

**2024 PRELIMINARY EXAMINATION
SECONDARY FOUR EXPRESS**

CANDIDATE
NAME

CLASS

INDEX
NUMBER

BIOLOGY

6093 / 02

Paper 2

Candidates answer on the Question Paper.

27 August 2024

No additional materials are required.

1 hour 45 mins

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on the work handed in.

Write in dark blue or black pen.

You may use a 2B pencil for any diagrams or graphs.

Do not use paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

Section A (70 marks)

Answer **all** questions. Write your answers in the spaces provided on the question paper.

Section B (10 marks)

Answer any **one** question.

Write your answers in the spaces provided on the question paper.

The number of marks is given in brackets [] at the end of each question or part question.

FOR ASSESSMENT USE
80

Section A [70 marks]

Answer all questions in the spaces provided.

- 1 Fig. 1.1 is a photomicrograph of a cell from the pancreas. The cell secretes the hormone insulin.

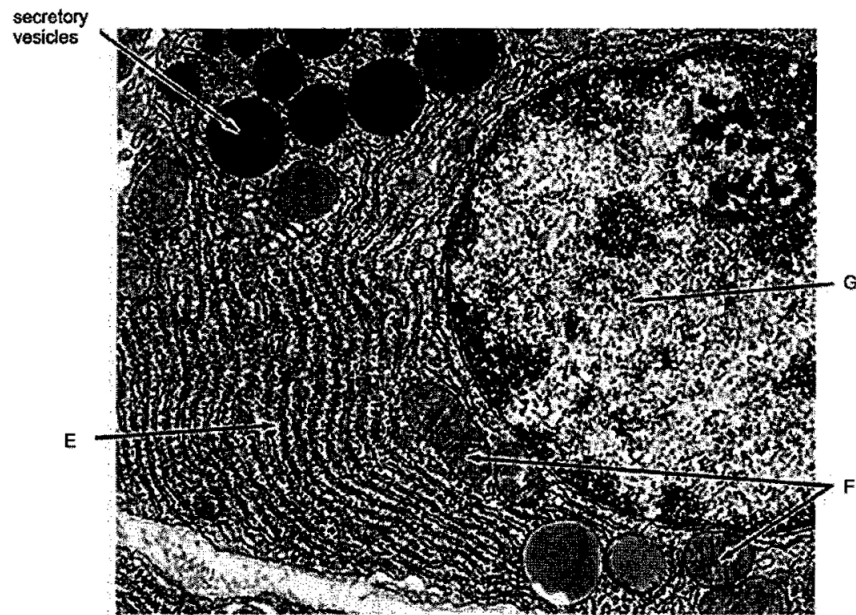


Fig. 1.1

- (a)** Name organelles E, F and G.

E:

F:

G:

[2]

- (b)** Define hormone.

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

(c) Explain the role of insulin in the regulation of blood glucose.

.....

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..... [3]

(d) Diabetics can control their blood glucose level by injecting the hormone through the skin. In recent years, intensive research is conducted on the possibility of introducing the hormone into the body through either ingestion of a tablet or inhalation through a nasal spray.

Suggest why using nasal sprays is preferred over using injections and tablets.

.....

..... [1]

[Total: 8]

- 2 Protoplasts are plant cells that have had their cell walls removed by treatment with enzymes. Scientists often use protoplasts when researching ways to improve the yield of crop plants.

Fig. 2.1 is a scanning electron micrograph of protoplasts of cells from the tobacco plant, *Nicotiana tabacum*.

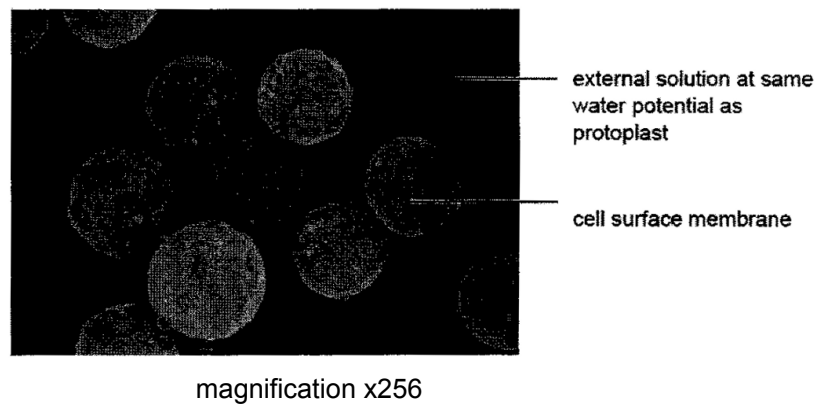


Fig. 2.1

- (a) Suggest the name of the enzyme used in the treatment to produce protoplasts.

