WJEC EDUQAS AS BIOLOGY · COMPONENT 2

BIOLOGY



EXAM QUESTION PACK

2.2 ADAPTATIONS FOR GAS EXCHANGE

SCORE	PERCENTAGE
/84	%

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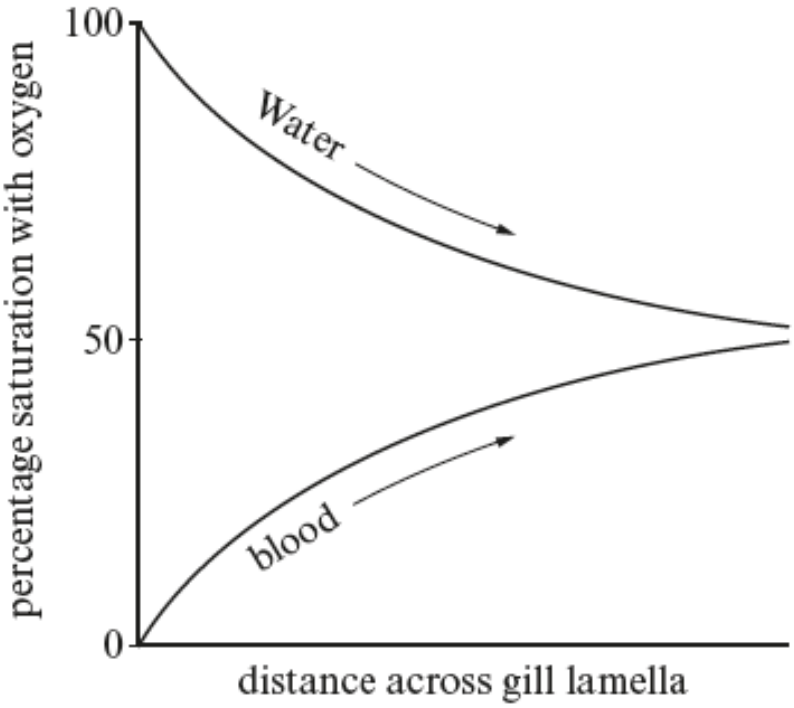
1. (a) Describe and explain the process of **inspiration** in a mammal.

[4]

(b) (i) Explain how counter current flow works in the gills of bony fish.

[4]

The graph below shows another type of flow.



(ii) Name the type of flow shown in the graph above.

[1]

(iii) Explain why this is less efficient than counter current flow.

[2]

(c) Suggest why gill filaments/ lamellae would not provide an efficient gas exchange surface on land.

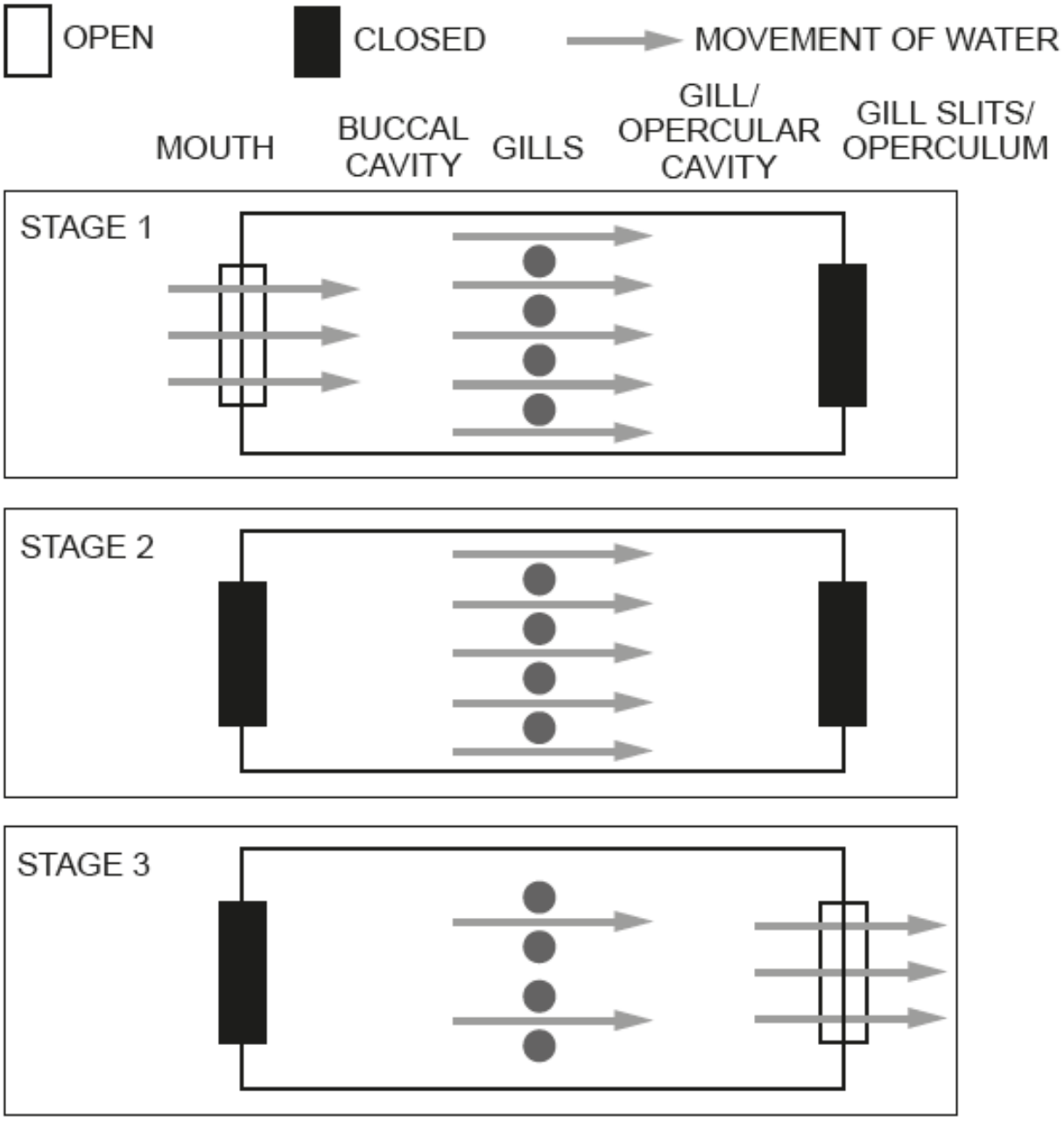
[2]

2. (a) Bony fish rely on gills and gill filaments for gaseous exchange. Explain how the presence of gill filaments is an adaptation to gaseous exchange.

