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# A Level Biology A

## H420/01 Biological processes

## Monday 12 June 2017 – Afternoon

### Time allowed: 2 hours 15 minutes

*6892730086*

**You must have:**
- the Insert (inserted)

**You may use:**
- a scientific or graphical calculator
- a ruler (cm/mm)

*H420/01*

| First name | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Last name | | | | | | | | | | |
| Centre number | | | | | | Candidate number | | | | |

**INSTRUCTIONS**
- The Insert will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

**INFORMATION**
- The total mark for this paper is **100**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **40** pages.

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## SECTION A

**You should spend a maximum of 20 minutes on this section.**

**Write your answer to each question in the box provided.**

Answer **all** the questions.

**1** Which of the options, **A** to **D**, correctly describes how an endotherm would respond to an increase in temperature?

**A** dilation of arterioles near the surface of the skin

**B** erector muscles contract, causing hairs to stand up

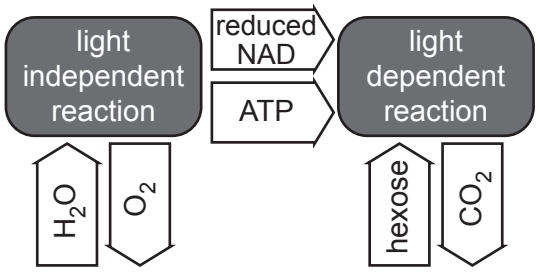
**C** rapid contractions of skeletal muscles

**D** sweat glands release less sweat

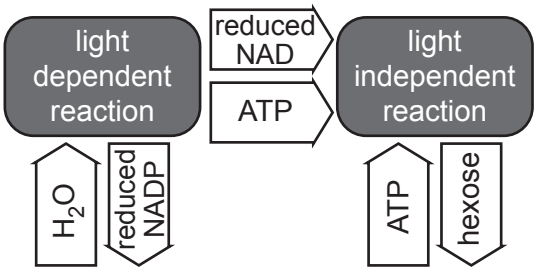
Your answer ☐ **[1]**

**2** Which of the images, **A** to **D**, correctly summarises photosynthesis?

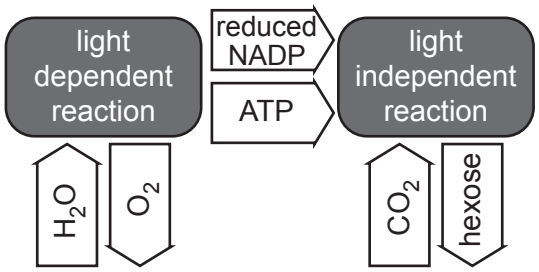
**A**



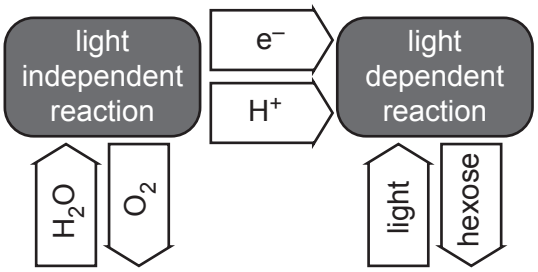

**B**




**C**




**D**

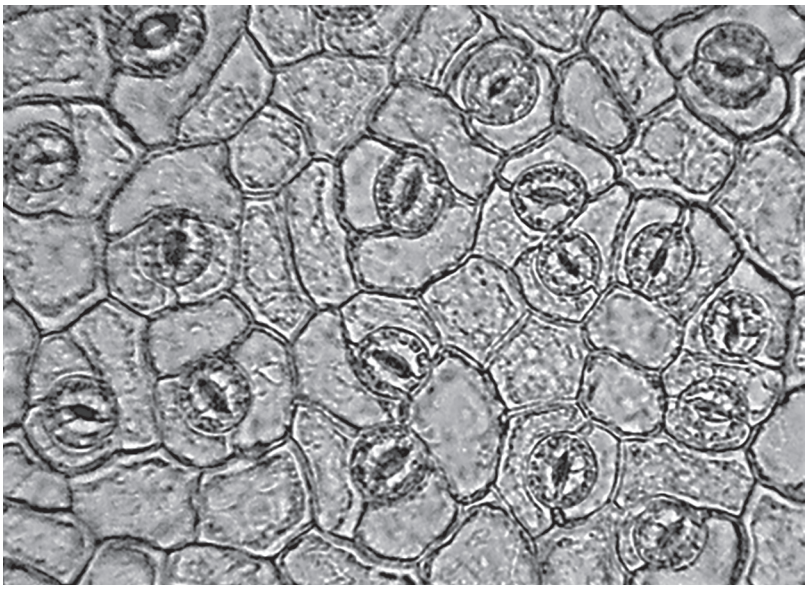



Your answer ☐ **[1]**

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**3** A student counted stomata on a leaf using a light microscope. The image below shows the stomata that were visible.

The image magnification is ×60.



Which of the options, **A** to **D**, is the correct stomatal density of this leaf?

