

# 6.4 Gas Exchange

## Question Paper

Course	DP IB Biology
Section	6. Human Physiology
Topic	6.4 Gas Exchange
Difficulty	Hard

**Time allowed:** 80  
**Score:** /60  
**Percentage:** /100

### Question 1a

a)  
Describe the pathway taken by a molecule of oxygen from the outside air to the blood of a human.

[3 marks]

[3 marks]

### Question 1b

b)  
Premature babies can suffer from a deficiency of a substance referred to here as substance X. This can lead to a condition known as respiratory distress syndrome (RDS). The image below shows the possible appearance of the lung tissue of an RDS patient (left) and the appearance of normal lung tissue (right).

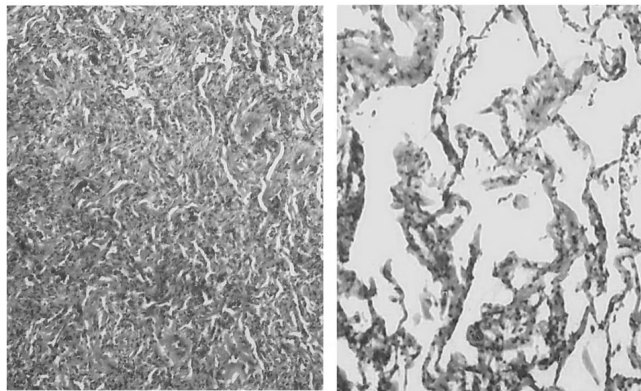


Image courtesy of Atlas of Pulmonary Pathology, licensed under the Creative Commons Attribution-ShareAlike 2.0 Generic license, and adapted and redistributed under conditions found at <https://creativecommons.org/licenses/by-sa/2.0/>

i)  
Suggest the identity of substance X.

[1 mark]

ii)  
Explain the appearance of the RDS lung tissue in the image above.

[2 marks]

[3 marks]

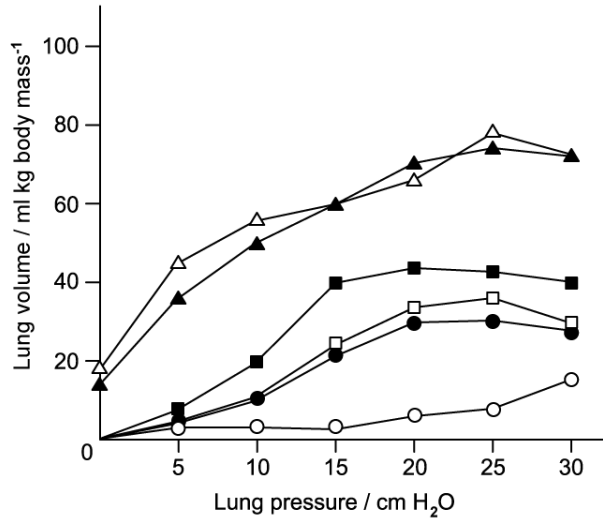


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**Question 1c**

c)

RDS can be treated by the administration of an alternative form of substance X to the lungs. The graph below shows the effect of different variations of substance X on the lung volume of rabbits at different pressures. The variations include substance X isolated from sheep lungs, as well as synthetic versions of substance X that contain its separate lipid and protein components. Note that cm H<sub>2</sub>O is a unit of pressure.



**Key:** △ = Substance X from sheep lungs  
 ▲ = SP-B protein  
 ■ = SP-C protein  
 □ = Solution containing phospholipids  
 ● = SP-A protein  
 ○ = No treatment

Use the information provided to explain why each of the following statements is incorrect:

i) Substance X is essential for lung expansion.

[1 mark]

ii) Phospholipids are the active component of substance X.

[1 mark]

iii) Substance X from sheep is the most effective treatment for RDS in premature babies.

[2 marks]

[4 marks]

### Question 1d

d)

The form of substance **X** produced in mammalian lungs contains proteins known as SP-A and SP-D, which are known to be involved with the activation of phagocytes.

Suggest, with a reason, a symptom that would result from a deficiency of SP-A and SP-D proteins.