..... [1]

- (b) Explain why scientists keep the protoplasts in a solution that is the same water potential as the cell.

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

(c) An investigation was carried out on a sample of protoplasts to determine the effect of light intensity on photosynthesis. Fig. 2.2 shows the results of the investigation.

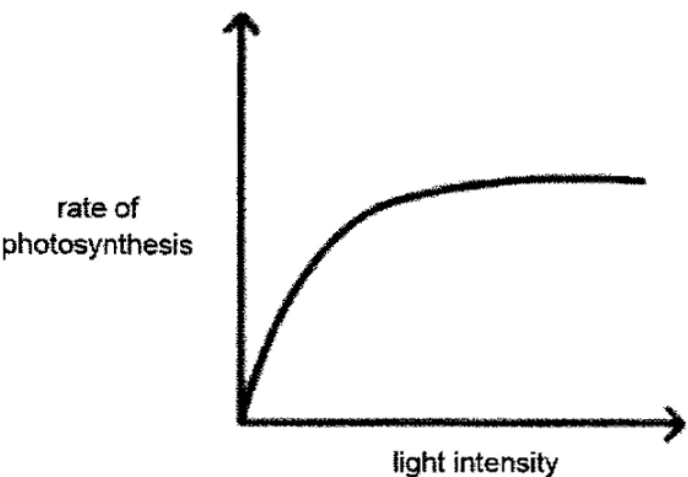


Fig. 2.2

- (i) Describe and explain the relationship between light intensity and rate of photosynthesis.
-
-
- [2]

Farmers often install additional lighting in their glasshouses for their tobacco plants. Table 2.1 summarises some of the factors considered by farmers when choosing the type of lamps to install.

Table 2.1

type of lamp	electrical energy used by the lamp/ J per s	light intensity output/ arbitrary units	notes
sodium	1041	1767	• releases lots of heat • best when used in addition to sunlight
LED	423	378	• releases very little heat • can be used as an alternative to sunlight
metal halide	651	817	• releases some heat • can be used as an alternative to sunlight
fluorescent	394	374	• releases some heat • best when used in addition to sunlight

- (ii) Calculate the percentage increase in the energy used by the metal halide lamp compared to the energy used by the fluorescent lamp.

Give your answer to two significant figures.

.....% [2]

- (iii) Some types of lamp release a lot of heat.

Explain the possible effects of excessive heat on the tobacco plants in a glasshouse.

.....
.....
.....
.....

[2]
[Total: 9]