**A** 7.50 stomata $mm^{-2}$

**B** 0.13 stomata $mm^{-2}$

**C** 2428 stomata $mm^{-2}$

**D** 0.21 stomata $mm^{-2}$

Your answer ☐ **[1]**

**4** Which of the options, **A** to **D**, occurs in the nucleus of a cell?

**A** synthesis of enzymes

**B** synthesis of RNA

**C** modification of polypeptides

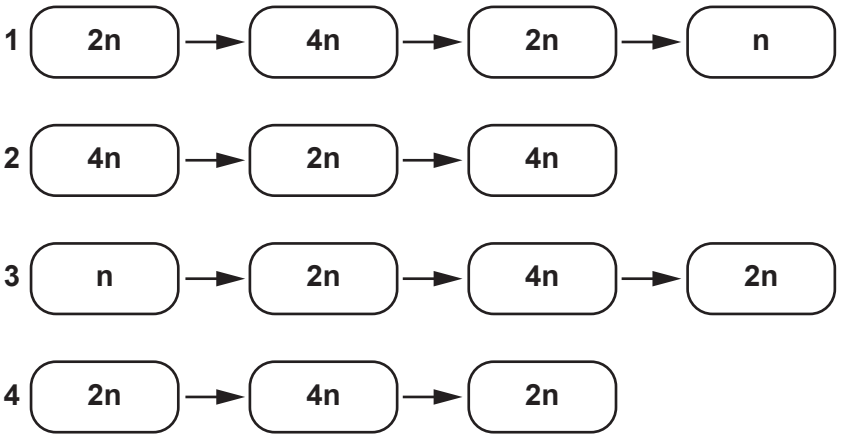
**D** synthesis of carbohydrates

Your answer ☐ **[1]**

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**5** During cell division, the chromosome number in the cells changes.

The following sequences describe the chromosome number in cells before, during and after different types of cell division.




Which of the options, **A** to **D**, correctly describes the stages of mitosis and meiosis in human cells?

**A** 1 is mitosis, 2 is meiosis

**B** 2 is mitosis, 3 is meiosis

**C** 3 is mitosis, 4 is meiosis

**D** 4 is mitosis, 1 is meiosis

Your answer ☐ **[1]**

**6** Patients with kidney failure can be treated in different ways.

Which of the following statements describes a feature of peritoneal dialysis?

1 Urea and mineral ions pass into the tissue fluid.
2 Blood is passed over an artificial membrane to remove toxins.
3 The patient receives immunosuppressant medication.

**A** 1, 2 and 3

**B** Only 1 and 2

**C** Only 2 and 3

**D** Only 1

Your answer ☐ **[1]**

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**7** Bony fish absorb dissolved oxygen from the water using gills. Water is passed through the buccal cavity and over the gill lamellae. The oxygen saturation of the blood and water changes as the water passes over the gills.

Which of the statements, **A** to **D**, correctly describes the way oxygen is transferred into the blood at the gills?

**A** Blood and water flow in a concurrent system with a constant concentration gradient between them.

**B** Blood and water flow in a countercurrent system with a constant concentration gradient between them.

**C** Blood and water flow in a concurrent system with a greater concentration gradient between them at the start of the gill lamella.

