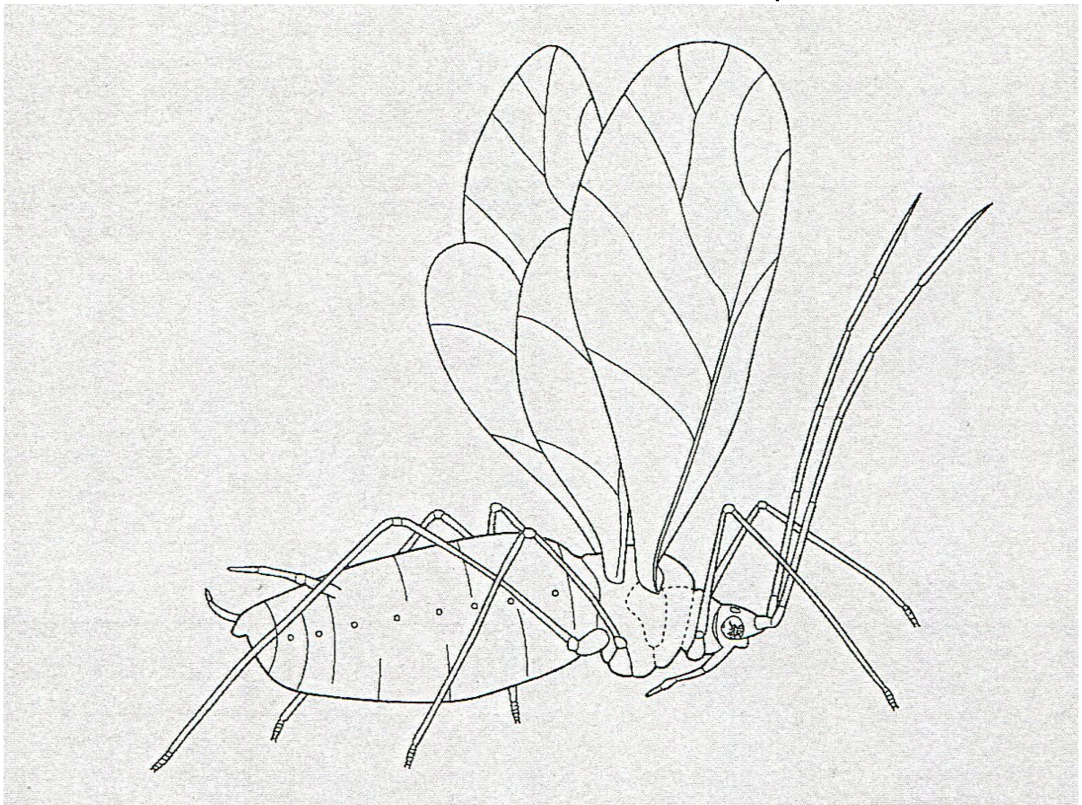
The figure below shows the structure of an arthropod. It had the chitinous exoskeleton which is characteristic of all arthropods.



(a) State two other features, visible in the figure, which are characteristic of arthropods.

(b) State the class of arthropod to which the example shown in the figure belongs, with three diagnostic features of the class that are visible in the figure.

(c) (i) State the name of one structure, visible in the figure, that is used for gaseous exchange.

(ii) State the name of two structures, visible in the figure, that are used for sensing of external stimuli.

Read the passage.

Substitute for blood to be tested

Trials are about to begin in England of a blood substitute that might replace 10 to 20% of transfusions, while making use of blood donations that have passed their ‘use-by’ date.

The artificial blood is a haemoglobin solution made from the oxygen carrying part of the red cells in human blood and is being tested in trauma cases. Because the red cell surfaces are missing, patients do not have to be typed and the blood cross-matched before transfusion.

The product has been developed by the US-based Baxter Healthcare which has overcome the problem that pure haemoglobin naturally tends to break into two molecules and be rapidly lost from the body. Baxter has found a way of locking the two sub-units together that makes the haemoglobin efficient oxygen deliverer and allows it to be heat treated to destroy viruses. The company is taking the haemoglobin from blood donations that have passed their 35-day shelf-life – a fate that on average happens to about 5% of donations in England.