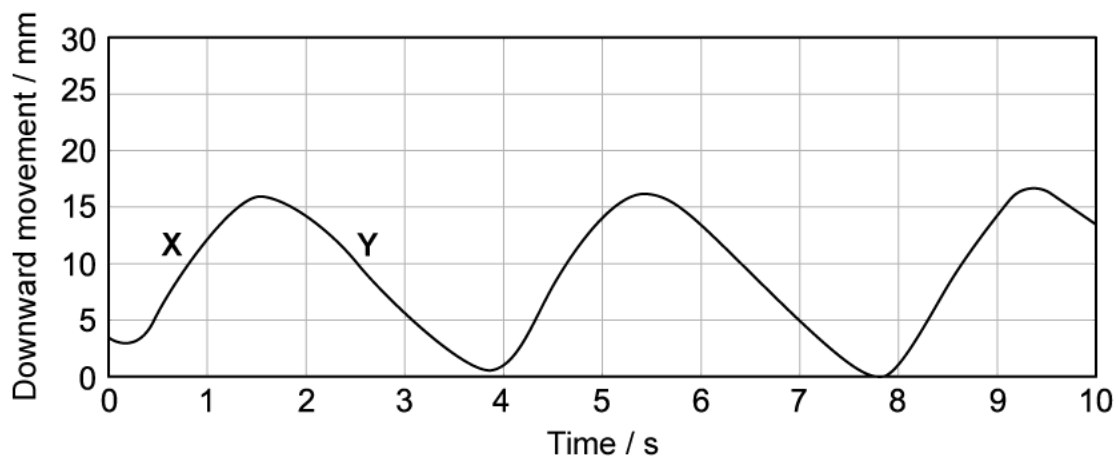
[2 marks]

[2 marks]

### Question 2a

a)

A study was carried out that looked at the movement of the diaphragm during normal breathing. The graph below shows the diaphragm movement in a healthy 55-year-old male.



Calculate the breathing rate of the individual shown in the graph.

[2 marks]

[2 marks]

## Question 2b

b)

i)

Identify the ventilation processes occurring at the stages marked **X** and **Y**.

[1 mark]

ii)

For the stage marked **Y** on the graph, name a muscle **other than** the diaphragm involved at this stage **and** identify its state.

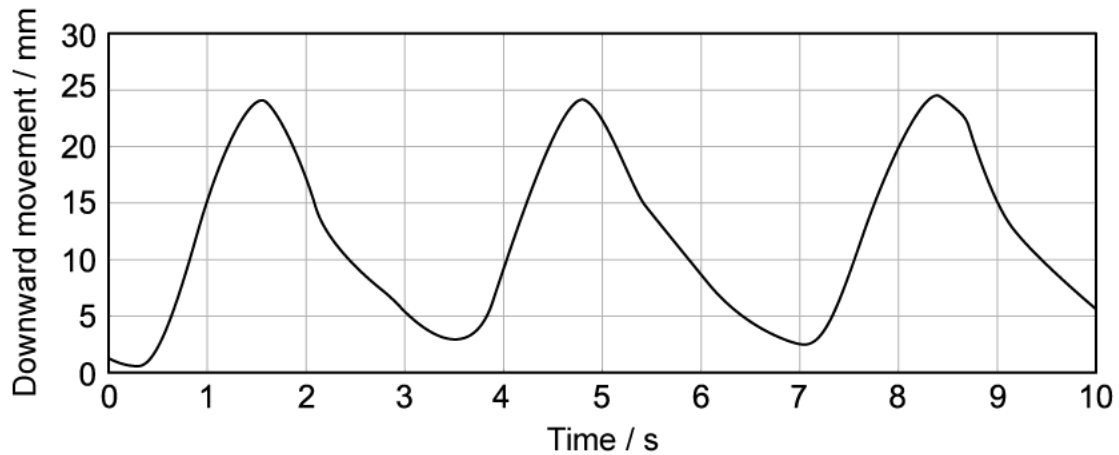
[2 marks]

[3 marks]

**Question 2c**

c)

The graph below shows the results of another participant in the study. This individual is a 57-year-old male with emphysema.



i)

Contrast the graph shown here with the graph in part a).

[2 marks]

ii)

Suggest an explanation for the differences between the graphs.

[2 marks]

[4 marks]

**Question 2d**

d)

Events such as surgical trauma or nerve degeneration can lead to weakness or even paralysis of the diaphragm.

Suggest the effect that this would have on ventilation

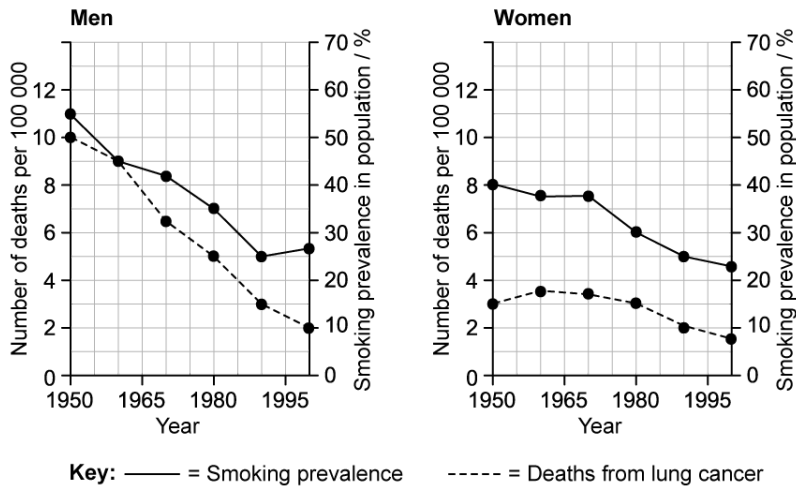
[2 marks]

[2 marks]

**Question 3a**

a)

The graphs below show smoking prevalence and lung cancer deaths in men and women in the UK between 1950 - 2000.