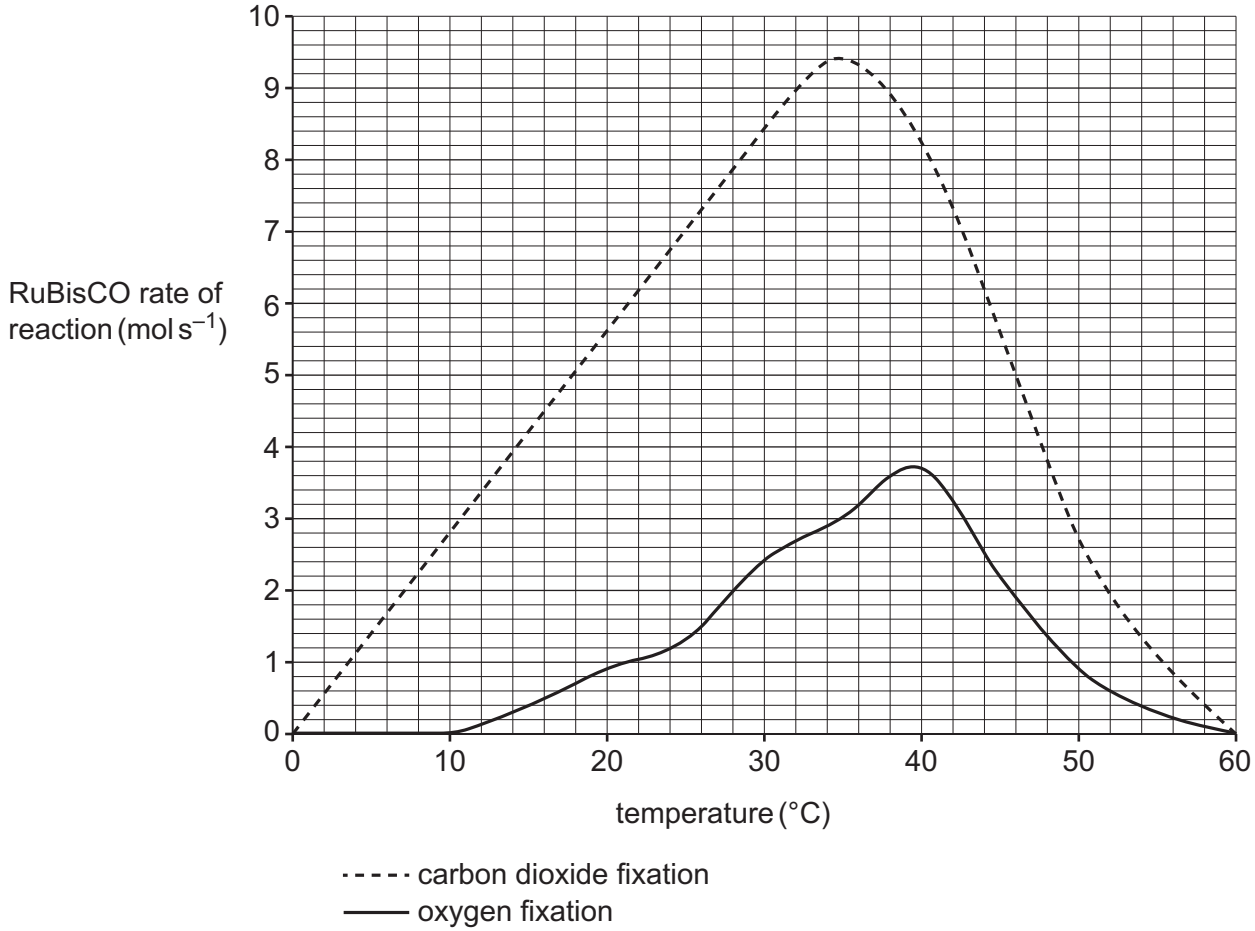
**D** Blood and water flow in a countercurrent system with a greater concentration gradient between them at the start of the gill lamella.

Your answer ☐ **[1]**

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**8** RuBisCO is an enzyme that fixes carbon dioxide in photosynthesis. In some conditions, RuBisCO also carries out oxygen fixation.

The graph below shows how the carbon dioxide and oxygen fixing activities of RuBisCO are affected by temperature.




What are the correct percentage changes in RuBisCO carbon dioxide and oxygen fixing activities between 30 °C and 40 °C?

**A** carbon dioxide fixation –12.7%, oxygen fixation 23.3%

**B** carbon dioxide fixation –14.6%, oxygen fixation 18.9%

**C** carbon dioxide fixation –2.4%, oxygen fixation 54.2%

**D** carbon dioxide fixation –3.6%, oxygen fixation 35.1%

Your answer ☐ **[1]**

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**9** The hormone hCG can be detected in urine using pregnancy tests.

Which of the following properties of the hormone hCG allows it to be detected in urine?

**A** hCG is a polar molecule

**B** hCG has a molecular mass of less than 69,000

**C** hCG is a polypeptide

**D** hCG binds to cells using glycoproteins

Your answer ☐ **[1]**

**10** The hormone ecdysone is synthesised in the prothoracic glands found in the upper thorax of some invertebrates and is released into haemolymph. It is then transported to cells near the surface of the body and causes the loss of the exoskeleton so that a new exoskeleton can form.

Which of the following statements explains how ecdysone is able to act on cells near the surface of the body?

1 Ecdysone is synthesised by specialised neurosecretory cells.
2 Ecdysone is soluble in haemolymph because it is a polar molecule.
3 Ecdysone is complementary to cell surface receptors on cells throughout the body of some invertebrates.

**A** 1, 2 and 3

**B** Only 1 and 2

**C** Only 2 and 3

**D** Only 1

Your answer ☐ **[1]**

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**11** Which of the statements, **A** to **D**, correctly describes the process of adhesion?

**A** attraction of water molecules to the impermeable walls of xylem tissue

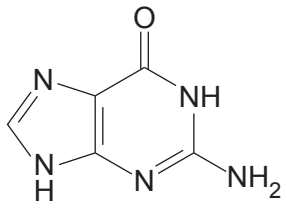
**B** attraction of water molecules to other water molecules in the xylem tissue

**C** active transport of water molecules into phloem tissue

**D** attraction of water molecules to other water molecules in the phloem tissue

Your answer ☐ **[1]**

**12** The image below shows the structure of the nucleotide base guanine.




Bird droppings are known as *guano* because they contain a high proportion of guanine. Unlike mammals, birds excrete nitrogenous waste as guanine instead of urea. Guanine is synthesised from ammonia in the liver.

The following statements relate to guanine:

1 ammonia is more toxic than guanine
2 urea is more soluble in water than guanine
3 guanine has a high proportion of nitrogen

Which of the statements correctly explains why birds excrete guanine?