Apart from being used in accident, injury and shock cases where oxygen delivery and fluid bulk is needed, one of the artificial blood’s most exciting possibilities is that it may offer treatment for strokes. In animal studies, the haemoglobin solution has been able to go round blood clots and reach the parts of the brain being oxygen-starved by the clot. Infusion of the solution soon after a stroke appears to reduce the damage done to brain tissue and thus the effects of the stroke, which in humans can leave the victim paralysed, or their speech affected.

The blood substitute will not reduce the need for donors because it is derived from human haemoglobin. But it will cut out the waste of out-dated blood, allow blood to be used more flexibly and the resulting artificial blood to be stored for long periods.

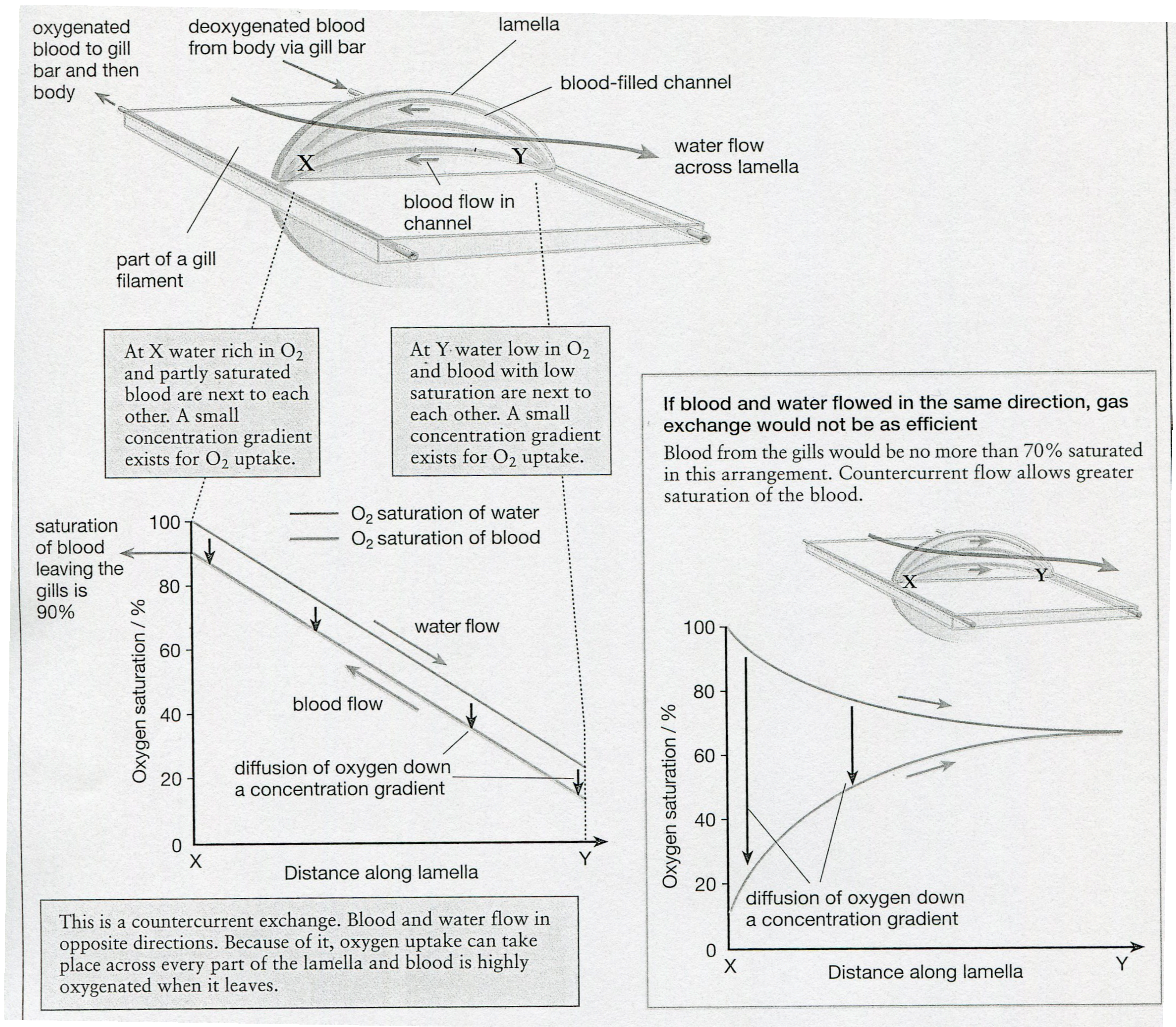
adapted from an article in the Independent (7/5/94)