[2]

(b) The system of ventilation in a bony fish enables water to be passed continuously over its gills whilst the fish is at rest.

The diagrams below show three stages in the process of ventilation.



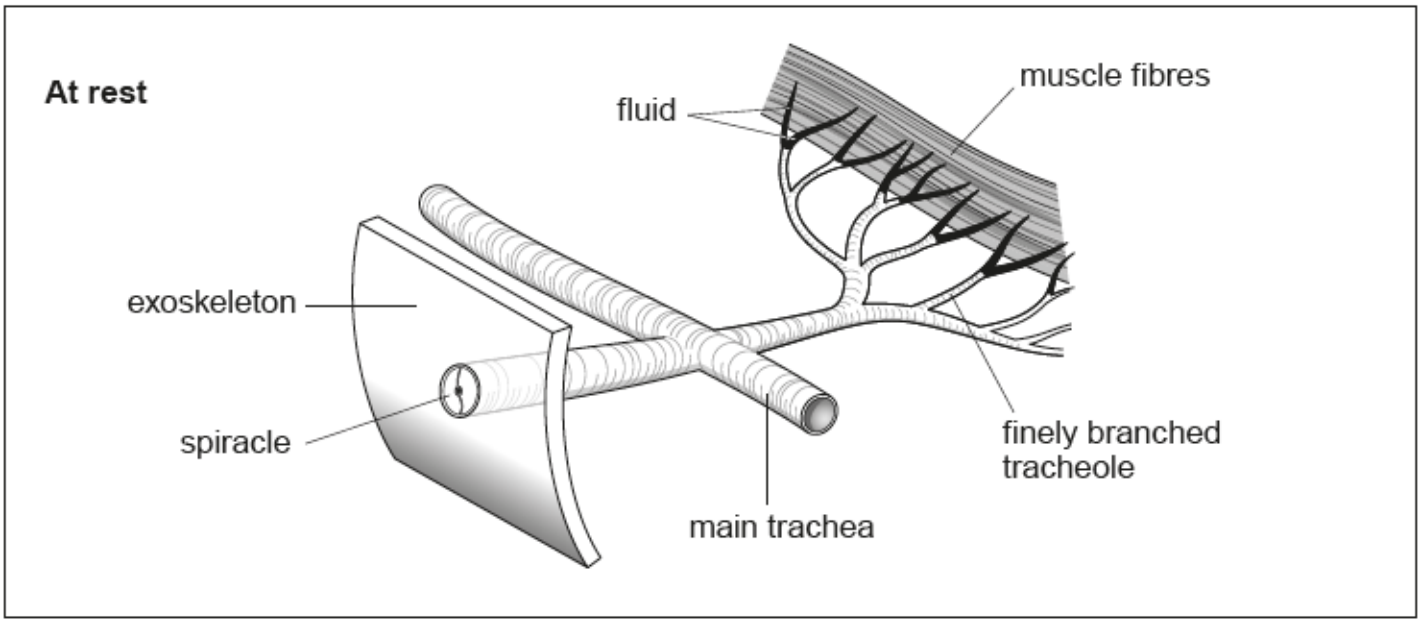
(i) Ventilation of the gills is achieved by pressure changes in the buccal and gill/ opercular cavities. Using information from the diagram opposite and your own knowledge describe the process of ventilation in a bony fish.

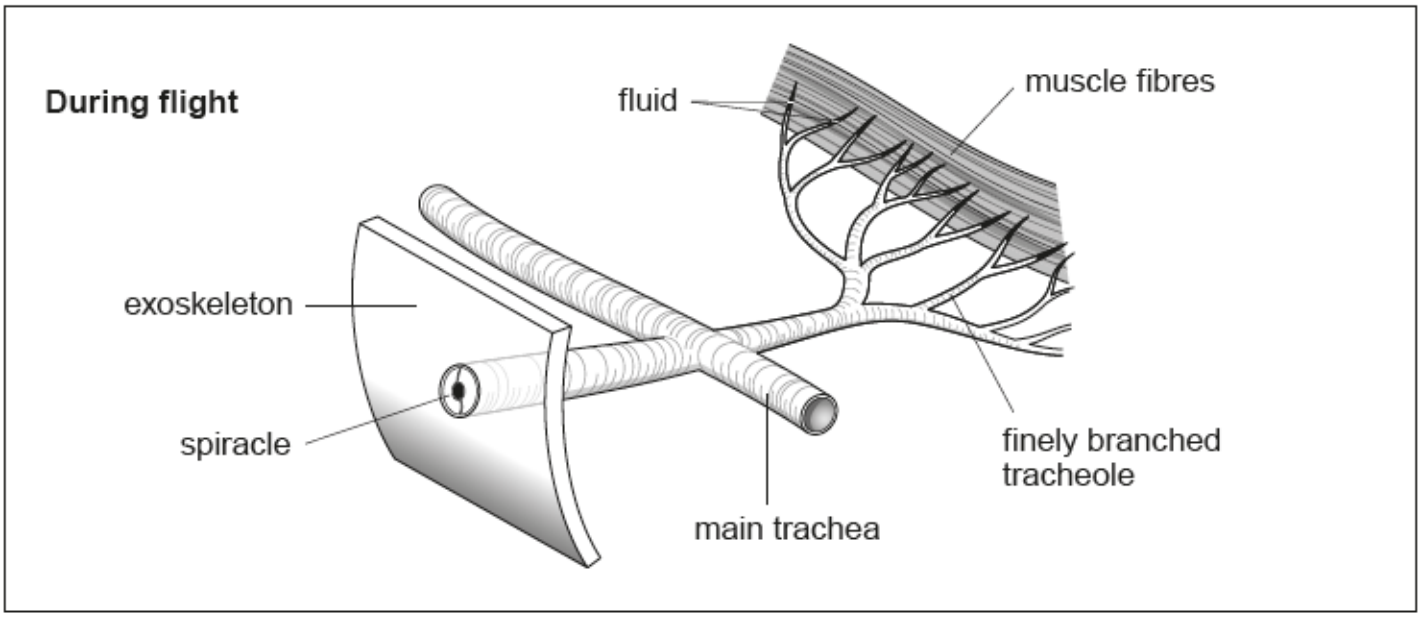
[4]

(ii) In order to further increase the efficiency of gas exchange, bony fish use a counter current flow. State what is meant by counter current flow and explain how this increases the efficiency of gas exchange in the bony fish.