**A** 1, 2 and 3

**B** Only 1 and 2

**C** Only 2 and 3

**D** Only 1

Your answer ☐ **[1]**

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**13** Different sized mammals have different surface area to volume ratios.

The table shows the surface areas and volumes of four different groups of mammals.

| Mammal genus | Surface area ($m^2$) | Volume ($m^3$) |
|---|---|---|
| *Oryctolagus* | 0.48 | $2.0 \times 10^{-2}$ |
| *Equus* | 18.26 | 2.24 |
| *Mus* | $1.9 \times 10^{-3}$ | $7.2 \times 10^{-5}$ |
| *Rattus* | 0.32 | $1.6 \times 10^{-2}$ |

Which of the options, **A** to **D**, is the correct order of surface area to volume ratios for the different mammals, arranged from the largest to the smallest?

**A** *Oryctolagus, Rattus, Equus, Mus*

**B** *Mus, Rattus, Oryctolagus, Equus*

**C** *Mus, Oryctolagus, Rattus, Equus*

**D** *Equus, Mus, Oryctolagus, Rattus*

Your answer ☐ **[1]**

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**14** The commercially grown tobacco plant, *Nicotiana rustica*, has many pests. One such insect pest is *Manduca sexta*, which causes damage to the stems and leaves of *N. rustica*.

The tiny wasp *Cotesia congregata* lays its eggs inside the body of *M. sexta*. When the larvae develop they feed on the body of the host, eventually killing it.

*N. rustica* produces a volatile organic compound called volicitin when its leaves are damaged.

Volicitin attracts *C. congregata* at high concentrations.

Which of the following explains why *N. rustica* releases volicitin?

1 volicitin release reduces herbivory in *N. rustica*
2 volicitin release increases *M. sexta* growth rate
3 volicitin release reduces parasitism of *M. sexta* by *C. congregata*

**A** 1, 2 and 3

**B** Only 1 and 2

**C** Only 2 and 3

**D** Only 1

Your answer ☐ **[1]**

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**15** Mistletoe is a plant parasite that lives on the stems of other plants. It survives by removing water and assimilates from the host plant.

The mistletoe binds to the stem of the host plant and grows a specialised root-like tissue called a haustorium that attaches to different tissues in the stem.

One species of mistletoe, *Viscum minimum*, contains no chloroplasts.

Which of the options, **A** to **D**, explains why *V. minimum* does not need chloroplasts?

**A** the haustorium of *V. minimum* attaches to sieve tube elements

**B** the haustorium of *V. minimum* attaches to xylem vessels

**C** the haustorium of *V. minimum* attaches to meristem cells

**D** the haustorium of *V. minimum* attaches to cambium tissue

Your answer ☐ **[1]**

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## SECTION B

Answer **all** the questions.

**16 (a)** Many insects such as moths and bumblebees are insulated with scales and hair, and are known as facultative endotherms.

Their metabolism during flight can cause the temperature of the flight muscles to increase 20–30 °C above the external temperature.

**(i)** Using the information provided, explain why many moths and bumblebees are described as endothermic.

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**(ii)** It is more difficult for moths and bumblebees to maintain their body temperature than for mammals and birds to maintain their body temperature.

Explain why.

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**(b)** When walking, the abdomen of caterpillars expands and contracts slowly. Air is taken into the tiny holes along the side of the body.

One of these holes is labelled in Fig. 16.

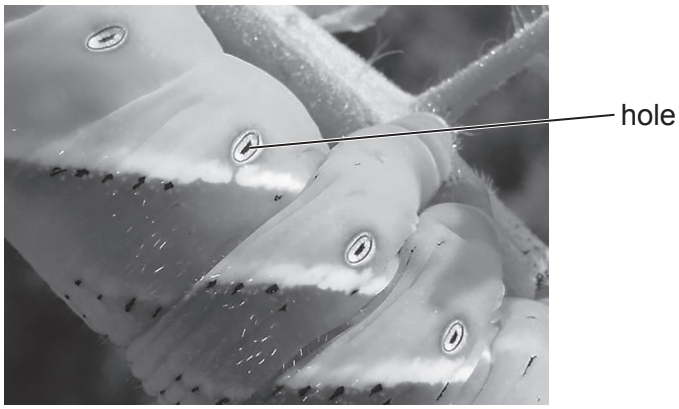



**Fig. 16**

**(i)** Name these holes.

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

**(ii)** Fluid is found in the tubes responsible for gaseous exchange in insects.

Name this fluid.

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**(c)** Outline the reasons why insects and other animals need well-developed transport systems.

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**(d)** A student planned to carry out a dissection of insect and fish gaseous exchange systems.

The student planned to complete diagrams of the different tissues. They were advised to observe the following guidelines:

- use a sharp pencil
- use ruled label lines
- include a scale bar.

Suggest **two** further guidelines for the student to follow to ensure they present their diagrams clearly and accurately.

1 .....

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

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**17** Cirrhosis of the liver can result from long-term liver damage. Alcohol or other toxins can cause this damage.

Scientists have suggested that cirrhosis can be detected by taking samples of body fluids and testing them for two different molecules: C-reactive protein and copeptin.