(a) The reason blood has a ‘use-by’ date is that blood cells have a much shorter life span than the other cells in the body. Suggest one reason, connected with their structure, why red blood cells have a shorter life span.

(b) Explain why artificial blood ‘can reach the parts of the brain being oxygen-starved by the clot‘

(c) Apart from its use in stroke victims, give two other advantages of using artificial blood rather than natural whole blood.

(d) Explain the role of haemoglobin in the loading, transport and unloading of oxygen.



(a) Why do fish need gills?

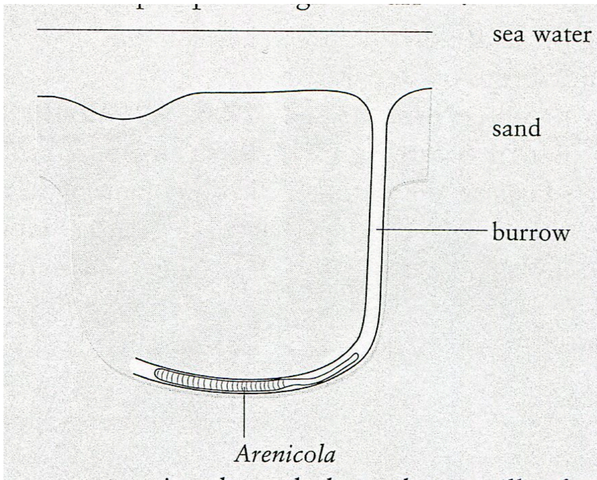
(b) In the graphs below, what is the degree of oxygenation of blood leaving the gills in reality, and what would be if blood and water flowed in the same direction?

(c) Explain the term **countercurrent exchange**.

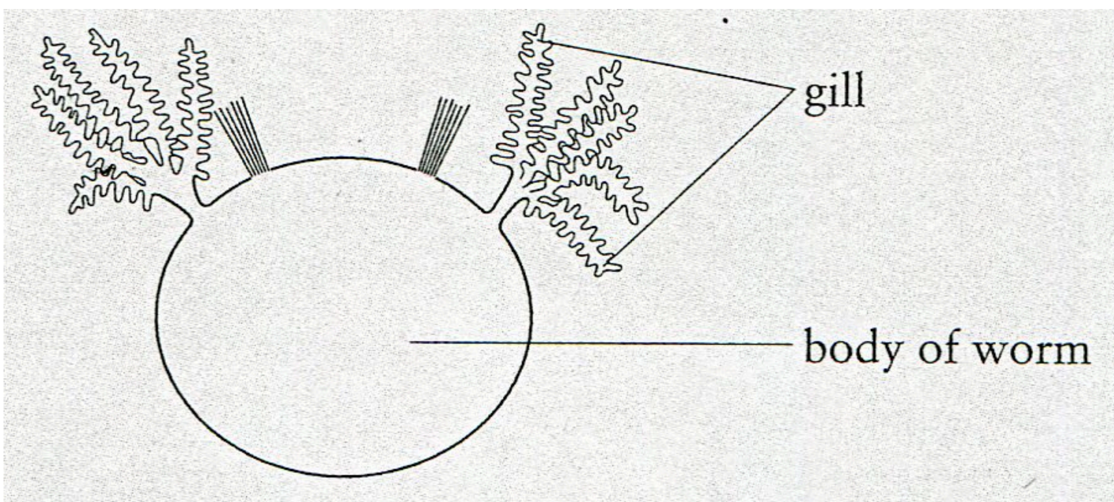
(d) What is the advantage of countercurrent exchange of oxygen and carbon dioxide in fish?

