Please note – These are extracts from one student's response

4

Living organisms need energy from respiration to survive and reproduce. Gas exchange is when oxygen is taken from the air or water and into the bloodstream, and carbon dioxide is released.

Fish are vertebrates which all require oxygen (O_2) to survive, and they carry out gas exchange in water as this is their habitat. They are adapted to occupy a specific ecological niche in fresh and salt water.

3

3

Because the percentage of dissolved oxygen is only l % in water compared 21% in air, getting oxygen for gas exchange is more difficult for fish than terrestrial animals. Water is also denser making it more strenuous to ventilate - it requires 15 times more energy.

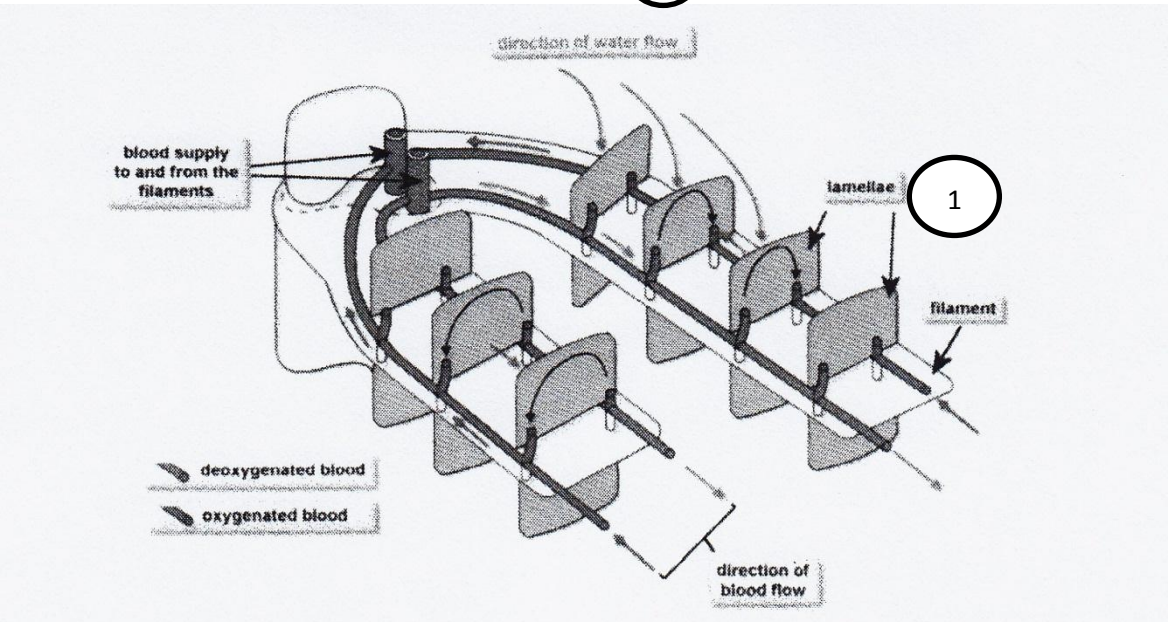
1

Fish use gills and the flow of water over their gills to take in O_2 and to remove CO_2. A fish breathes as it swims by opening its mouth and allowing water to flow over the gills. When the fish opens its mouth opercula (flaps) close, so that water can flow over the gills, O_2 can be removed and CO_2 can be released. When the fish closes its mouth the opercula are forced open, letting the water and waste CO_2 flow out of the fish.

2

The gills of a fish have filaments, which comb through the water. On the filaments are lamellae, shaped like a ladder, so that the O_2 poor blood travels up one side before crossing over to the other side and travelling back down as O_2 rich blood. As the blood travels across, through the capillaries, it takes in O_2 by diffusion.

2



1

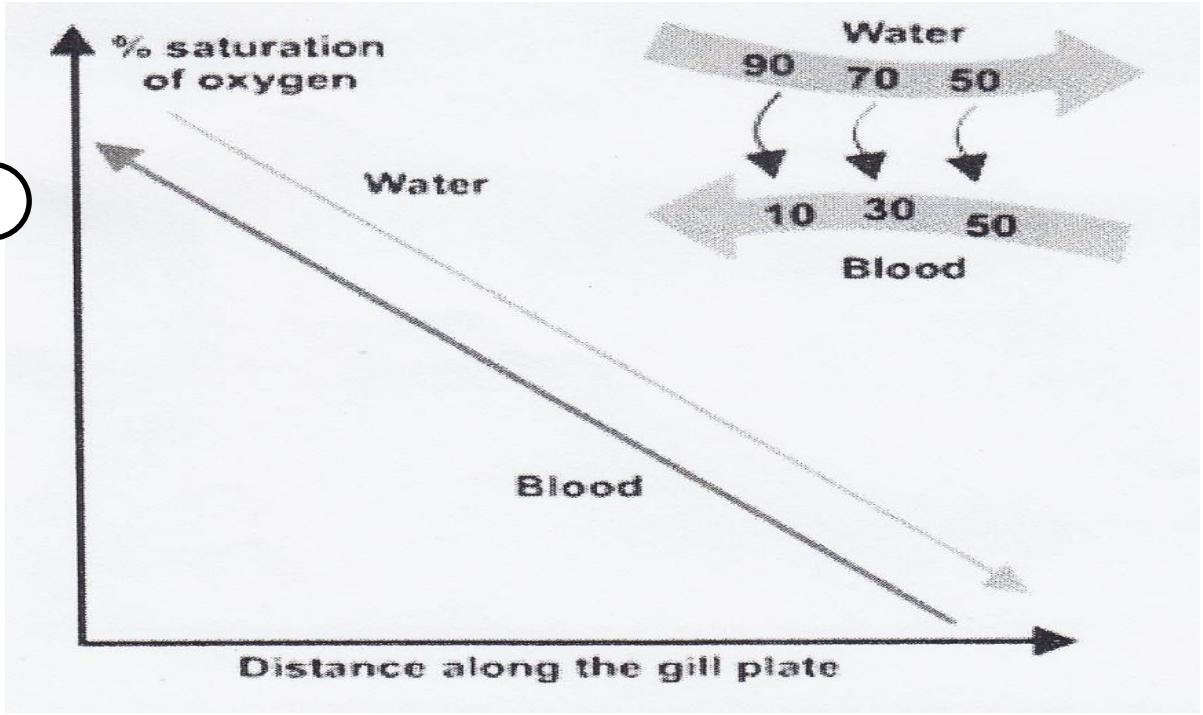
- Diagram showing the direction of blood flow against the flow of water (counter current)

(Google images, 2012)

2

A counter current system makes sure that the water which meets the blood in the gills always has a higher concentration of oxygen, thereby producing a relatively effective gradient for the diffusion of oxygen into the fish's circulatory system.

1



(Counter current flow, Google images, 2012)

The graph shows that when water with high oxygen saturation meets the blood with low oxygen saturation, the oxygen diffuses from the water across the lamellae and into the capillaries. This is more effective than concurrent flow, in which blood flows the same way as water.

2