1)

(a) State the maximum magnification that can be achieved by a light microscope and a transmission electron microscope.

Select your answers from the list below.

10x   40x   100x   400x   1500x   25 000x   50 000x   500 000x

light microscope   x

transmission electron microscope x   [2]

(b) Describe what is meant by the term *resolution*.

                                                                              [2]
....

Fig. 1.1 is an electron micrograph of xylem tissue in the stem of a plant.
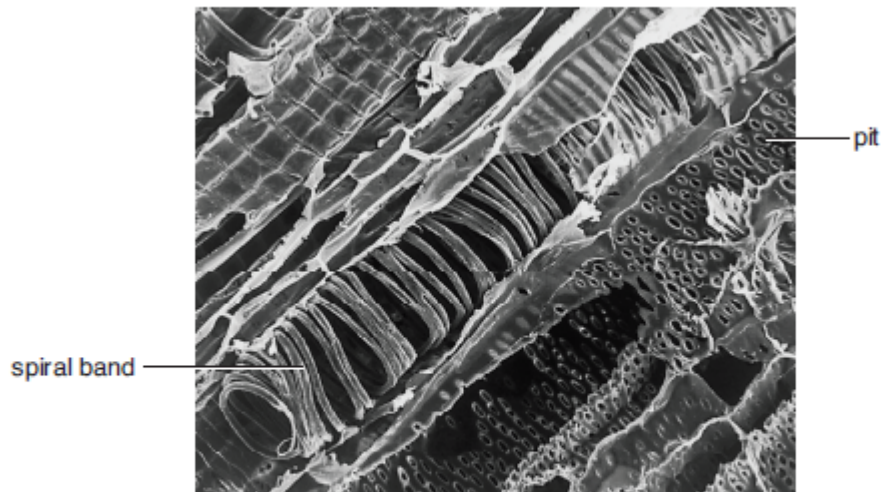
Fig. 1.1

(i)   State **one** function of xylem tissue.
.... [1]

(ii) The spiral band in the xylem vessel shown in Fig. 1.1 contains a substance called lignin.

State the function of this spiral band of lignin **and** explain why it is important that the xylem vessel becomes lignified in this way.
.... [3]

(iii) Explain the function of the pits seen in Fig. 1.1.
.... [2]

2)

(a) (i) Fig. 5.1 represents a transverse section of an artery and a vein.

Draw a line to show the relative position of the endothelium of the **vein**.

endothelium

artery   vein

[1]

Fig. 5.1

(ii) State **two other** ways in which the wall of an artery is different from the wall of a vein. [2]

(b) (i) Blood in the arteries has a high hydrostatic pressure.

State how this hydrostatic pressure is generated in the heart.

.... [1]

(ii) Explain why the hydrostatic pressure of the blood drops as blood moves away from the heart.

[2]

(iii) Capillaries have walls that are one cell thick.

Fig. 5.2 shows how the hydrostatic pressure of the blood changes as it moves through a capillary.

Fig. 5.2 also shows the water potential of the blood, due largely to the plasma proteins, which tends to move water into the blood.
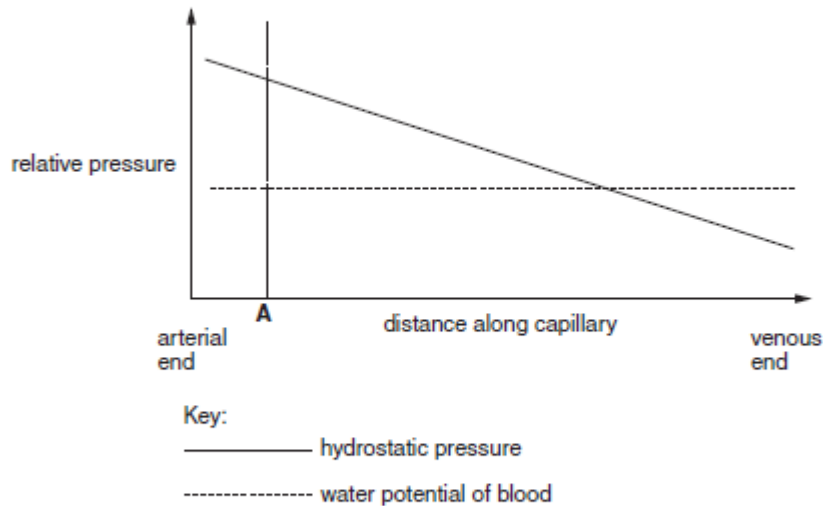
relative pressure

A   distance along capillary
arterial   venous
end   end

Key:

———————— hydrostatic pressure

---------------- water potential of blood

Fig. 5.2

Describe **and** explain what happens to the blood plasma at point **A** along the capillary in Fig. 5.2.

.. [3]

....

(c) Carbon dioxide is produced in tissues as a waste product of respiration.

