



A-Level Biology

Gas Exchange

Question Paper

Time available: 62 minutes

Marks available: 48 marks

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1.

(a) Describe and explain **one** feature of the alveolar epithelium that makes the epithelium well adapted as a surface for gas exchange. Do **not** refer to surface area or moisture in your answer.

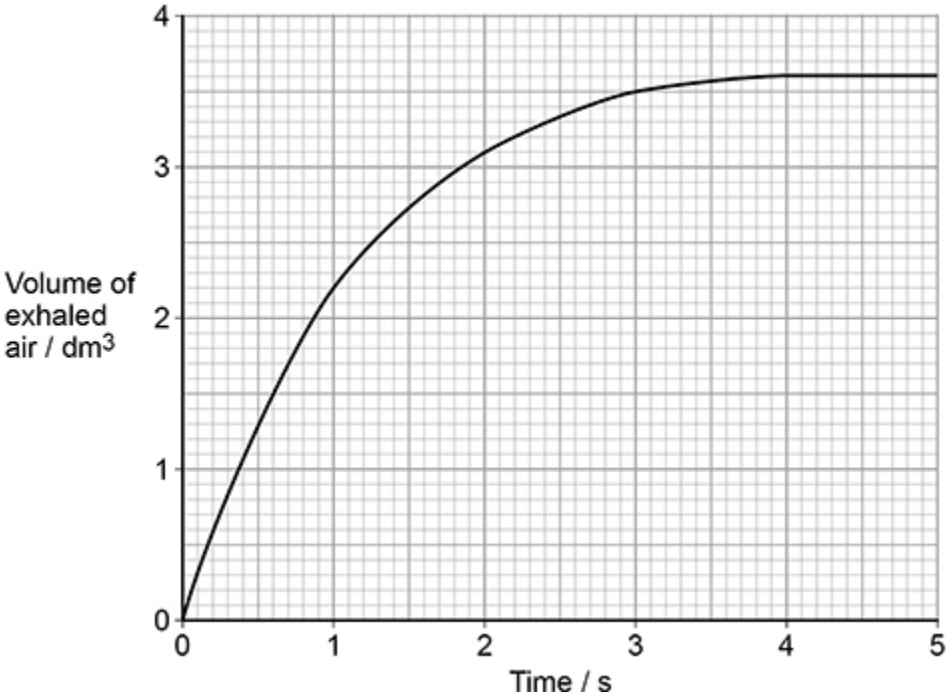
(2)

Doctors measure the health of lungs by calculating the FEV₁:FVC ratio.

- FEV₁ is the maximum volume of air exhaled in one second.
- FVC is the maximum volume of air exhaled in one breath.

The minimum FEV₁:FVC ratio of healthy lungs is 0.7:1

A man with the lung disease emphysema inflated his lungs fully. He then exhaled as much of this air as quickly as possible in one breath. The figure below shows how the volume of exhaled air changed during this breath.



- (b) Use the information provided to determine the FEV₁:FVC ratio of this man's lungs.

Go on to determine how many times greater the minimum ratio of healthy lungs is than his ratio.

FEV₁:FVC ratio of man's lungs = _____

How many times greater? _____

(2)

- (c) Tidal volume is the volume of air inhaled and exhaled during a single breath when a person is resting. The tidal volume in a person with emphysema is reduced compared with the tidal volume in a healthy person.

Suggest and explain how a reduced tidal volume affects the exchange of carbon dioxide between the blood and the alveoli.

(3)

(Total 7 marks)