[3]

(c) The diagrams below show insect tracheoles supplying muscle fibres at rest and during flight.





(i) The tracheoles are found on the outside of the muscle fibres. Suggest why the maximum diameter of a muscle fibre never exceeds 20 μm in diameter.

[2]

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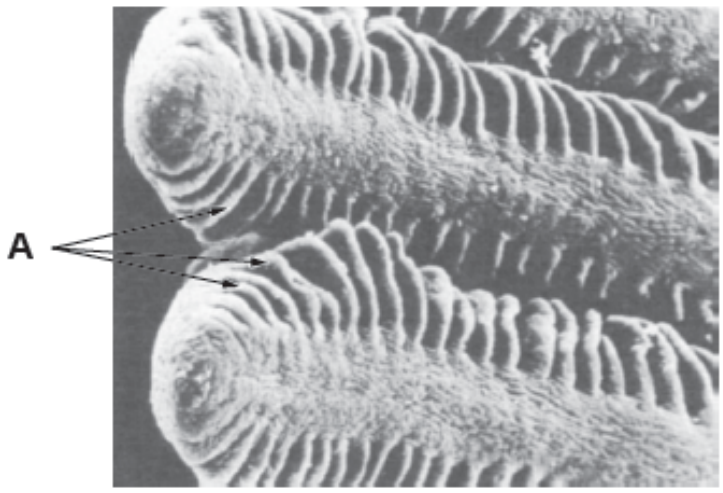
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(ii) Describe the change in fluid level in the tracheoles during flight. Suggest how this change benefits gaseous exchange during flight.

[2]

3. The photograph below shows a scanning electron micrograph of fish gills.



http://ars.els-cdn.com/content/image

(a) Name the structures labelled A in the photograph above.

[1]

(b) Describe how a bony fish ventilates its gills and absorbs oxygen from water.

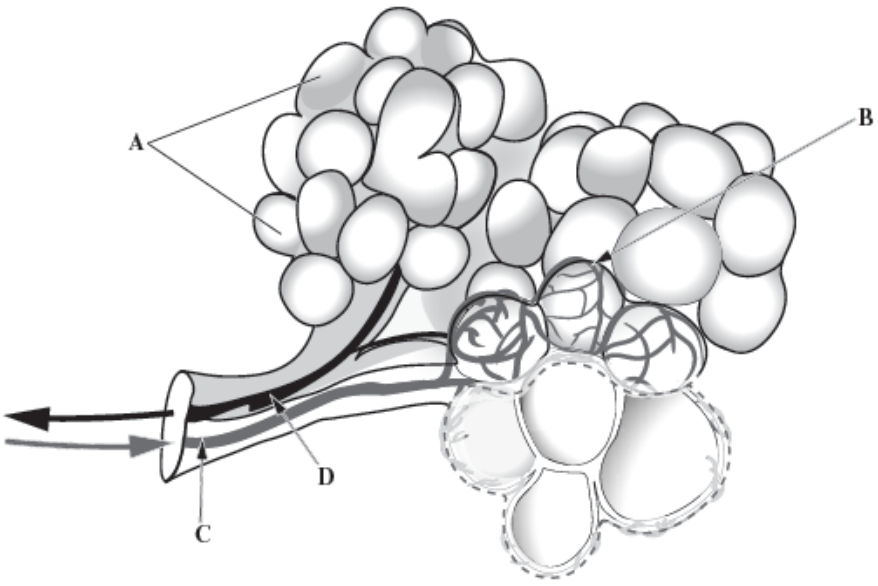
[4]

(c) Using the photograph above and your own knowledge, describe four similarities in the adaptations of the gill for gaseous exchange and a mammalian villus for the absorption of digested products.

[4]

4. The image below shows part of the lung viewed under high magnification.

The arrows indicate direction of blood flow.



(a) (i) Identify the structures A and B.

[1]

A . . . . . .

B . . . . . .

(ii) Identify the blood vessels which connect C and D to the heart.

[1]

C . . . . . .

D . . . . . .

(b) State two important structural features of A visible in the diagram.

[2]

1

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2

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(c) Briefly explain how inspiration is brought about.

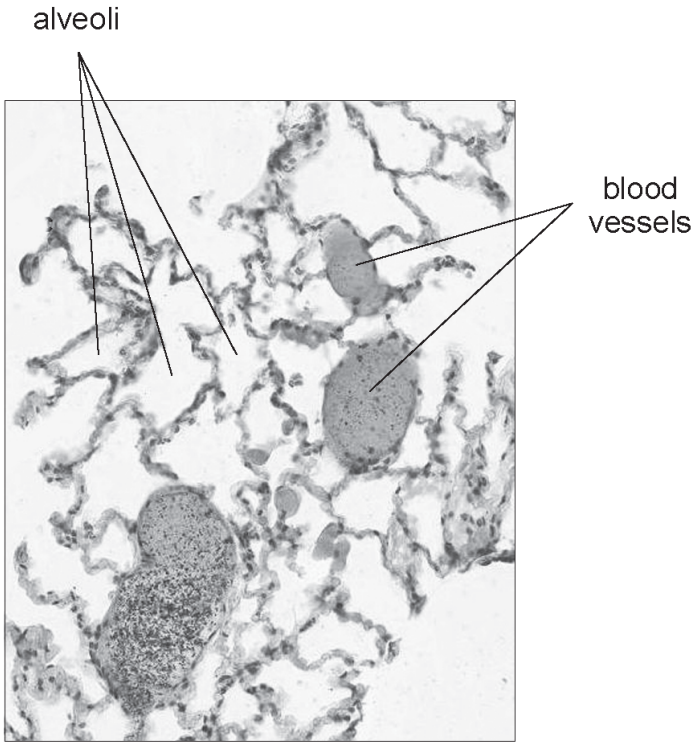
[2]

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5. Shown below is a micrograph of a section through part of a mammalian lung.



