. Explain why fish suffocate when taken out of water?
   _____
   _____
   _____
4. List the four respiratory surface adaptations for gas exchange that every vertebrate has.
   _____
   _____
   _____
   _____

Gas Exchange in Amphibians –gills, lungs and skin

- Amphibians were the first vertebrates' adapted for life on land.
- They form the evolutionary link between fish and land vertebrates.
- Young amphibians, i.e. **tadpoles** survive in water using external ***gills*** for gas exchange.
- Adult amphibians live on land, relying partly on their lungs.
- The land- dwelling adult forms, use their moist skin and their lungs for gas exchange. For effective diffusion amphibians must keep their skin moist at all times.
- To stay moist, toads and other amphibians often hide under rocks or logs until it rains or until after the sun sets.



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