3 Fig. 3.1 shows part of a capillary and two alveolar cavities.

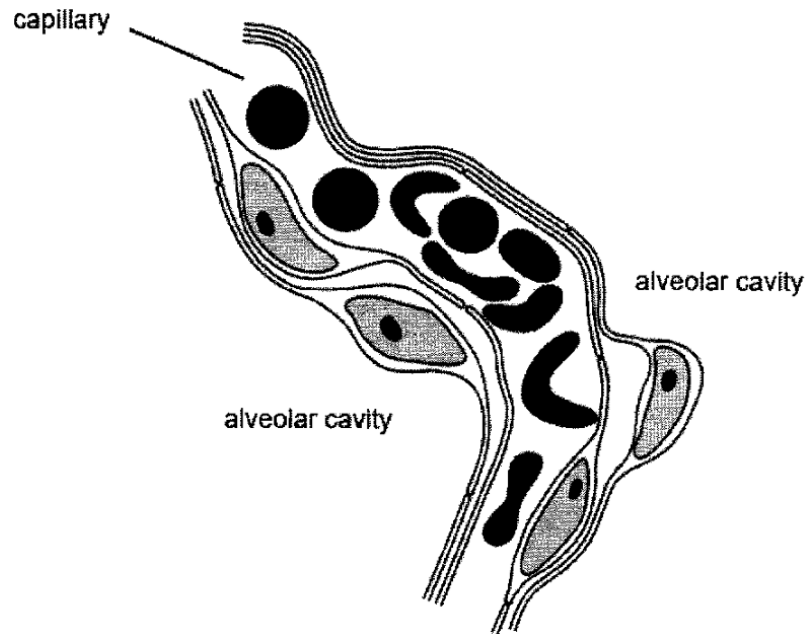


Fig. 3.1

(a) With reference to Fig. 3.1, describe the adaptation(s) of the

(i) alveoli,

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

(ii) red blood cell.

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

- (b) Fig. 3.2 shows a section of a bronchiole from the lungs of a person who never smoked cigarettes (non-smoker) and a section of a bronchiole from a person who smoked cigarettes (smoker) for the past five years. The two sections were taken from the same relative position in the lungs and are drawn to the same scale.

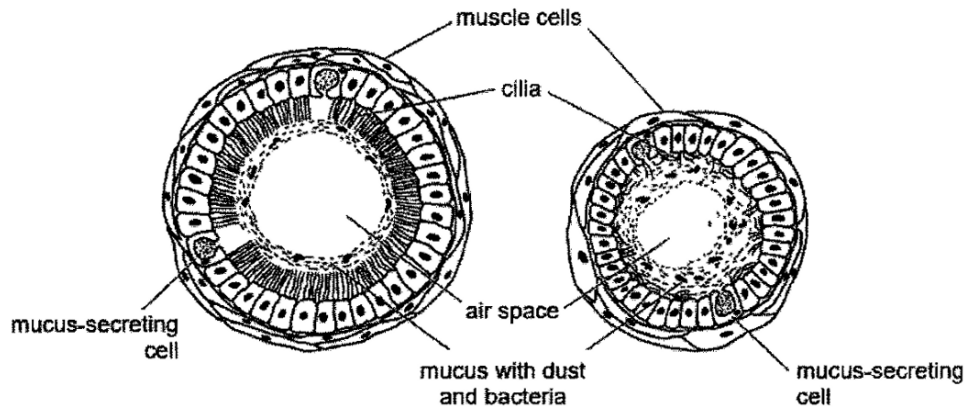


Fig. 3.2

- (i) With reference to Fig. 3.2, state two visible changes in the bronchiole of a smoker.

.....

.....

..... [2]

- (ii) State the component of cigarettes that could have caused the changes in the bronchiole of a smoker.

..... [1]

- (iii) With reference to Fig. 3.2, explain why the smoker has a higher risk of lung infections than a non-smoker.

.....

.....

..... [2]

[Total: 9]

- 4 Fig. 4.1 shows the circulatory system in a fetus developing in the uterus. The foramen ovale is an opening between the right and left atria. The opening naturally closes six to twelve months after birth.

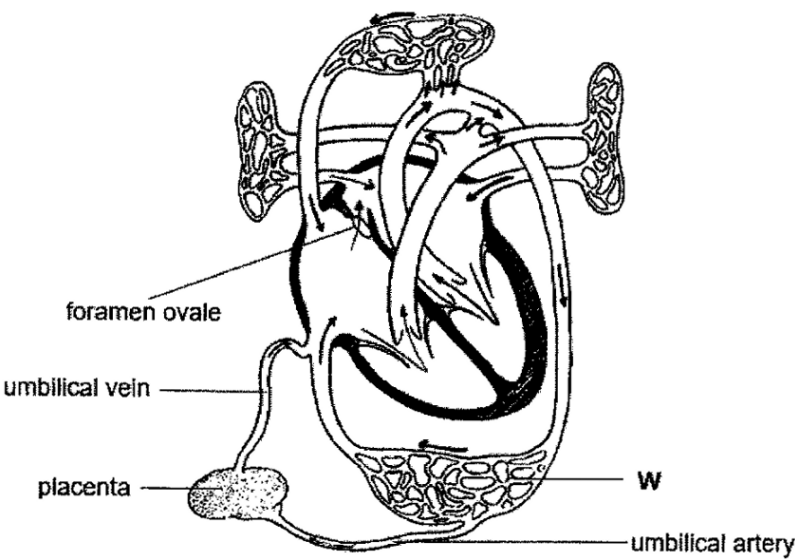


Fig. 4.1

- (a) Describe and explain the difference in the composition of blood in the right ventricle of a fetus and a healthy adult.