(a) Describe and explain how **two** features **shown in the micrograph** are adaptations for efficient gas exchange. [4]

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(b) (i) Describe and explain the process of expiration in a mammal. [4]

(ii) Mammals have a high oxygen demand. Suggest why they need a complex ventilation mechanism. [2]

10

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6.

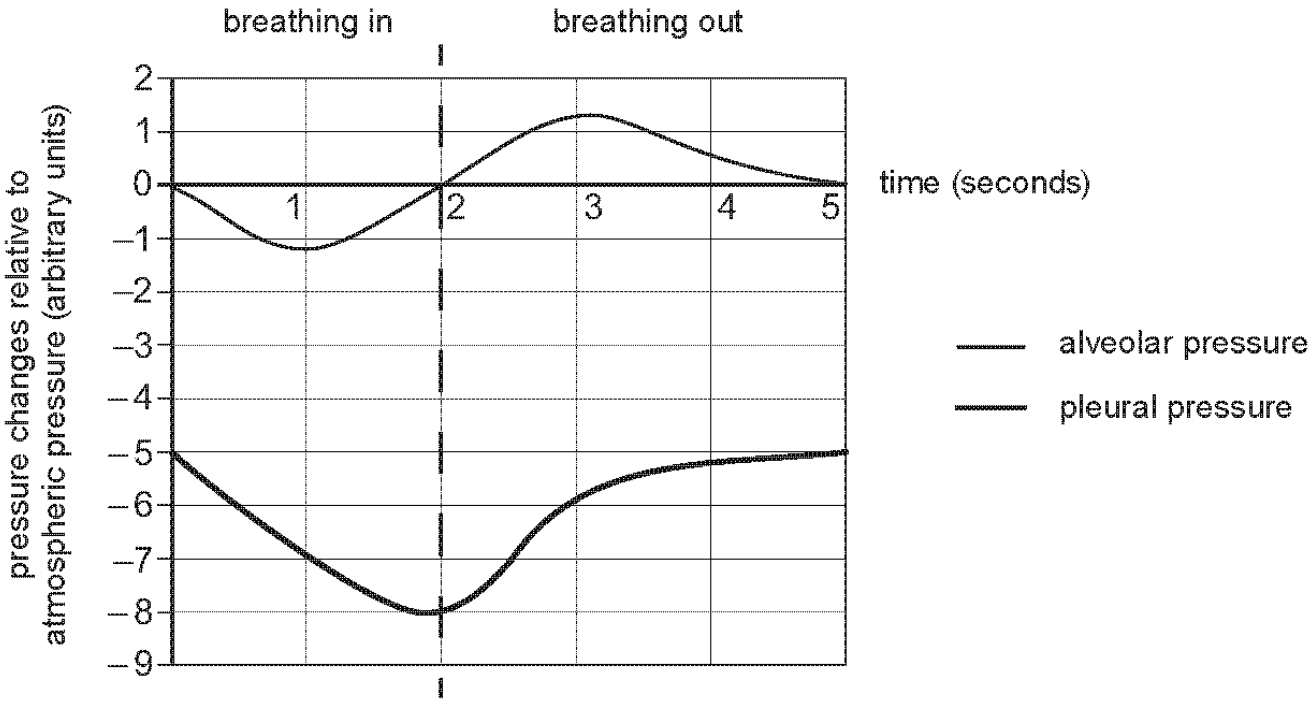
(a) Give **two** advantages of humans having internal gas exchange surfaces. [1]

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Lungs are enclosed inside the body and so humans have to breathe in actively to get oxygen to the gas exchange surface. Breathing out at rest relies mainly on elastic recoil.

The graph below shows how the pressures in the alveoli and the pleural cavity change during breathing in and out.



(b) The outer pleural membrane is attached to the ribcage and the inner pleural membrane is attached to the outer surface of the lungs. Using your knowledge of ventilation, and with reference to the graph, explain how the outward movement of the ribcage causes the changes in the pleural and alveolar pressures during breathing in. [4]

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(c) State **one** medical use of artificial surfactant and explain why it would be needed. [2]

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7

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7. The photograph below shows a scanning electron micrograph of fish gills.

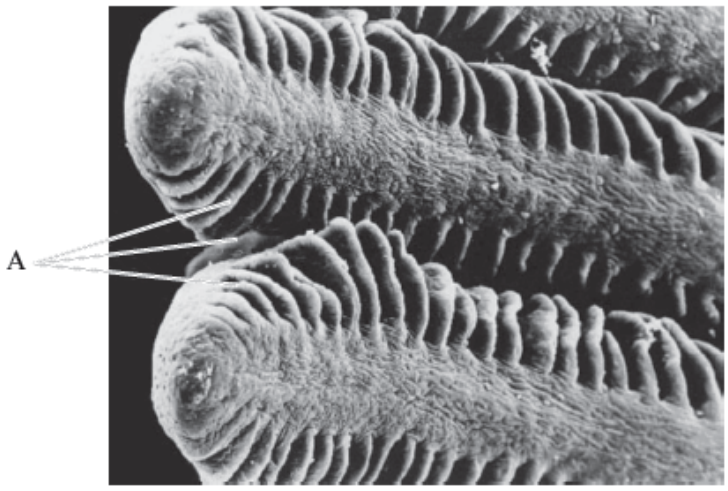


Photo courtesy of Electron Microscopy Unit, Royal Holloway University of London

(a) Identify structures A.

[1]

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(b) Using the photograph above and your own knowledge, describe three features of fish gills which allow them to achieve efficient gas exchange.

[3]

1

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2

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3

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(c) Water is a dense medium with a low oxygen content. Explain how bony fish have overcome the problems of oxygen uptake in water.