(e) Why is it not possible to have a countercurrent mechanism in human gas exchange?

Arenicola is a worm that lives in a burrow in the seashore as shown below. It uses gills to obtain oxygen from the sea water that it pumps through its burrow.

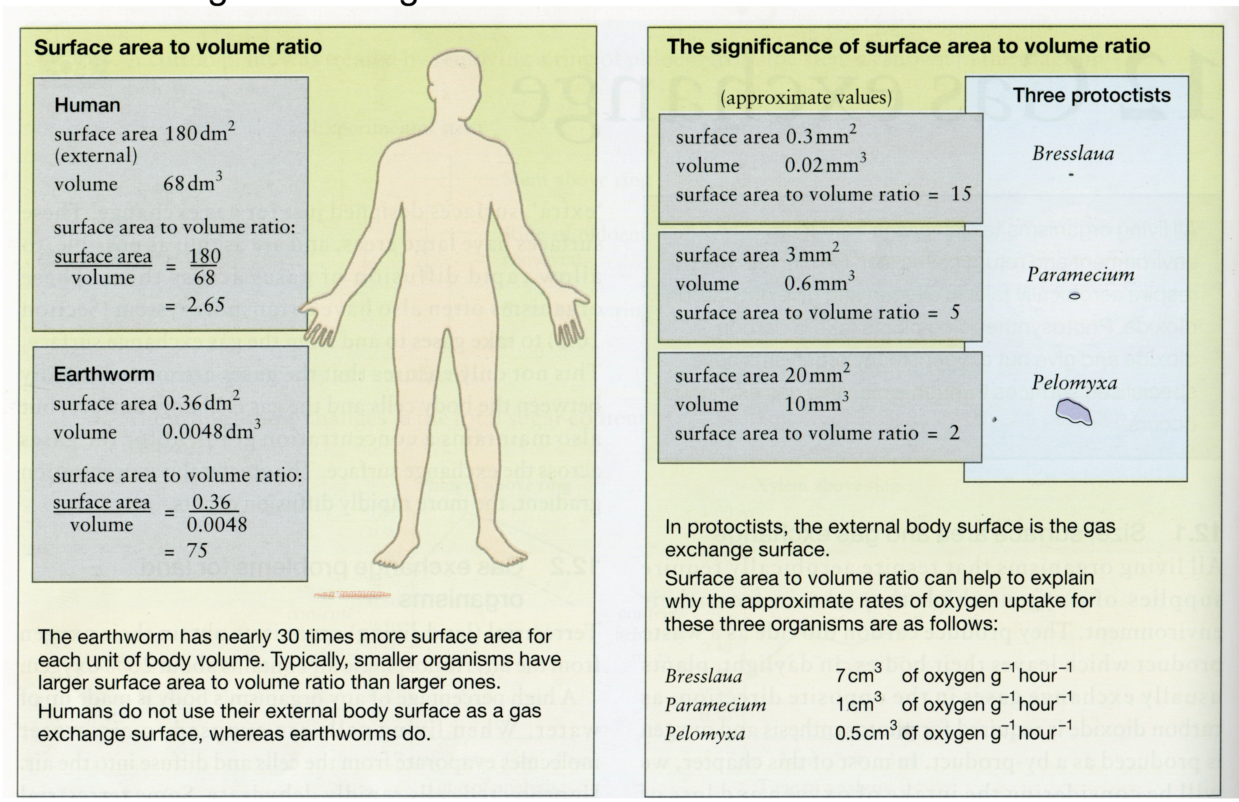


(a) The figure below shows a cross section through the body and gills of the worm.



Using information from the second figure explain how the shape of the gill makes it an efficient structure for absorbing oxygen.

(b) Explain in terms of gas exchange the advantage to the animal of pumping sea water through its burrow (a)Suggest two reasons why humans do not use their external body surfaces for gas exchange.



(b) Explain how the surface area to volume ratio of *Bresslana, Paramecium* and

Pelomyxa could explain the rate of oxygen uptake in the organisms.

(c) Give another possible reason for the differences in the rates of oxygen uptake

other than surface area to volume ratio.