The liver produces these two molecules, and increased levels can indicate liver damage due to cirrhosis.

Different bodily fluids from a patient suspected of having cirrhosis were tested for C-reactive protein and copeptin.

Fig. 17.1 is a graph of the results.

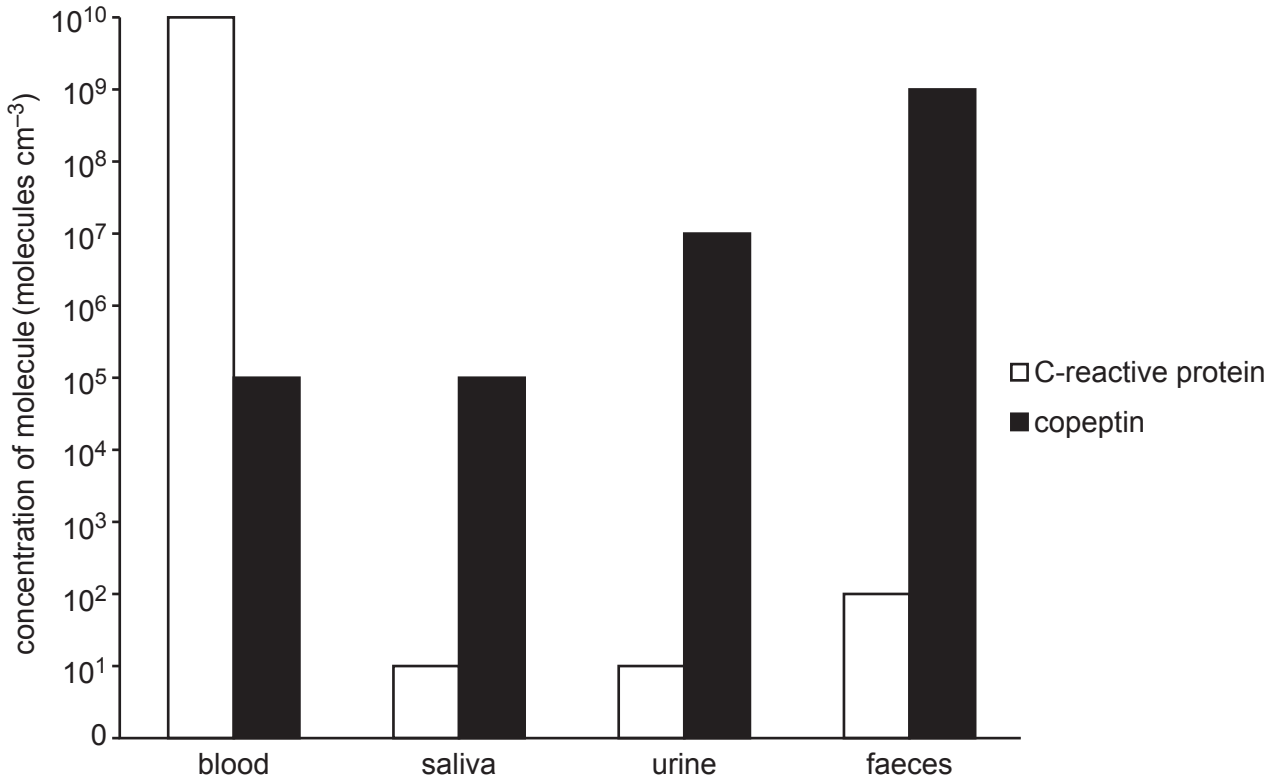



**Fig. 17.1**

**(a)** Different bodily fluids have different concentrations of the different molecules.

**(i)** Calculate the order of magnitude by which concentration of copeptin in the **faeces** is higher than the concentration of C-reactive protein in the **saliva**.

Show your working.

Answer = ..... molecules cm$^{-3}$ **[2]**

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**(ii)** Suggest why blood and faeces have the highest concentrations of C-reactive protein and copeptin.

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**(b)** Fig. 17.2 is an image of a Kupffer cell from the liver.

