1 Fig. 6.1 is a diagram of a spirometer, a piece of apparatus used to measure some aspects of breathing, such as breathing rate and vital capacity.

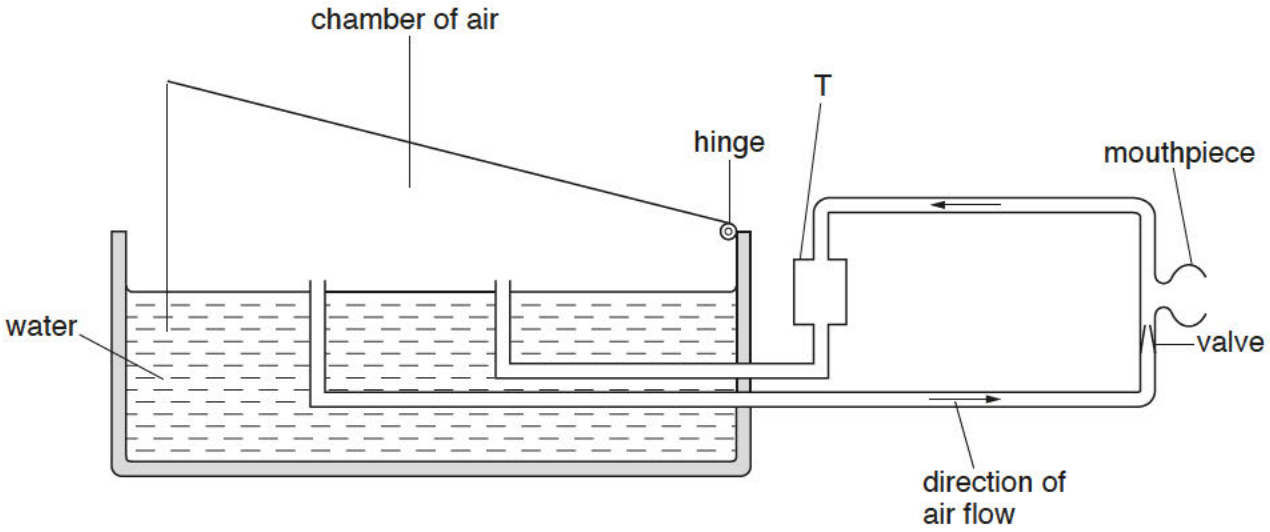


Fig. 6.1

(a) (i) Outline the mechanism of **inspiration**.

In your answer you should use appropriate technical terms, spelt correctly.

.....

.....

.....

.....

.....

..... **[3]**

(ii) A person breathes through the mouthpiece of a spirometer.

State what happens to the air chamber in Fig. 6.1 during **inspiration**.

..... **[1]**

(iii) Chamber **T** contains a chemical that absorbs carbon dioxide.

Suggest a chemical that could be used in chamber **T** to absorb carbon dioxide.

.....

..... **[1]**

(b) Explain why a person using the spirometer to measure their vital capacity should wear a nose clip.

.....

.....

.....

..... **[2]**

(c) State **two** other precautions that should be taken when using a spirometer to measure vital capacity.

1 .....

.....

2 .....

..... **[2]**

[Total: 9]

2 Fig. 1.1 (a) is a diagram of a part of a mammalian lung.

Fig. 1.1 (b) is an enlargement of part of the lining of the bronchus.