.....

 [2]

- (b) With reference to Fig. 4.1, explain how the structure of W allows it to carry out its function efficiently.

.....

 [2]

(c) A pregnant woman has the blood type B while her growing fetus has blood type A. Explain why it is dangerous if their bloods were to mix.

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..... [2]

[Total: 6]

5 Some dogs have different-coloured eyes. This genetic condition is called heterochromia. The allele for heterochromia is dominant.

(a) Fig. 5.1. shows a family of dogs with heterochromia.

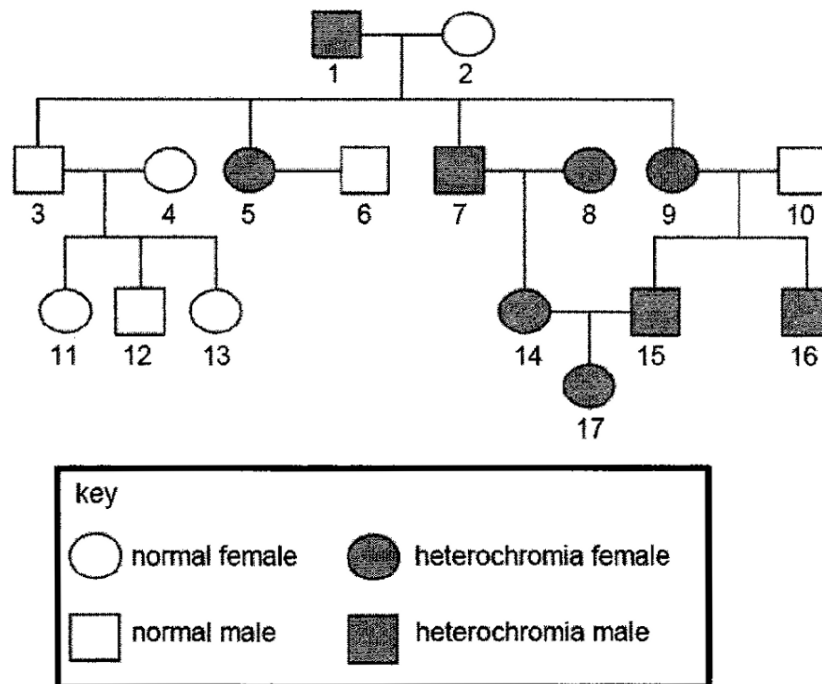


Fig. 5.1

(i) Describe what is an allele.

..... [1]

(ii) Using the numbers 1 to 17, identify the dogs that are heterozygous.

..... [1]

(iii) Dog 13 is crossed with dog 7.

State the expected phenotypic ratio of their offspring. Explain your answer.

..... [3]

(iv) Explain why the observed ratio of dogs from the cross between dog 9 and dog 10 with heterochromia is different from the expected ratio.

..... [1]

(b) Table 5.1 shows a comparison of the base sequence from a section of the DNA that controls eye colour in dogs.

Table 5.1

condition	base sequence
dogs not affected by heterochromia	CGT TAA AGA GGC GTA
dogs affected by heterochromia	CGT TAA AGA GCA GTA

(i) Using information from Table 5.1, explain why some dogs display heterochromia while some do not.

.....

.....

.....

..... [2]

(ii) State the name of the process that causes changes in DNA sequence.

..... [1]

[Total: 9]

6 Fig. 6.1 shows the changes that occur in atmospheric pressure and oxygen concentration as altitude changes. The highest altitude at which people live permanently is 5100 m.