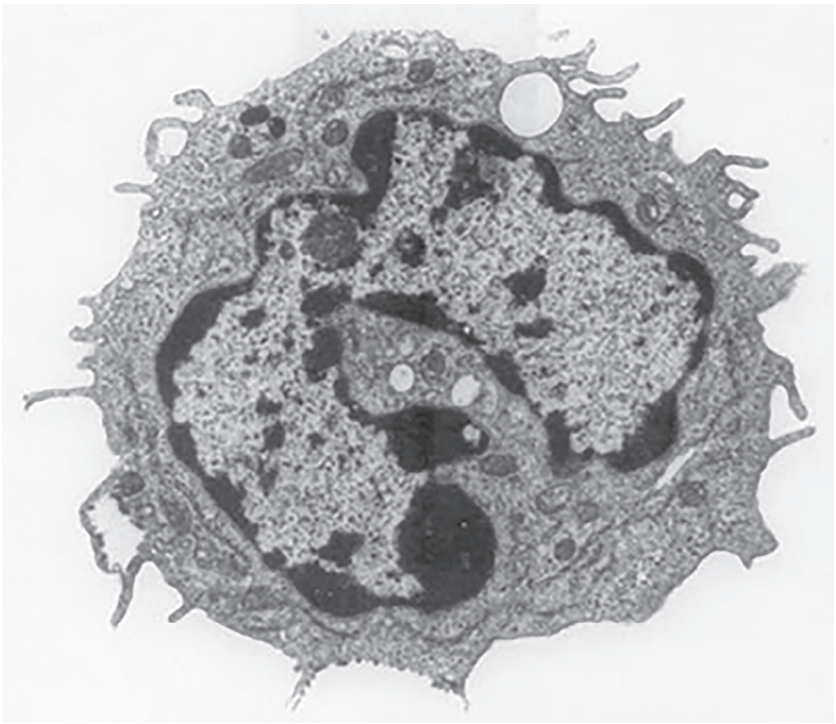



**Fig. 17.2**

**(i)** The diameter of the Kupffer cell in the image is 9.1 cm. Assuming it is spherical, calculate the actual volume of this cell.

Give your answer to **four** significant figures. Show your working.

Answer = ..... **[3]**

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**(ii)** Which type of microscope has been used to obtain this image? Explain your answer.

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**18 (a)** Light intensity, carbon dioxide concentration and temperature are all limiting factors in photosynthesis.

Explain what is meant by a **limiting factor**.

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**Question 18(b) begins on page 20**

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**(b)** An investigation was carried out into the effect of adding different volumes of water on the survival of seedlings.

There were 60 seedlings in each group.

The results are shown in Table 18.

| Volume of water added to soil ($cm^3$) | Day | Number of seedlings surviving |
|---|---|---|
| 10 | 3 | 60 |
| | 6 | 59 |
| | 9 | 59 |
| | 12 | 58 |
| | 15 | 57 |
| | 18 | 57 |
| 20 | 3 | 60 |
| | 6 | 57 |
| | 9 | 54 |
| | 12 | 54 |
| | 15 | 54 |
| | 18 | 53 |
| 30 | 3 | 60 |
| | 6 | 58 |
| | 9 | 56 |
| | 12 | 50 |
| | 15 | 50 |
| | 18 | 48 |
| 40 | 3 | 60 |
| | 6 | 48 |
| | 9 | 40 |
| | 12 | 34 |
| | 15 | 26 |
| | 18 | 20 |
| 60 | 3 | 60 |
| | 6 | 41 |
| | 9 | 21 |
| | 12 | 6 |
| | 15 | 2 |
| | 18 | 2 |

**Table 18**

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**(i)** Summarise the conclusions that can be drawn from these data.

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

**(ii)*** Water can fill air spaces in the soil surrounding the roots.

This prevents oxygen from reaching root hair cells.

Using your knowledge of aerobic and anaerobic respiration, explain why overwatering can kill plants.

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..... **[6]**

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**(c) (i)** Soluble mineral ions are present in soil.

Explain why water molecules can form hydrogen bonds with nitrate ($NO_3^-$) ions.

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**(ii)** Fig. 18 shows a process that occurs in the cell surface membrane of the endodermis in the root.

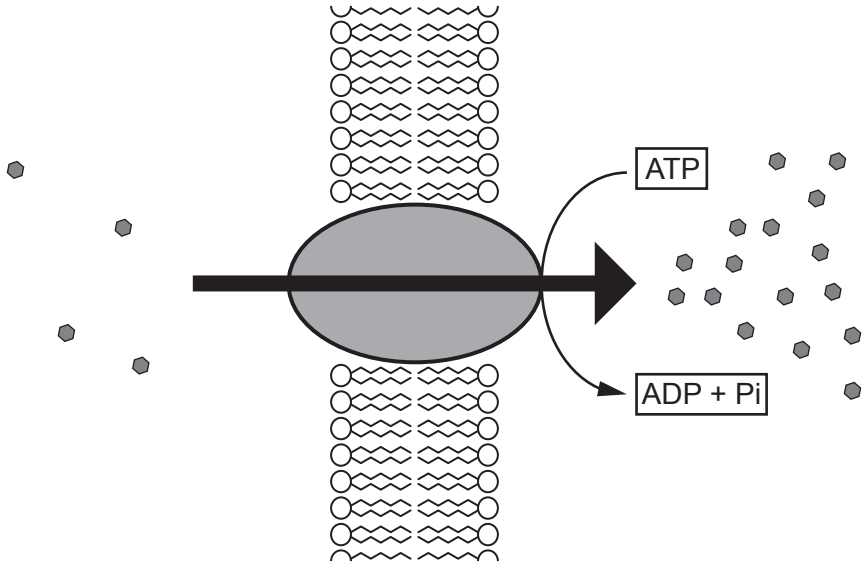



**Fig. 18**

Explain how the events shown in Fig. 18 cause water to enter the endodermis.

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**(d)** Explain why a plant leaf is described as an organ.