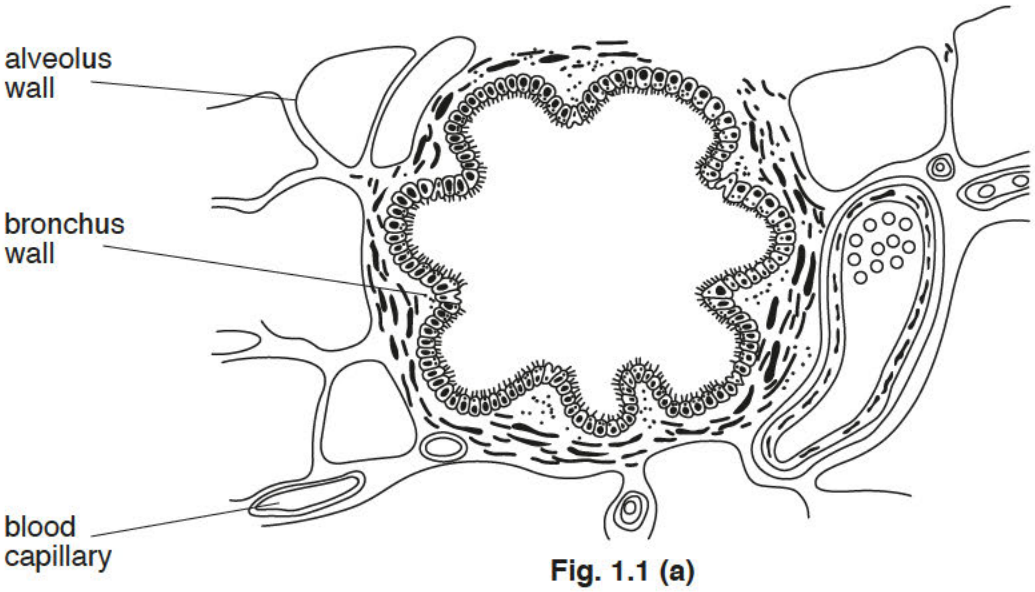


Fig. 1.1 (a)

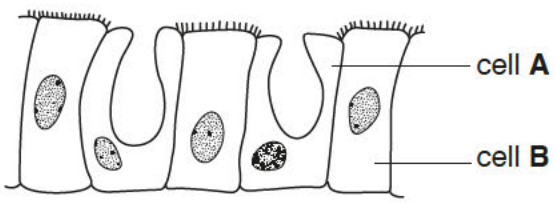


Fig. 1.1 (b)

(a) (Name the two types of cell, **A** and **B**, shown lining the **bronchus**.

A .....

B ..... **[2]**

(ii) Describe how cell types **A** and **B** work together to keep the lung surface clear of dust and other particles.

.....

.....

.....

.....

.....

..... **[3]**

(iii) The bronchus wall also contains smooth muscle fibres.

State the function of the smooth muscle fibres.

.....

..... **[1]**

(b) (Explain why blood capillaries and alveoli are very close together.

.....

.....

.....

.....

..... **[2]**

(ii) The walls of the alveoli contain elastic fibres.

State the function of these elastic fibres.

.....

..... **[1]**

[Total: 9]

3 **(a)** Explain, using the term **surface area to volume ratio**, why large, active organisms need a specialised surface for gaseous exchange.

.....

.....

.....

.....

.....

..... **[2]**

(b) Table 4.1 describes some of the features of the mammalian gas exchange system.

Complete the table by explaining how each feature improves the efficiency of gaseous exchange. The first one has been completed for you.

Table 4.1

feature of gas exchange system	how feature improves efficiency of gaseous exchange
many alveoli	this increases the surface across which oxygen and carbon dioxide can diffuse
the epithelium of the alveoli is very thin	
there are capillaries running over the surface of the alveoli	
the lungs are surrounded by the diaphragm and intercostal muscles	

[3]

(c) Outline how the diaphragm **and** intercostal muscles cause **inspiration**.

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

(d) Fig. 4.1 shows the trace from a spirometer recorded from a 16-year-old student.