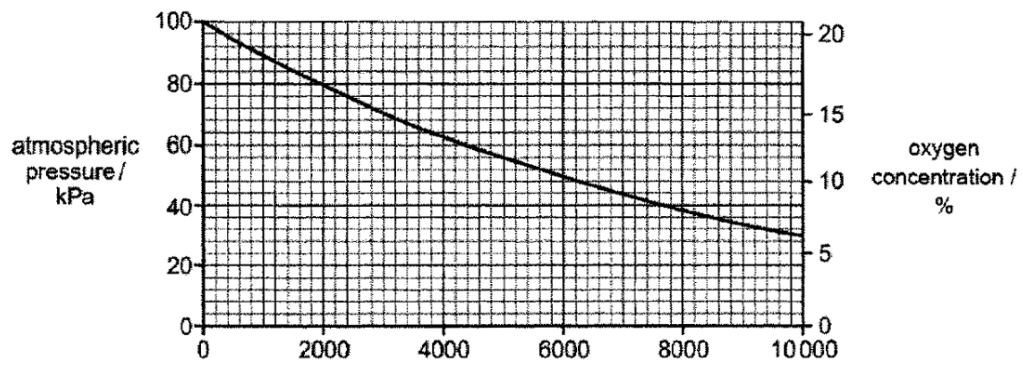


Fig. 6.1

(a) With reference to Fig. 6.1,

- (i) describe the effect of increasing altitude on both atmospheric pressure and the oxygen concentration,

.....

 [2]

- (ii) calculate the change in atmospheric pressure when a person travels from sea level to an altitude of 3500 m.

Show your working.

..... [2]

- (b) When a person travels from 0 m (sea level) to a high altitude, gas exchange in the lungs is affected. A condition known as hypoxia results, where the body tissues do not receive an adequate oxygen supply.

Explain how hypoxia occurs when a person ascends from sea level to a high altitude.

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..... [3]

- (c) At high altitudes, short-term responses by the body to hypoxia include:
- a decrease in the volume of plasma in the blood
 - a decrease in the volume of blood pumped out of the heart per heart beat
 - an increase in the heart rate
 - an increase in the breathing rate

Explain why an increase in the heart rate occurs in response to hypoxia.

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..... [2]

[Total: 9]

- 7 During pregnancy, the peptide human chorionic gonadotrophic (hCG) hormone is produced by the embryo. HCG hormone stimulates the ovary to produce progesterone. Table 7.1 shows the concentration of hCG hormone in the blood of a woman in the first 18 weeks of pregnancy. Fertilisation occurs in week 3.

Table 7.1

weeks of pregnancy	2	4	6	8	10	12	14	16	18
hCG concentration/ mIUcm ⁻³	0	800	10000	12000	11000	6000	2000	1000	1000