[4]

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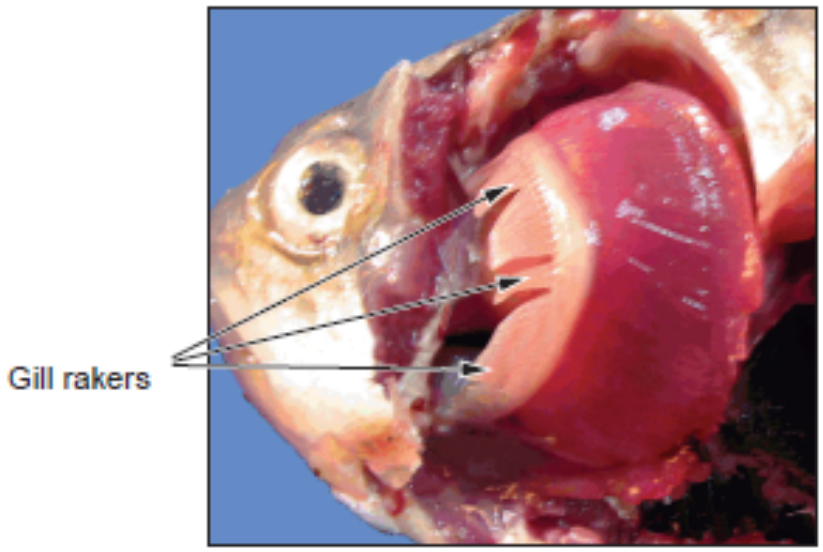
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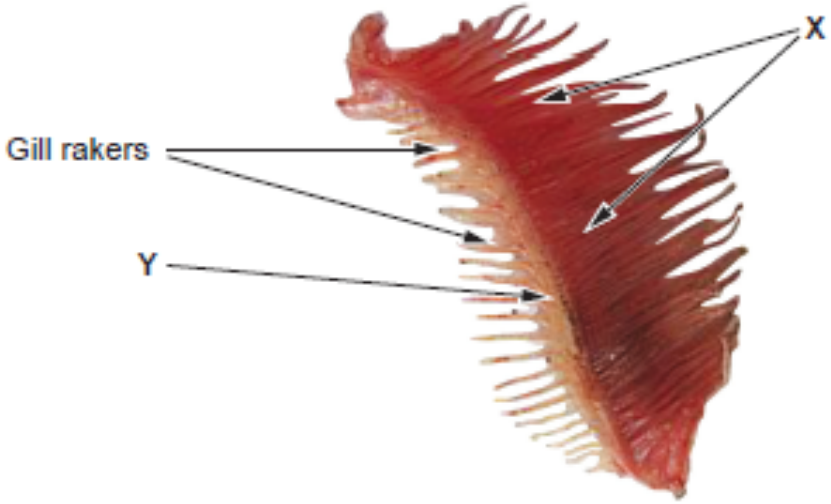
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8. **Photograph A** shows a freshly dissected bony fish with the operculum removed to show the gills.
Photograph B shows a single gill 30 minutes after having been removed from the fish.

Photograph A



Photograph B



(a) (i) Identify the structures labelled **X** and **Y** in **Photograph B**. [1]

X .....

Y .....

(ii) Suggest the function of the gill rakers. [1]

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(iii) Use the photographs, and your knowledge, to explain why fish suffocate when out of water. [4]

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(b) Gas exchange in bony fish uses the countercurrent flow mechanism, where blood flows through the capillaries of the gill lamellae in the opposite direction to water flowing across them. In parallel flow, blood flows through the capillaries of the gill lamellae in the same direction as water flowing across them. Explain the advantages of the countercurrent flow mechanism compared to the parallel flow mechanism. [4]

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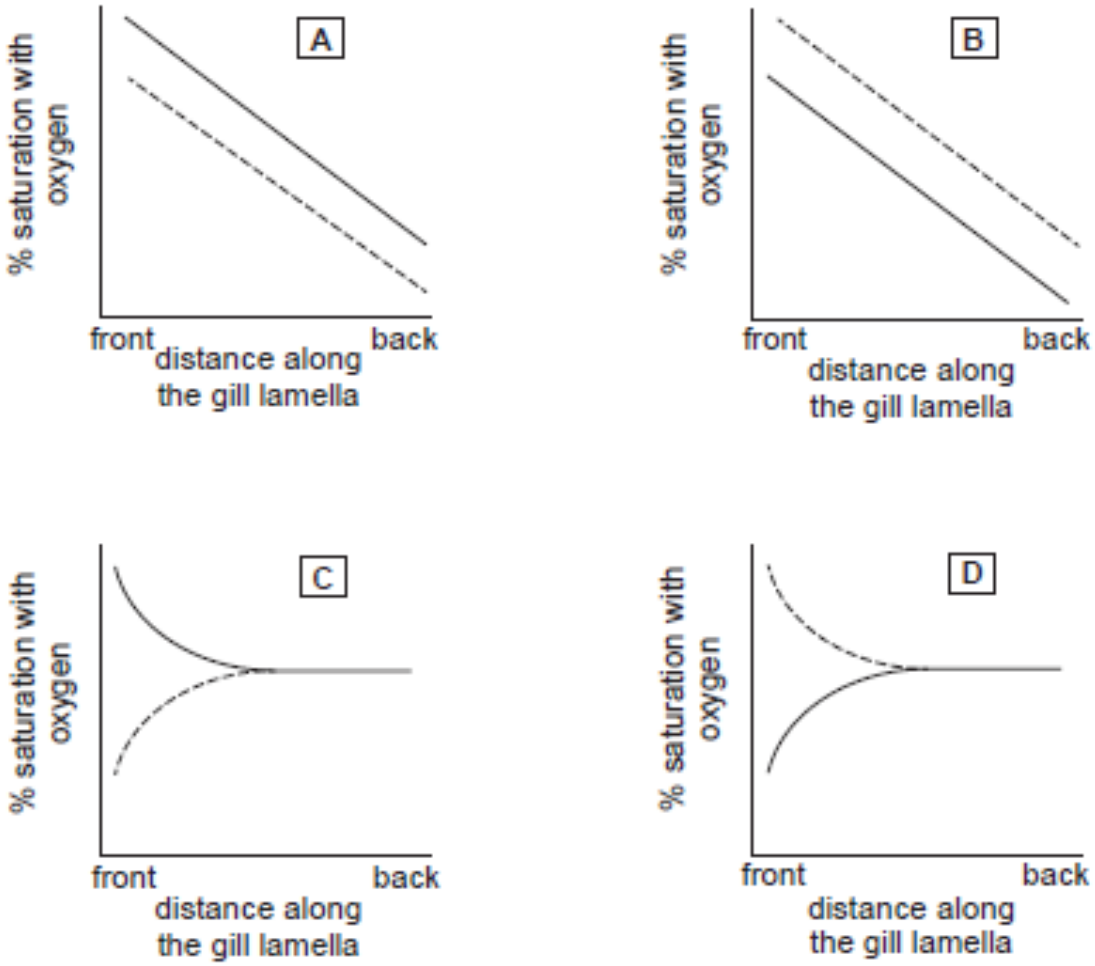
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(c) The graphs below show representations of changes in oxygen concentration as water flows across the gill lamellae.