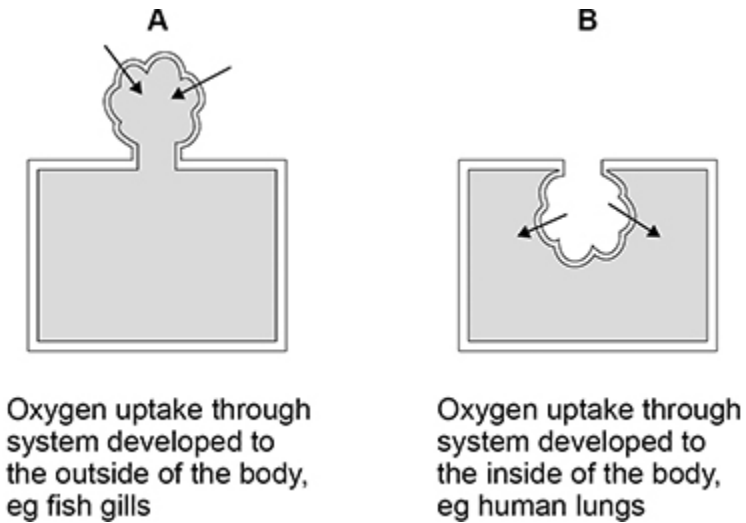
2.

(a) Explain the advantage for larger animals of having a specialised system that facilitates oxygen uptake.

(2)

Figure 1 shows two models of oxygen uptake found in animals.

Figure 1

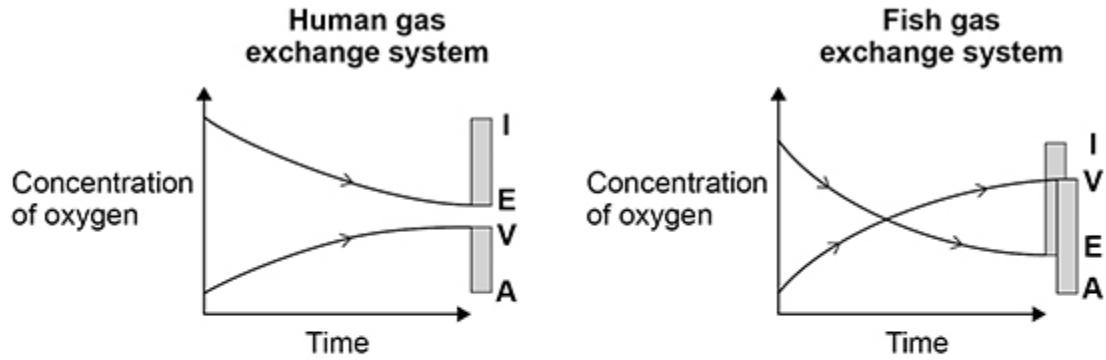


(b) Suggest how the environmental conditions have resulted in adaptations of systems using **Model A** rather than **Model B**.

(2)

(c) **Figure 2** shows changes in concentration of oxygen in two gas exchange systems.

Figure 2



Key

- I Air/water entering the gas exchange system
- E Air/water leaving the gas exchange system
- A Arterial blood entering the gas exchange system
- V Venous blood leaving the gas exchange system

A student studied **Figure 2** and concluded that the fish gas exchange system is more efficient than the human gas exchange system.

Use **Figure 2** to justify this conclusion.

(2)

(d) Explain how the counter-current principle allows efficient oxygen uptake in the fish gas exchange system.

(2)

(e) The table below shows features of two mammals.

Bats are flying mammals; shrews are ground-living mammals.

Mammal	Mean body mass / kg	Mean lung volume / cm ³
Bat	0.096	12.48
Shrew	0.024	0.72

Calculate how many times the lung volume per unit of body mass of the bat is greater than that of the shrew.

Give your answer to an appropriate number of significant figures.

Give **one** suggestion to explain this difference.

Answer _____

Explanation _____

(3)
(Total 11 marks)

3.