The majority of carbon dioxide is carried as hydrogencarbonate ions (HCO_3^-) in the plasma.

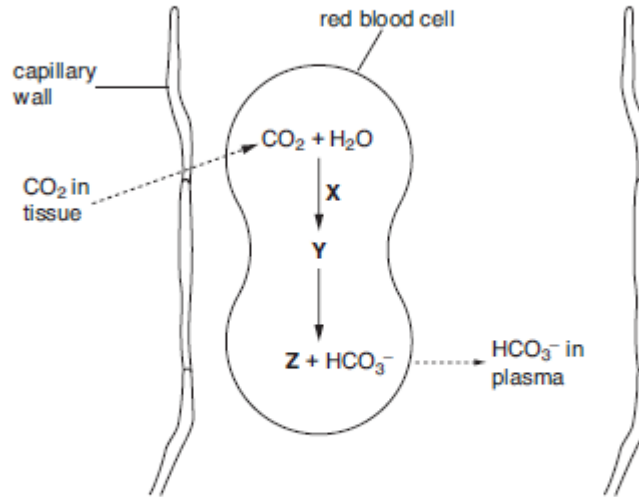Fig. 5.3 shows the chemical pathway in which carbon dioxide is converted into HCO_3^- in a red blood cell.

Fig. 5.3

Identify the following:

enzyme **X** ....

substance **Y** ....

ion **Z** .... **[3]**

3)

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.
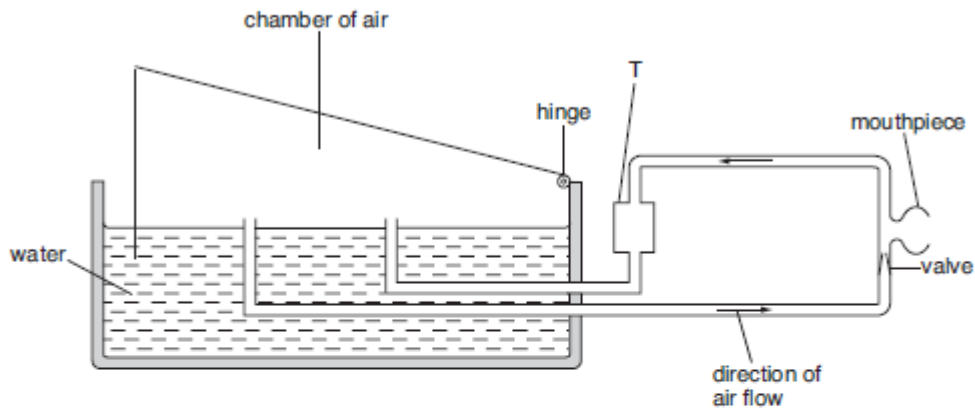

Fig. 6.1

(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.

[2]

4)

When a new species is discovered, it needs to be classified.

(a) Define the term *classification*.

.... [2]

(b) (i) Suggest what criteria a taxonomist may take into account when classifying a new species.

[3]

(ii) Table 2.1 shows the main taxonomic groups. The groups are **not** in the correct order.

Table 2.1

	Q	R	S	T	U	V	W
taxonomic group	species	order	class	phylum	genus	kingdom	family

Place the **letters** representing the taxonomic groups into the correct order.

The first one has been done for you.

V

.... [3]

(c) The classification of organisms into domains is relatively new.

Describe the differences between a classification system based on domains and one based on kingdoms.

[4]

....

5)

(a) In Scotland, in 2007, there was a major food poisoning outbreak that killed three people.

Suggest **one** group in the population that is more likely to die from food poisoning **and** give a reason for your suggestion.

group ....

reason ....

.... **[2]**

(b) The food poisoning outbreak involved the bacterium *Escherichia coli* 0157 (*E. coli* 0157) which had been responsible for contaminating meat products. The meat had been stored at 11 °C rather than the recommended 5 °C and this led to meat spoilage.

(i) Explain how bacteria cause food spoilage.

.... **[3]**

(ii) Food normally spoils much faster if stored at temperatures higher than 5 °C.

Explain why food spoils faster at higher temperatures.

[3]

(c) Microorganisms, such as the fungus *Fusarium*, can be grown and then purified to produce mycoprotein. This mycoprotein can be used as a food source for humans.

Table 3.1 compares mycoprotein with beef.

Table 3.1

food	content per 100g					
	energy (kJ)	protein (g)	carbohydrate (g)	total fat (g)	saturated fat (g)	iron (mg)
mycoprotein	357	12	9	2.9	0.6	0.1
beef	1163	26	0	18.2	7.0	2.6

Use the data in Table 3.1 to **describe and explain** the advantages and disadvantages of using microorganisms to produce food for human consumption.

[8]

*In your answer you should make comparisons using the information in Table 3.1.*

6)

(a) Smoking increases the risk of lung infections.

(i) Explain how the mucus and the cilia in the air passages reduce the chance of developing lung infections.