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

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**19** Sperm cells in animals are formed by a process known as spermatogenesis.

Fig. 19.1 is a summary of the process of spermatogenesis.

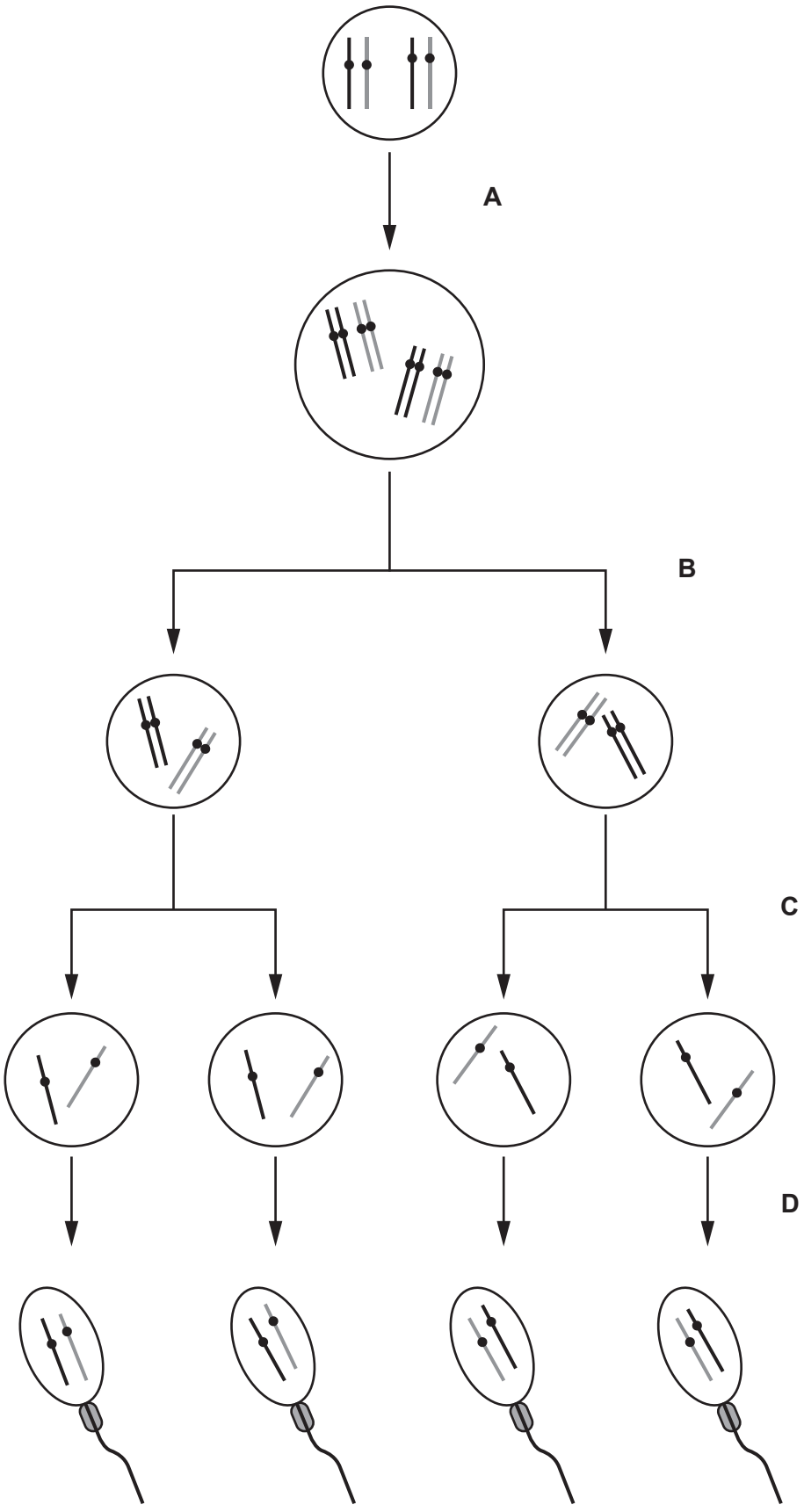



**Fig. 19.1**

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**(a)** Three phases of meiosis are listed below.

Match each phase of meiosis to a letter on Fig. 19.1.

Metaphase 1 occurs during the stage labelled .....

Telophase 2 occurs during the stage labelled .....

Anaphase 1 occurs during the stage labelled .....

**[3]**

**(b)** The chromosomes carried by sperm are made of DNA.

The following passage about nucleic acids has four words missing. Choose the correct missing words from the list below and complete the passage by writing them in the gaps.

**pentose** **nucleus** **adenosine** **hydrolysis**

**spiral** **polymers** **nucleotide** **fibres** **hexose**

**phosphate** **strands** **base** **two**

Nucleic acids are made from ..... monomers.

Phosphodiester bonds form between the monomers. They consist of a

..... group between the ..... molecules, forming the

'backbone' of the molecule.