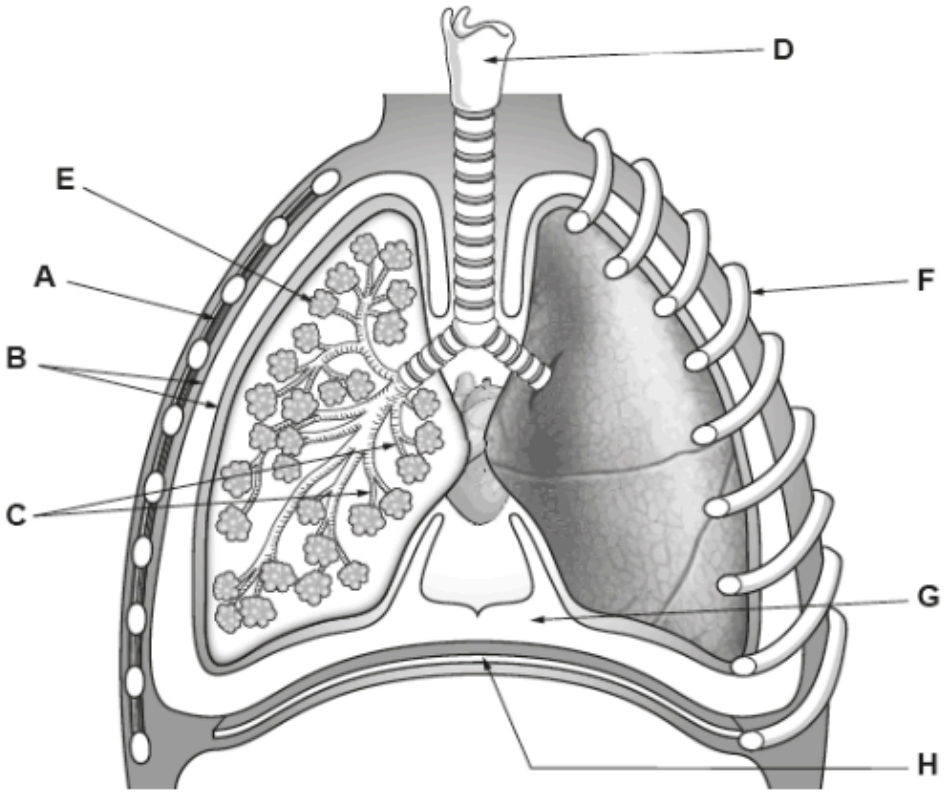
Key: ———— = water; – – – – – = blood

(i) Identify which graph illustrates parallel flow and which graph illustrates countercurrent flow. [1]

Parallel flow ..... Countercurrent flow .....

(ii) Clearly insert arrows on the graph which represents countercurrent flow to show the direction of blood flow and of water flow. [1]

9. The diagram represents the human respiratory system.



(a) Use some of the letters from the diagram to match the structures to the following functions.

[3]

Function	Structure
Flattens during inhalation to increase the volume of the thorax	
Become constricted and inflamed during an asthma attack	
Contain a surfactant to reduce surface tension	

(b) The structures labelled **E** have thin walls and are surrounded by an extensive capillary network.

Explain how these adaptations increase the efficiency of gas exchange

[3]

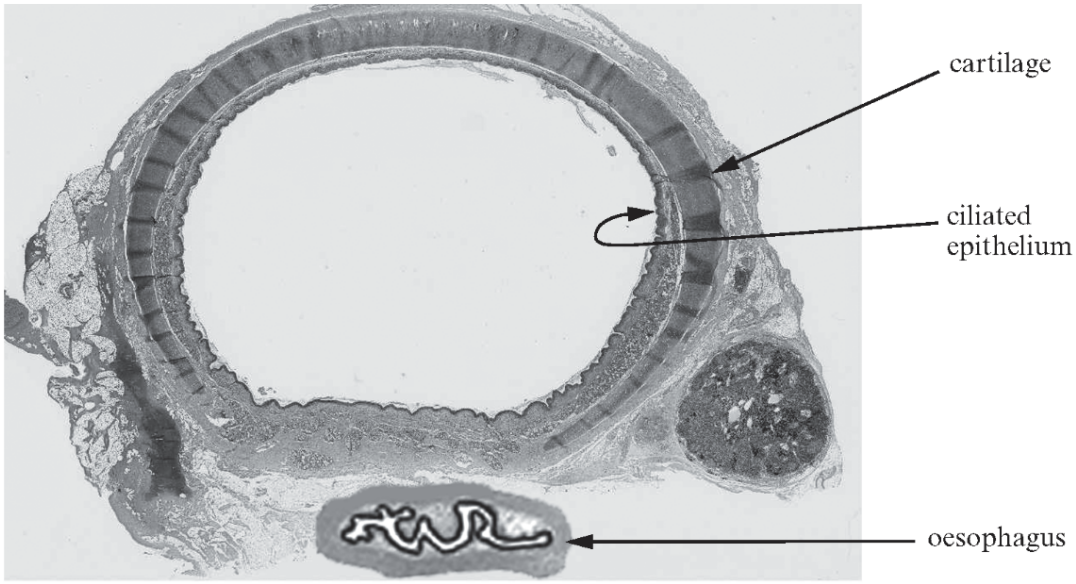
Thin walls . . . . . .

. . . .

Extensive capillary network . . . . . .

. . . .