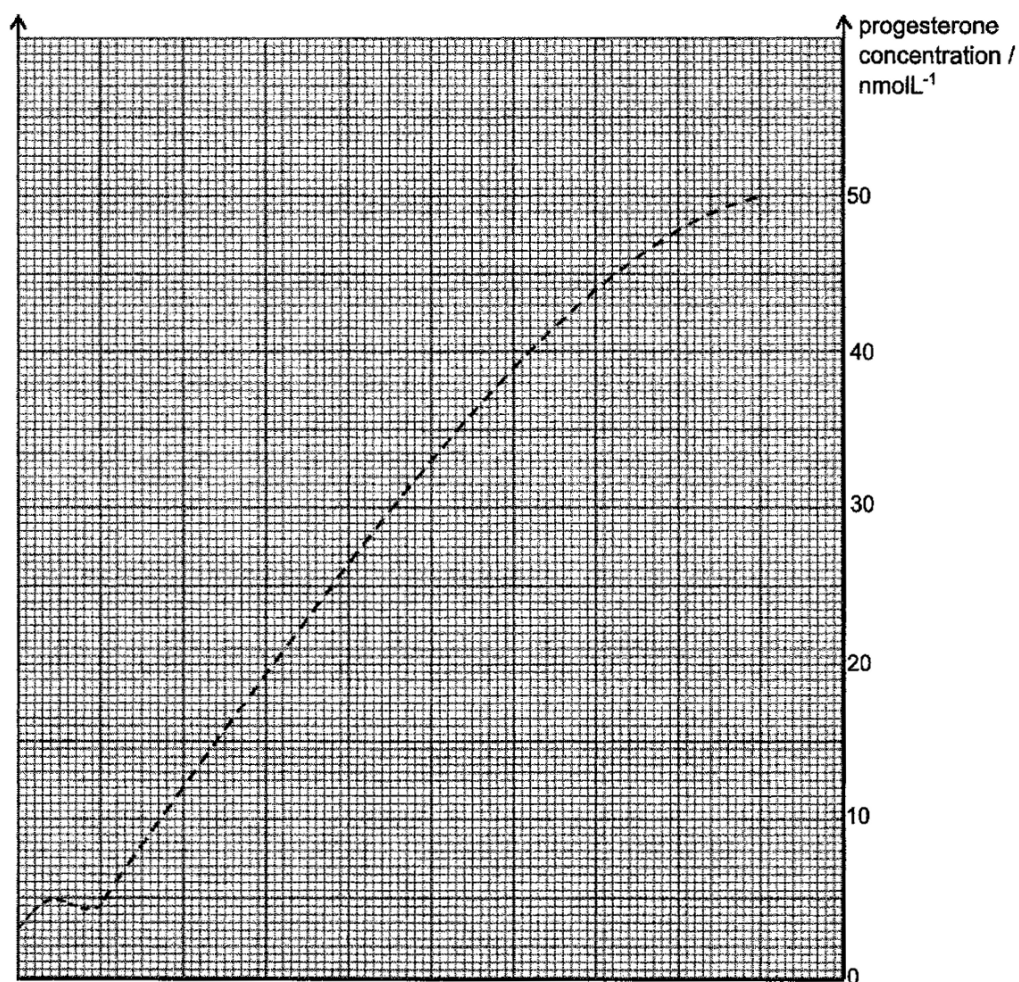


Fig. 7.1

- (a) Draw a line of best fit in Fig. 7.1 using the same grid to show the concentration of hCG in the first 18 weeks of pregnancy.

(b) Describe the trend in hCG concentration from week 2 to 16 of a pregnancy.

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..... [2]

(c) Suggest why progesterone concentration continues to increase even when hCG concentration decreases.

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..... [2]

(d) Home pregnancy test kits commonly test for the presence of hCG in urine.
Suggest why hCG can be found in the urine of pregnant women even though it is a protein.

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..... [1]

(e) Oligohydramnios is a condition in pregnancy characterised by low quantities of amniotic fluid.
Explain how this condition can be dangerous for a developing fetus.

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..... [2]

[Total: 10]

- 8 Two subspecies of reindeer, *Rangifer tarandus*, live in North America. Members of the different subspecies belong to the same species but have some physical differences and are found in different geographical locations. Fig. 8.1 shows a reindeer.



Fig. 8.1

Table 8.1 compares the features of the two reindeer subspecies.

Table 8.1

feature	woodland subspecies, <i>R. tarandus caribou</i>	barren-ground subspecies, <i>R. tarandus groenlandicus</i>
habitat	warmer, southern woodland	snowy, northern tundra
colour of fur	dark	light
type of food	tree leaves, grass	lichen, moss

- (a) During the last ice age, an ice sheet separated the southern and northern populations of *R. tarandus* in North America.

Using your understanding of natural selection and Table 8.1, explain how the ice sheet resulted in the evolution of two subspecies of *R. tarandus*.

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..... [4]

(b) A scientist studied the effects on kidney function of reindeer fed either with a low-protein diet or supplemented with salt (sodium chloride).

- (i)** When fed with a low-protein diet, there was a significant decrease in glomerular filtration rate (GFR) in the reindeer. The GFR can change when the afferent arteriole carrying blood to the glomerulus constricts.

Explain why the lumen of the afferent arteriole needs to be wider than the lumen of the efferent arteriole.

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

- (ii)** State one adaptation of the afferent arteriole that allows it to change its lumen size.

..... [1]

- (iii)** Explain why a smaller volume of concentrated urine was produced in reindeer whose diet was supplemented with salt.

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..... [3]

Section B [10 marks]

Answer only **one** of the questions in the space provided.

- 9** Some pollutants are not broken down easily and remain in the environment for a long time. These are described as persistent pollutants. PCBs are a waste material from the manufacturing of electrical insulation. PCBs are one of the most persistent pollutants in the environment.