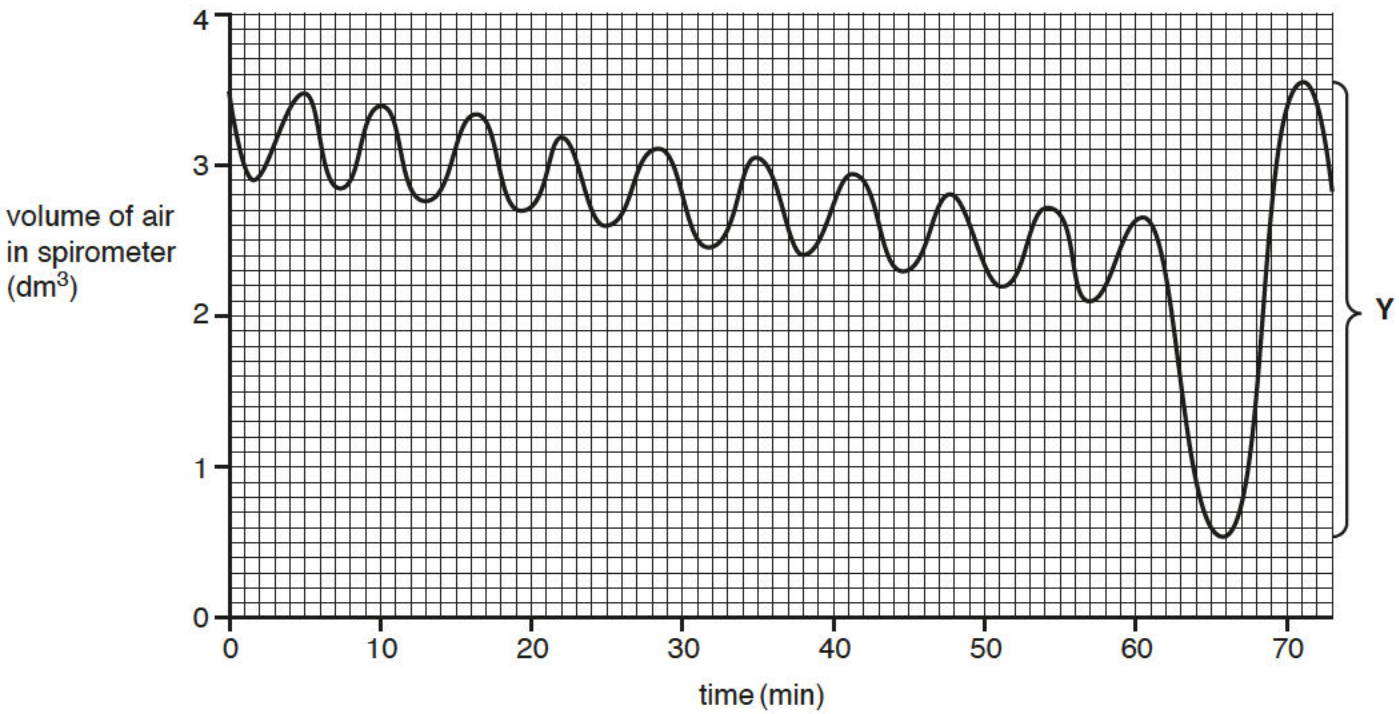


Fig. 4.1

(i) **Label on the trace**, using the letter **X**, a point that indicates when the student was inhaling. **[1]**

(ii) At the end of the trace the student measured his vital capacity. This is indicated by the letter **Y**.

State the vital capacity of the student.

..... **[1]**

[Total: 11]

4 Gene sequencing is an important technique in molecular biology.

Fig. 3.1, **on page 3 of the Insert**, shows part of a computerised graph obtained from an automated gene sequencing machine.

- The section of the DNA molecule represented in Fig. 3.1 is from base position 117 (on the left of the graph) to base position 137 (on the right of the graph).
- The bases in the DNA sequence are labelled with four different coloured fluorescent dyes.
- The identities of some of the bases (117 to 119 inclusive and 129 to 137 inclusive) are indicated below the graph.

(a) Use Fig. 3.1 to identify the order of bases from positions 120 to 128.

.....	.....	.....	.....	.....	.....	.....	.....	.....
120	121	122	123	124	125	126	127	128

[1]

(b) To produce the type of graph shown in Fig. 3.1, the automated gene sequencing machine needs to be loaded with the following:

- the DNA to be sequenced
- short primer sequences specific to the DNA to be sequenced
- many normal DNA nucleotides
- some chain-terminating DNA nucleotides labelled with coloured dyes
- the enzyme *Taq* polymerase.

A regular cycle of temperature changes allows many DNA fragments of different lengths to be built up by the polymerase chain reaction (PCR).

Fig. 3.2 (**on the next page**) shows the end parts of the sequences of seven of these different length fragments, labelled 1 to 7. The end parts of the sequences for fragments 1 to 4 are complete but those for fragments 5 to 7 are not.
These seven fragments correspond to the **last seven peaks** on the right hand side of the graph in Fig. 3.1.

The letters in boxes represent labelled chain-terminating DNA nucleotides.
The letters not in boxes represent normal DNA nucleotides.

(i) Use the information in Fig. 3.1 to fill in the missing nucleotide bases on fragments 5 to 7 on Fig. 3.2.

You should distinguish between the normal and labelled nucleotides in the sequence for each fragment.

1 – **[T]**

2 – **T** **[A]**

3 – **T** **A** **[T]**

4 – **T** **A** **T** **[T]**

5 – **T** **A**

6 – **T** **A**

7 – **T** **A**

[2]

Fig. 3.2

(ii) Explain how the automated sequencing machine orders the DNA fragments from the PCR reaction into the size order shown in Fig. 3.2.