10. The micrograph shows a section of the trachea of a human.



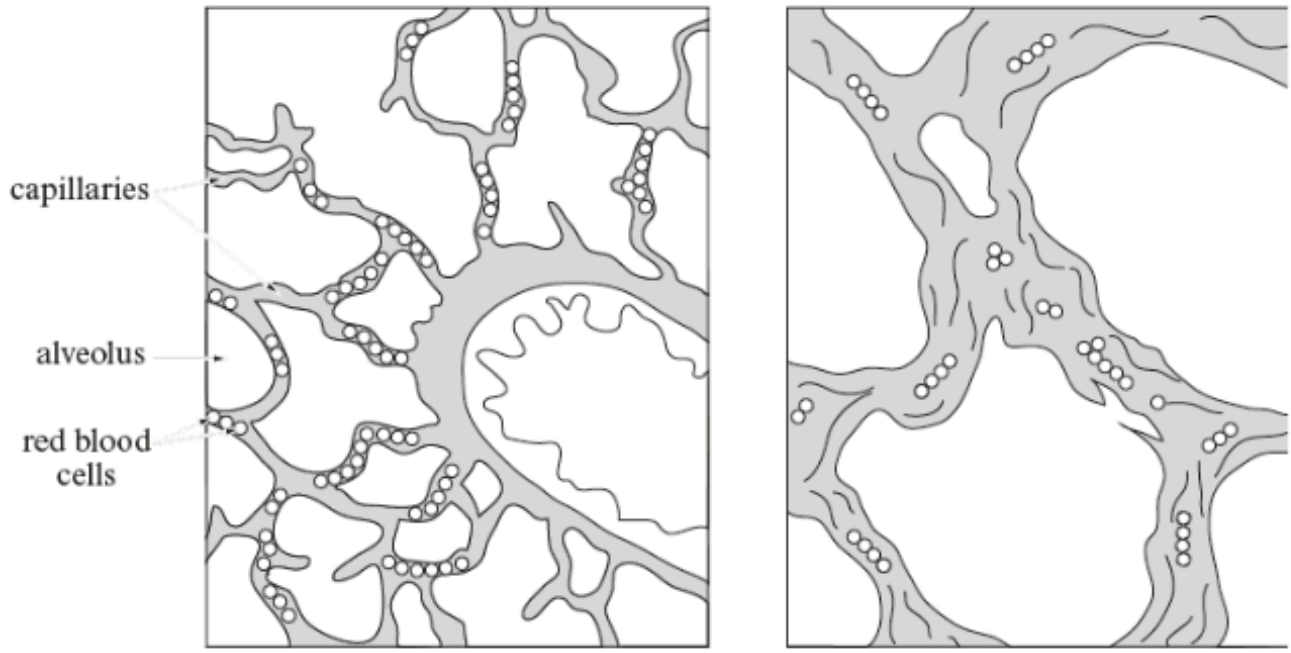
(a) What is the function of the ciliated epithelial layer? [2]

(b) (i) What is the function of the layer of cartilage? [2]

(ii) Suggest why the cartilage is not in the form of a complete ring. [1]

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11. The diagrams below show a section through a healthy lung and a section through a lung from a patient suffering from emphysema. Both diagrams are drawn to the same scale.



Healthy lung

Emphysema sufferer

(a) List **three** adaptations for gas exchange **shown** in the healthy lung diagram above.

[3]

(i)

.....

(ii)

.....

(iii)

.....

(b) Describe how **one** of the adaptations listed in part (*a*) aids gas exchange.

[1]

Adaptation . . . . . .

. . . . . .

Description . . . . . .

. . . . . .

1.

Question			Marking details	Marks Available
1.	(a)		Any 4 Intercostal muscles <u>contract</u> <u>and</u> ribs move <u>up and out</u>; Diaphragm (muscles) <u>contract</u> <u>and</u> diaphragm <u>flattens</u>; (Internal) volume of <u>thorax</u> increases; accept chest reject lungs Pressure in lungs/ thorax decreases; {Higher/ <u>difference</u> in} air <u>pressure</u> outside {forces/ pushes/ moves/ drawn} air into lungs;	4
	(b)	(i)	blood flows across (gills/ filaments/ lamellae/ gill plates) in opposite direction to water; water always has more oxygen than blood/ (oxygen) {diffusion/ concentration} gradient maintained; oxygen passes from water into blood; across entire {gill/ gas exchange} surface; NOT longer higher saturation of blood with oxygen/ more oxygen taken up;	4
		(ii)	Parallel (flow);	1
		(iii)	Equilibrium is reached (part way across the gill plates/ lamellae)/{diffusion/ concentration} gradient not maintained; {Lower percentage saturation with/ <u>only</u> 50% saturation} oxygen/ less oxygen uptake/ less diffusion of oxygen; NOT slower	2
	(c)		gills dry out; prevents oxygen from dissolving on surface of gills; gills may {stick together/not open as easily/ collapse}; decrease in surface area; (Explanation cannot be accepted alone)	2 max
			Question 1 Total	**[13]**

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2.

Question			Marking details	Marks Available
2	(a)		Increases surface area; Diffusion takes place (over whole area);	2
	(b)	(i)	Mouth opens/floor of buccal cavity lowered; Volume of {buccal cavity/inside the mouth} increases/pressure lowered inside {buccal cavity/mouth}; Water {pulled in from outside/ enters due to pressure difference}; Mouth closes **and** {buccal cavity then contracts/ floor of buccal cavity raises}; Water forced {across/through} gills (into gill cavity); Pressure in gill cavity increases; Forces open the operculum / gill slits;	Max 4
		(ii)	Blood flows across (gills/ filaments/ lamellae/ gill plates) in opposite direction to water; Blood always meets water containing a higher oxygen concentration/{diffusion/ concentration} gradient maintained/ equilibrium is never reached; Across entire {gill/ gas exchange surface}; Higher saturation of blood with oxygen achieved;	Max 3
	(c)	(i)	Diffusion pathway would be too long/ ensures a short diffusion pathway; Speed of diffusion too slow; To supply sufficient oxygen;	Max 2
		(ii)	Less fluid/ fluid moves into muscle fibres/ fluid level decreases; More area for gaseous exchange/ shorter diffusion pathway;	2
			Question 2 Total	**[13]**

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3.

Question		Marking details	Marks Available
3	*(a)*	lamellae/gill plates;	1
	(b)	water {forced/ flows} over gill (filaments); by pressure changes/ OWTTE; (pumping) action of mouth and operculum/ OWTTE; water flows in opposite direction to blood/counter-current mechanism; maintains {diffusion/ concentration} gradient across {entire/ whole} gill (filament); as blood always meets water with a higher oxygen concentration/ equilibrium is never reached;	max 4
	(c)	Any four large surface area; {(dense) network/ large number} of capillaries; NOT good blood supply {thin/permeable} epithelium; moist; short diffusion pathway;	max 4
		Question 3 Total	**[9]**

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4. (a)

(i)

A Alveoli/alveolar sacs; [1]

B Capillary (network);

Both for 1 mark.