[2]

In an individual with bronchitis, the mucus contains a large number of pathogenic bacteria. Phagocytic white blood cells destroy the bacteria.

Fig. 5.1 shows the sequence of events that results in the destruction of a bacterium.
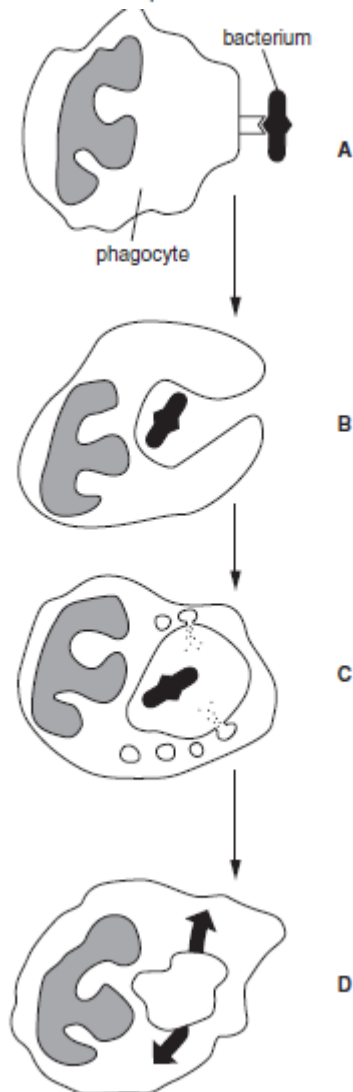
17

(ii) Describe the events taking place at stages **A**, **B**, **C** and **D**, in sequence.

.... [6]

(b) The immune system will produce specific antibodies in response to infection.

(i) Name the type of cell that produces antibodies.

.... [1]

(ii) Describe how the structure of an antibody molecule is related to its function.

In your answer you must clearly link structure and function.

.. **[7]**

(iii) Identify the type of immunity provided by antibodies in breast milk.

Place a tick (✔) in the correct box.

[1]

type of immunity

artificial active	
artificial passive	
natural active	
natural passive	

7)

(a) Before any major development can take place, an Environmental Impact Assessment (EIA) needs to be carried out.

One such development is the proposed extension to the M27 motorway in Hampshire. This extension would cut through an important heathland ecosystem.

Suggest **three** aspects of this development that would need to be considered when carrying out the EIA.

.... [3]

(b) An ecologist carried out a survey of butterfly species on the heathland.

The ecologist walked along a marked path on four different days in June. She counted

- the number of butterfly species
- the number of individual butterflies of each species.

(i) Suggest how this method of collecting data could be improved.

.... [3]

(ii) The ecologist's results are shown in Table 6.1.

These results can be used to calculate the Simpson's Index of Diversity (D) for butterflies in this heathland using the formula:

$$D = 1 - [\Sigma \, (n/N)^2]$$

where n = number of individuals of a species in the sample
N = total number of individuals of all species in the sample

Complete the table by filling in the **three** missing values.

Table 6.1

species	n	n/N	(n/N)²
Grayling (*Hipparchia semele*)	3	0.0968	0.09370
Large Heath (*Coenonympha tullia*)	11	....	0.12588
Gatekeeper (*Pyronia tithonus*)	6	0.1935	0.03744
Green Hairstreak (*Callophrys rubi*)	2	0.0645	0.00416
Silver-studded Blue (*Plebeius argus*)	2	0.0645	0.00416
Small Heath (*Coenonympha pamphilus*)	7	0.2258	0.05099
		Sum (Σ)	....
		1 – Σ	D = ...

[3]

(iii) Suggest the implications of a high value of Simpson's Index of Diversity on planning decisions.

.... [2]

(c) (i) The six species of butterfly identified by the ecologist in the survey are shown **on the insert** in Fig. 6.1.

The ecologist used a dichotomous key to identify these butterflies. This key is shown below:

Key:			
Question 1	Round spots on the under wing	yes	go to question 2
		no	go to question 4
Question 2	Orange upper wing	yes	go to question 3
		no	**Silver-studded Blue**
Question 3	One spot on upper wing	yes	**Gatekeeper**
		no	**Large Heath**
Question 4	Spots on upper wing	yes	go to 5
		no	**Green Hairstreak**
Question 5	One spot on upper wing	yes	**Small Heath**
		no	**Grayling**

Identify the butterflies shown in Fig. 6.1 using the key.

Complete Table 6.2 below. One butterfly has been identified for you.

Table 6.2

species	letter
Grayling (*Hipparchia semele*)	
Large Heath (*Coenonympha tullia*)	
Gatekeeper (*Pyronia tithonus*)	
Green Hairstreak (*Callophrys rubi*)	
Silver-studded Blue (*Plebeius argus*)	
Small Heath (*Coenonympha pamphilus*)	E

(ii) State why Small Heath and Large Heath butterflies both share part of their scientific name.

.... [2]