Calculate the percentage decrease in smoking prevalence between 1950 - 1990 for:

- i) Men
- ii) Women

[2 marks]

[2 marks]

**Question 3b**

b)

Compare and contrast the **trends** in smoking prevalence and lung cancer deaths between men and women in the graphs shown in part a).

[3 marks]



[3 marks]

### Question 3c

c)  
A student looked at the graphs in part a) and concluded that cigarette smoking causes lung cancer.  
Evaluate this conclusion from the graphs shown.

[3 marks]

[3 marks]

### Question 3d

d)  
Data from other studies provide support for the student's conclusion in part c) and scientists now accept that smoking can cause lung cancer.

Explain the link between smoking and lung cancer.

[3 marks]

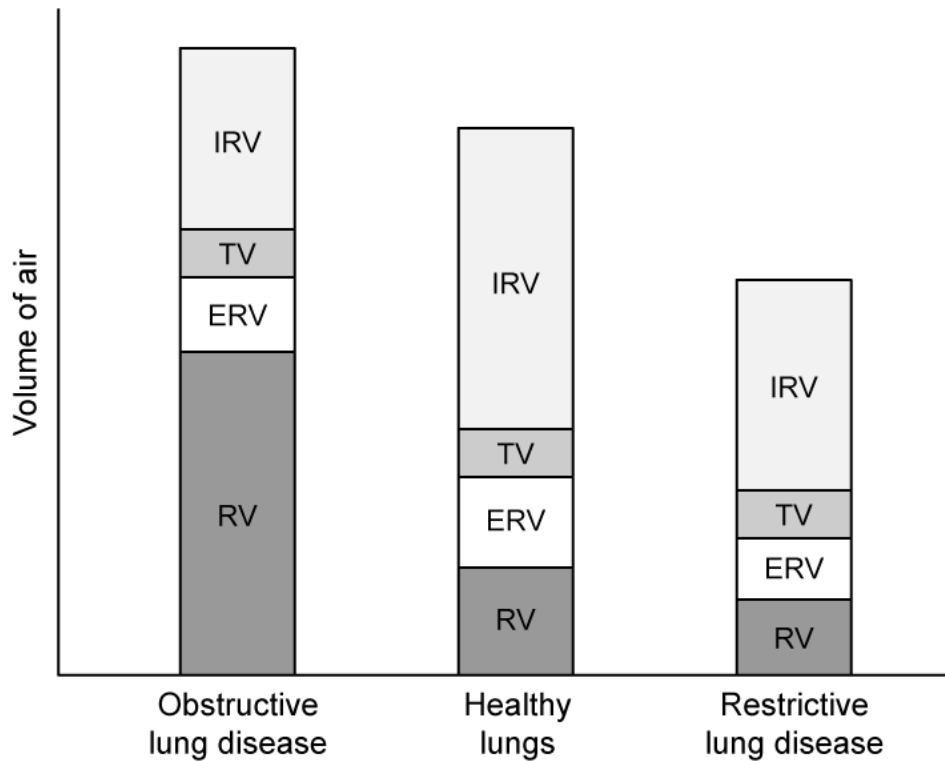
[3 marks]

**Question 4a**

a)

Certain types of lung disease can be categorised as either obstructive or restrictive. The effect of obstructive and restrictive lung diseases on ventilation can be seen in the graph below, where:

- Tidal volume (TV) = the volume of air breathed in and out with each normal breath
- Inspiratory reserve volume (IRV) = the additional volume of air that can be drawn into the lungs during a large inward breath
- Expiratory reserve volume (ERV) = the additional volume of air that can be expelled from the lungs during forced expiration
- Residual volume (RV) = the volume of air that remains in the lungs after forced expiration



Compare and contrast the effects of obstructive and restrictive lung disease.

[3 marks]

[3 marks]

### Question 4b

b)  
An example of an obstructive lung disease is emphysema.  
Suggest how emphysema causes the features of an obstructive lung disease shown in the graph in part a).

[3 marks]

[3 marks]

### Question 4c

c)  
Explain why sufferers of both obstructive and restrictive lung disease find exercise difficult.

[3 marks]

[3 marks]

### Question 4d

d)  
Use the graph in part a) to suggest what might be happening to the lungs in a restrictive lung disease.

[2 marks]

[2 marks]

### Question 5a

*One mark is available for clarity of communication throughout this question.*

a)

Outline the need for a ventilation system in mammals.

[3 marks]

[3 marks]

### Question 5b

b)

Draw an annotated diagram to explain the process of inspiration.

[6 marks]

[6 marks]

**Question 5c**

c)

Explain how the lungs are adapted to their function.

**[6 marks]****[6 marks]**