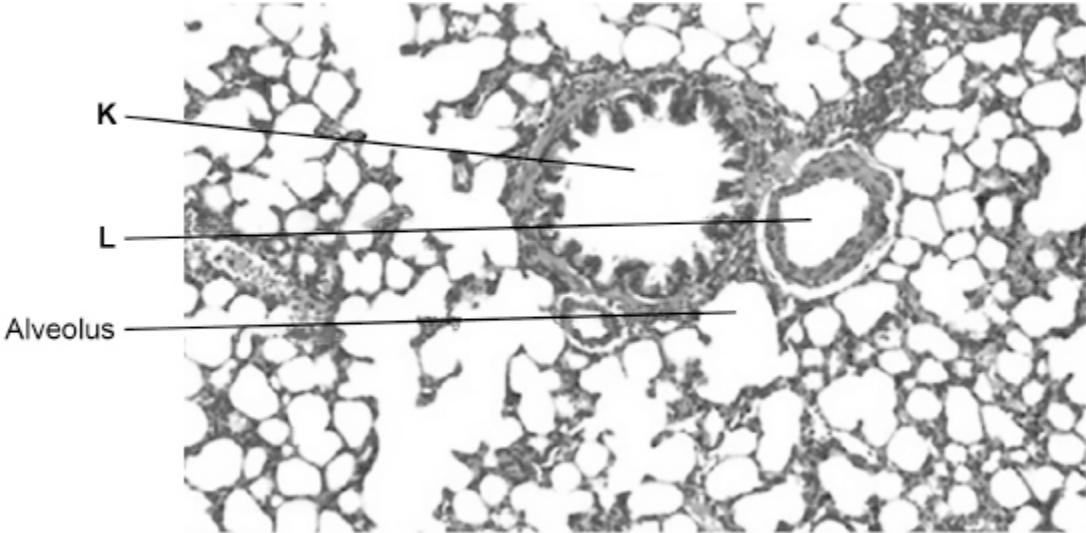
(a) Describe and explain the mechanism that causes lungs to fill with air.

(3)

A scientist observed sections of lung tissue using an optical microscope.

The image below shows one of these sections.

K is an air-filled tube and **L** is a blood vessel.



(b) Identify the structures labelled **K** and **L**.

K _____

L _____

(1)

(c) Two solutions often used to stain tissues are haematoxylin solution and iodine solution.

- Haematoxylin solution stains DNA a blue colour.
- Iodine solution stains starch a blue-black colour.

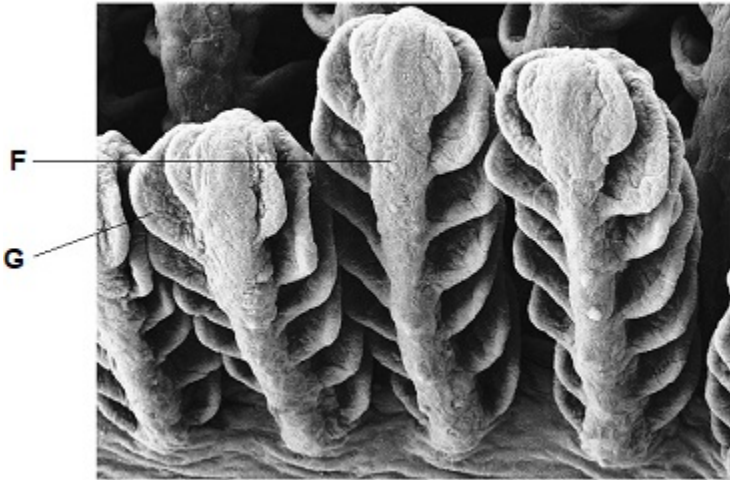
The scientist used haematoxylin solution and **not** iodine solution to stain the lung tissue.

Suggest why.

(2)

4.

Below is an image of a fish gill taken using a scanning electron microscope.



(a) Identify structures labelled **F** and **G**.

F _____

G _____

(1)