(ii)

C Pulmonary artery; [1]

D Pulmonary vein;

Both for 1 mark.

(b)

Any 2 [2]

Thin alveolus (walls) /one cell thick;

NOT membrane or thin alone.

Large surface area / highly folded;

(volume - neutral)

Large number of capillaries (or implied);

(c)

Contraction of intercostal muscles and diaphragm OR ribcage moves up and out and diaphragm flattens / contract; [2]

Increased volume and decreased pressure so air moves in(to lungs);

Question total 6

5.

Question			Marking details	Marks Available
5	*(a)*		1. They have <u>many</u> alveoli; 2. Which increases / provides a large surface area (for gas exchange); 3. The {alveolar / capillary} <u>walls</u> are {thin / one cell thick} / capillaries are close to alveoli / alveoli are composed of squamous epithelial cells; 4. Providing a short diffusion {pathway / distance} (for oxygen to enter the blood); 5. Many blood {capillaries / vessels} / {<u>rich / good</u>} blood supply / capillary network; reject arteries / veins 6. To maintain (steep) concentration gradients; (Max 2 from 1,3 and 5 and Max 2 from 2,4 and 6)	Max 4
	(b)	(i)	1. The intercostal muscles relax allowing the ribcage to move downwards <u>and</u> inwards; (ignore reference to internal / external) 2. The diaphragm (muscles) relaxes <u>and</u> becomes dome shaped; 3. This decreases the volume of the {<u>thoracic cavity / thorax</u>}; NOT lungs 4. Which increases the pressure inside the {lungs / thoracic cavity}; 5. {Forcing / pushing} air out of the lungs / moving air out of the lungs down a pressure gradient; (NB must be reference to air moving from higher pressure to lower pressure not simply 'air moves out of lungs' unqualified)	Max 4
		(ii)	• Have high metabolic rates / are {homeothermic / endothermic}; • Ventilation maintains a (steep) concentration gradient (at the alveoli) / {sufficient / enough / more} <u>oxygen</u> supplied to the {alveoli / gas exchange surface};	2
			Question 5 total	**[10]**

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6.

Question			Marking details	Marks Available
6	*(a)*		{minimise / reduce} heat <u>and</u> water loss Reject: prevent	1
	(b)		Any **four** from: • Intercostal muscles contract (and expand the ribcage); • (outer) pleural membranes pulled out (by expanding ribcage); • pleural pressure reduced; • (inner) pleural membrane pulls on lungs and expand alveoli; • alveolar pressure lowers; • air moves in {when alveolar pressure is lower than atmospheric pressure / and increases alveolar pressure}; • reference to data from graph;	4
	(c)		Premature babies / lung transplants / respiratory distress syndrome; lowers surface tension of the fluid in the alveoli / to prevent alveoli from collapsing;	2
			Question 6 Total	**[7]**

7. (a)

(Gill) lamellae / filaments / plates; [1]

(b)

Any 3 [3]

Large surface area (for diffusion); (volume neutral)

Thin / short diffusion pathway;

Permeable;

Good blood supply or implied; NOT transport system

NOT moist.

(c)

Water is forced over the gill by {ventilation mechanisms / pressure differences / continuous swimming}; [4]

Unidirectionally / one way flow;

Countercurrent flow of blood and water / or description of;

{Diffusion / concentration} gradient is maintained or description of;

over the entire gill surface;

High affinity Hb;

Question total [8]

8.

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)	(i)		**Both needed for one mark** X = (gill) filaments Y = (gill) arch/bar	1			1		1
		(ii)		{Filter/sieve/remove/catch} {food/particles/solids NOT molecules} /protection from debris/preventing damage to the gill filaments (1)		1		1		
		(iii)		A. normally water separates {filaments/lamellae/plates/gills}/Gills dry out (when out of water) (1) B. {Filaments/lamellae/plates/gills} {stick together/collapse} (1) C. Reduced Surface Area for {diffusion/gas exchange} (1) D. Water needed for diffusion (of gases)/{oxygen/gases} need to be in solution to diffuse (1)	4			4		
	(b)			Accept reverse argument for any point A. Countercurrent more efficient (1) B. Maintains {diffusion/concentration} gradient/or description of/equilibrium not met (1) C. Across {entire/whole} {gill/filament/lamellae/plate} (1) D. {Higher/more} {saturation/oxygen absorbed} (1) Accept correct references to higher percentages in counter current/use of values e.g. 80% compared to 50%	4			4		
	(c)	(i)		C = parallel flow **and** A = countercurrent flow (1)		1		1		
		(ii)		Correct insertion of arrows on A only (1) **NOT ECF**	1			1		
				Question 4 total	**10**	**2**	**0**	**12**	**0**	**1**

9.

Question		Marking details		Marks Available
5.	(a)			3

FUNCTION	STRUCTURE
Flattens	H/ diaphragm
Become constricted	C/ bronchioles
Contain a surfactant	E/ alveoli

(b)	(Thin walls)	Reduce diffusion distance/short diffusion path (for gas exchange);	1
	(capillaries)	In close contact to reduce diffusion distance/speed up gas exchange; Circulation {creates/establish/maintains} {diffusion/concentration} gradient; Transports gases to and from site of gas exchange; Large surface area {for gas exchange (with blood)/ so oxygen can be absorbed/ to ensure blood is saturated with oxygen};	max 2

10.

(a) Beat;

Move mucus + bacteria upwards. [2]

(b) (i) Prevent trachea closing;

During inspiration. [2]

(ii) to allow room for oesophagus to expand when swallowing food. [1]

Total 5 marks

11.

Question			Marking details	Marks Available
4	*(a)*		large surface area; thin walls; NOT cell wall {extensive/large} capillary network; (NOT good blood supply)	3
	(b)		Any one from	1 max

Adaptation	Explanation
large surface area	increases area over which diffusion can occur;
thin walls	reduces diffusion distance/ short diffusion paths; Not diffusion occurs faster
extensive capillary network	maintains diffusion gradient;

Question 4 Total **[4]**