.....

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

(c) Gene sequencing can help us to understand how an individual's genome affects their body's response to drugs.

One research study has looked at the effectiveness of drugs used to treat asthma in children. Asthma is a condition in which the bronchioles become reduced in diameter. This results in the child finding it difficult to breathe.

(i) Using your knowledge of the structure of bronchioles, suggest how their diameter might become reduced.

.....

.....

.....

.....**[2]**

(ii) Explain why it is difficult to expel air from the lungs if the bronchioles become reduced in diameter.

.....

.....

..... **[1]**

(d) Asthma in children may be treated with drugs. One of the most commonly used drugs is salmeterol.

Salmeterol acts by binding to protein receptors in the lining of the bronchioles. However, in approximately 14% of children with asthma, salmeterol is not very effective. This is thought to be the result of a genetic mutation in these children.

Suggest why this mutation reduces the effectiveness of salmeterol.

.....

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

(e) In a recent medical trial, 62 children with this genetic mutation were studied.

- Their asthma was not controlled well by salmeterol.
- 31 children continued using salmeterol and the remaining 31 were given an alternative drug, montelukast.
- Montelukast is not routinely prescribed because salmeterol is far more effective for most children with asthma.

(i) After one year, the children taking montelukast had better control of their asthma and were able to reduce their use of montelukast.

Suggest why these children responded better to montelukast than to salmeterol.

.....

.....

.....

.....

.....

..... **[2]**

(ii) Comment on the reliability of the results of this medical trial.

.....

.....

..... **[1]**

(iii) It is proposed that a simple saliva test could identify those children who have the mutation.

What would be the source of the genetic material used in this test?

.....

..... **[1]**

[Total: 16]

5 **(a)** Fig. 1.1 is a diagram of a bacterium as seen under an electron microscope.

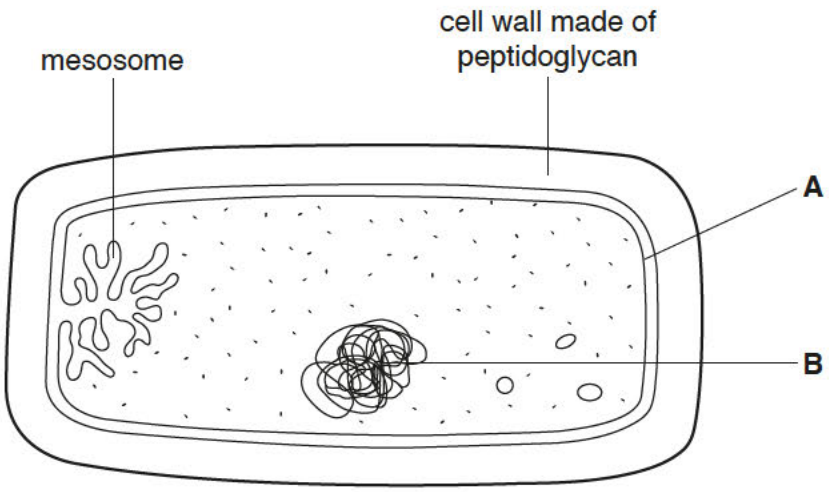


Fig. 1.1

(i) Name the structures labelled **A** and **B**.

A .....

B ..... **[2]**

(ii) It has been suggested that the mesosome has the same role as mitochondria in eukaryotic cells.

Suggest the role of the mesosome in prokaryotic cells, such as bacteria.

..... **[1]**

(iii) Eukaryotic cells, such as *Euglena*, contain membrane-bound organelles. Each organelle has a specific function in the cell.

State the **process** that is carried out in each of the organelles listed below.

ribosome .....

chloroplast ..... **[2]**

(b) Explain why a single-celled organism, such as *Euglena*, does **not** need a specialised area to carry out gaseous exchange.

.....

.....

.....

.....

..... **[2]**

(c) The mammalian gas exchange system contains a variety of types of cells and tissues.

Complete Table 1.1, stating the function of each of the cells and tissues. The first row has been completed for you.

Table 1.1

cell / tissue	function
squamous epithelium	to provide a thin surface for a short diffusion distance
elastic tissue	....
ciliated epithelium	....
goblet cells	....
smooth muscle	....

[4]

[Total: 11]