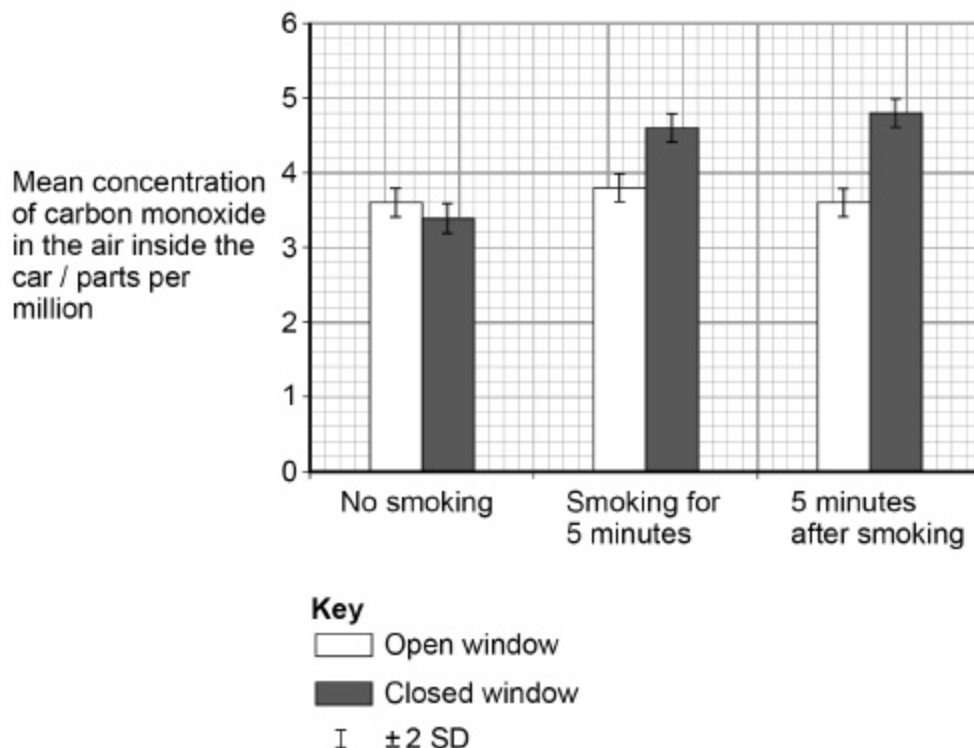
(b) Describe and explain the advantage of the counter-current principle in gas exchange across a fish gill.

(3)

(Total 4 marks)

Carbon monoxide is a poisonous gas that is present in cigarette smoke. This carbon monoxide can be absorbed into the blood where it binds with haemoglobin.

Scientists investigated the concentration of carbon monoxide in cars in which people were smoking or not smoking. They measured the concentration with the car windows open and closed. The graph shows the scientists' results as they presented them. A value of ± 2 standard deviations from the mean includes over 95% of the data.



- (c) In England, in October 2015, a law was introduced making it illegal to smoke in a car carrying someone who is under the age of 18.

Following the introduction of the law, a politician stated:

'It is dangerous to smoke when a child is in the car. Higher levels of deadly toxins can build up, even on short journeys, and children breathe faster than adults, meaning they inhale more of the deadly toxins.'

6.

Breathing out as hard as you can is called forced expiration.

(a) Describe and explain the mechanism that causes forced expiration.

(4)

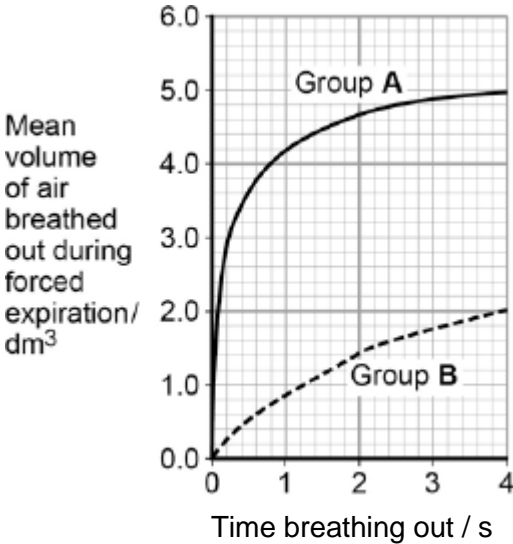
Two groups of people volunteered to take part in an experiment.

- People in group **A** were healthy.
- People in group **B** were recovering from an asthma attack.

Each person breathed in as deeply as they could. They then breathed out by forced expiration.

A scientist measured the volume of air breathed out during forced expiration by each person.

The graph below shows the results.



(b) Forced expiration volume (FEV) is the volume of air a person can breathe out in 1 second.

Using data from the first second of forced expiration, calculate the percentage decrease in the FEV for group **B** compared with group **A**.

Answer = _____ %

(1)

(c) The people in group **B** were recovering from an asthma attack.

Explain how an asthma attack caused the drop in the mean FEV shown in the figure above.

(4)

(Total 9 marks)