Between 1947 and 1976, factories dumped large quantities of PCBs into the Hudson River in the USA. Studies measured the concentrations of PCBs in the tissues of organisms in a food chain in the sea near Hudson River, as shown in Fig. 9.1.

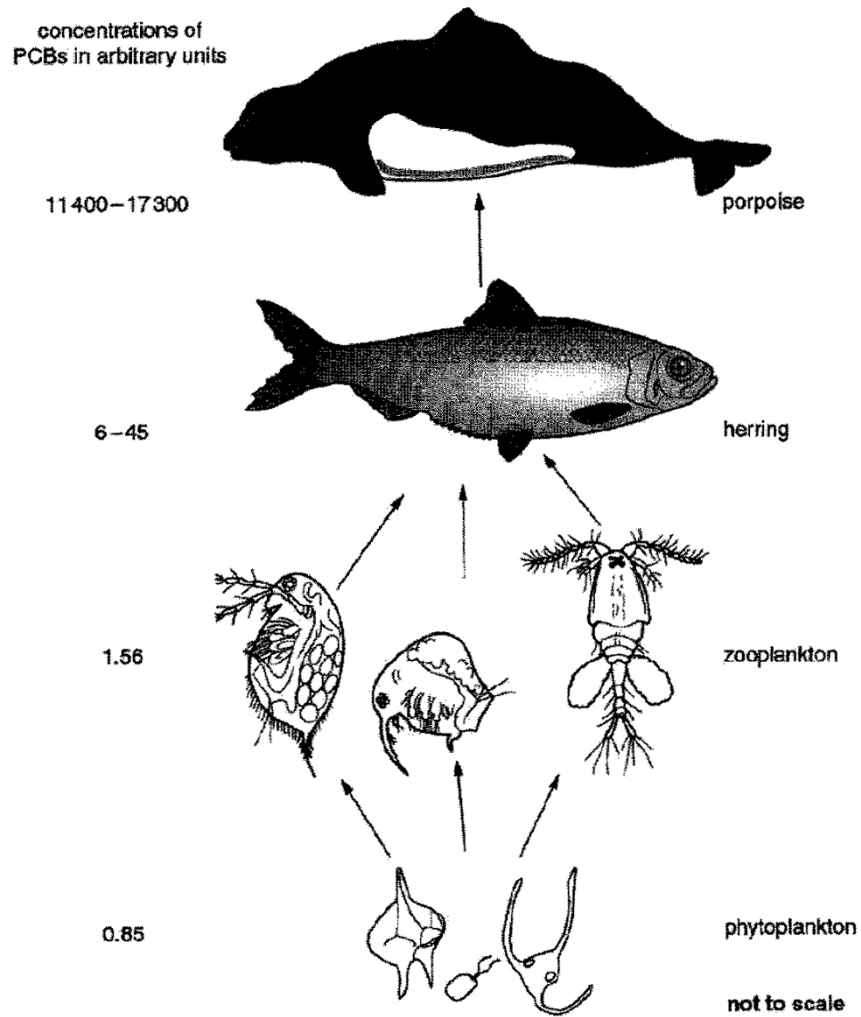


Fig. 9.1

(a) (i) Describe the results shown in Fig. 9.1.

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..... [3]

(ii) Suggest an explanation for the different concentrations of PCBs in the organisms of the food chain.

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..... [3]

(b) Explain why there are no more than four trophic levels in the ecosystem shown in Fig. 9.1.

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..... [3]

(c) Humans play a significant role in ecosystems.

Suggest possible conservation programmes that have helped to prevent the extinction of endangered species.

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..... [1]

[Total: 10]

10 Fig. 10.1 shows a strawberry plant.

- (b) Three strawberry plants of the same species were placed in different greenhouses A, B and C. The conditions of each greenhouse are shown in Table 10.1.

Table 10.1

conditions	greenhouse A	greenhouse B	greenhouse C
humidity/ %	0.2	0.5	
Light intensity/ arbitrary unit	50	30	

- (i) It was found that the plant in greenhouse C shown the highest rate of water loss.
Complete Table 10.1 by predicting the humidity and light intensity in greenhouse C.

[1]

- (ii) Explain how humidity and light intensity affect the rate of water loss in the strawberry plant in greenhouse C.

..... [5]
[Total: 10]