In DNA, hydrogen bonding between the two antiparallel ..... causes the

characteristic double helix shape. **[4]**

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**(c)** Fig. 19.2 is a transverse section of a sperm cell. The mitochondria of sperm cells form a spiral around the central flagellum.

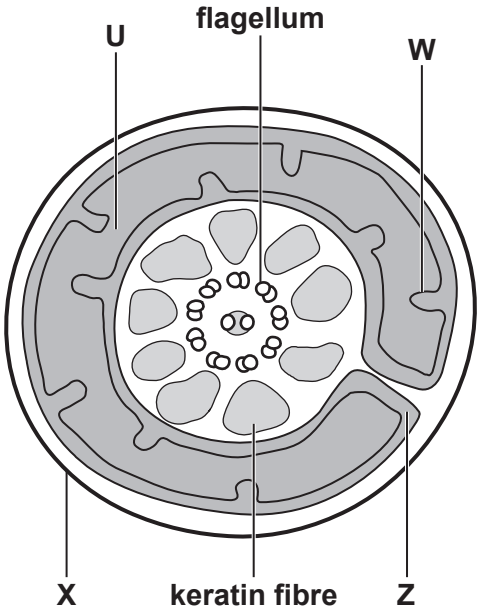



**Fig. 19.2**

**(i)** Identify the structures labelled with the following letters:

**U** .....

**W** .....

**Z** .....

**[3]**

ATP, $FADH_2$ and hexose 1,6-bisphosphate are three organic products of respiration in sperm cells.

Table 19 shows how the production of ATP, $FADH_2$ and hexose 1,6-bisphosphate in sperm cells is affected by three different substances.

| Substance | Organic products of respiration per sperm cell | | |
|---|---|---|---|
| | ATP ($10^{-10}$ mol $s^{-1}$) | $FADH_2$ ($10^{-11}$ mol $s^{-1}$) | Hexose 1,6-bisphosphate ($10^{-11}$ mol $s^{-1}$) |
| Cyanide | 2.54 | 0.00 | 5.78 |
| Fluoride | 0.00 | 0.00 | 0.00 |
| Sucrose | 6.89 | 2.53 | 5.42 |

**Table 19**

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**(ii)** What can be concluded about the difference between the effects of **cyanide** and **fluoride** on respiration in sperm?

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

**Turn over for the next question**

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**20** A student carried out an investigation into the production of $CO_2$ in five different species of yeast.

The yeast cells were placed in different environments and the $CO_2$ production was measured.

Table 20 shows the results of the experiment. The mean values for these data are also represented as a graph in Fig. 20.

| **Conditions** | | **Carbon dioxide produced (bubbles min$^{-1}$)** | | | | |
|---|---|---|---|---|---|---|
| | | **Species** | | | | |
| | | *S. cerevisiae* | *C. krusei* | *C. albidus* | *C. albicans* | *A. pullulans* |
| **Aerobic** | Trial | | | | | |
| | 1 | 23 | 18 | 34 | 12 | 22 |
| | 2 | 18 | 17 | 20 | 15 | 21 |
| | 3 | 23 | 19 | 32 | 26 | 24 |
| | 4 | 24 | 23 | 26 | 13 | 22 |
| | 5 | 25 | 19 | 28 | 14 | 26 |
| | 6 | 15 | 17 | 29 | 12 | 22 |
| | 7 | 16 | 19 | 20 | 15 | 25 |
| | 8 | 17 | 23 | 36 | 13 | 27 |
| | 9 | 23 | 19 | 20 | 10 | 27 |
| | 10 | 25 | 17 | 19 | 13 | 25 |
| | 11 | 25 | 16 | 34 | 11 | 25 |
| | 12 | 23 | 16 | 20 | 11 | 25 |
| **Standard deviation** | | 4 | 2 | 7 | 4 | 2 |
| **Anaerobic** | Trial | | | | | |
| | 1 | 12 | 6 | 22 | 8 | 34 |
| | 2 | 10 | 9 | 29 | 22 | 36 |
| | 3 | 12 | 10 | 19 | 6 | 29 |
| | 4 | 13 | 12 | 34 | 12 | 32 |
| | 5 | 15 | 7 | 25 | 19 | 28 |
| | 6 | 9 | 8 | 19 | 10 | 26 |
| | 7 | 10 | 9 | 23 | 14 | 27 |
| | 8 | 15 | 10 | 27 | 9 | 29 |
| | 9 | 15 | 5 | 35 | 6 | 35 |
| | 10 | 14 | 7 | 26 | 7 | 20 |
| | 11 | 15 | 8 | 19 | 21 | 30 |
| | 12 | 11 | 9 | 25 | 13 | 34 |
| **Standard deviation** | | 2 | 2 | 5 | 6 | ..... |

**Table 20**

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**(a)** Using the information in Table 20, calculate the standard deviation for the number of $CO_2$ bubbles produced by *A. pullulans* in anaerobic conditions.

Write the answer into the space provided in Table 20. Give your answer to **one** significant figure. Show your working.

*[Answer on Table 20]* **[3]**

**(b)** Fig. 20 is a graph showing the mean values of the data from Table 20.

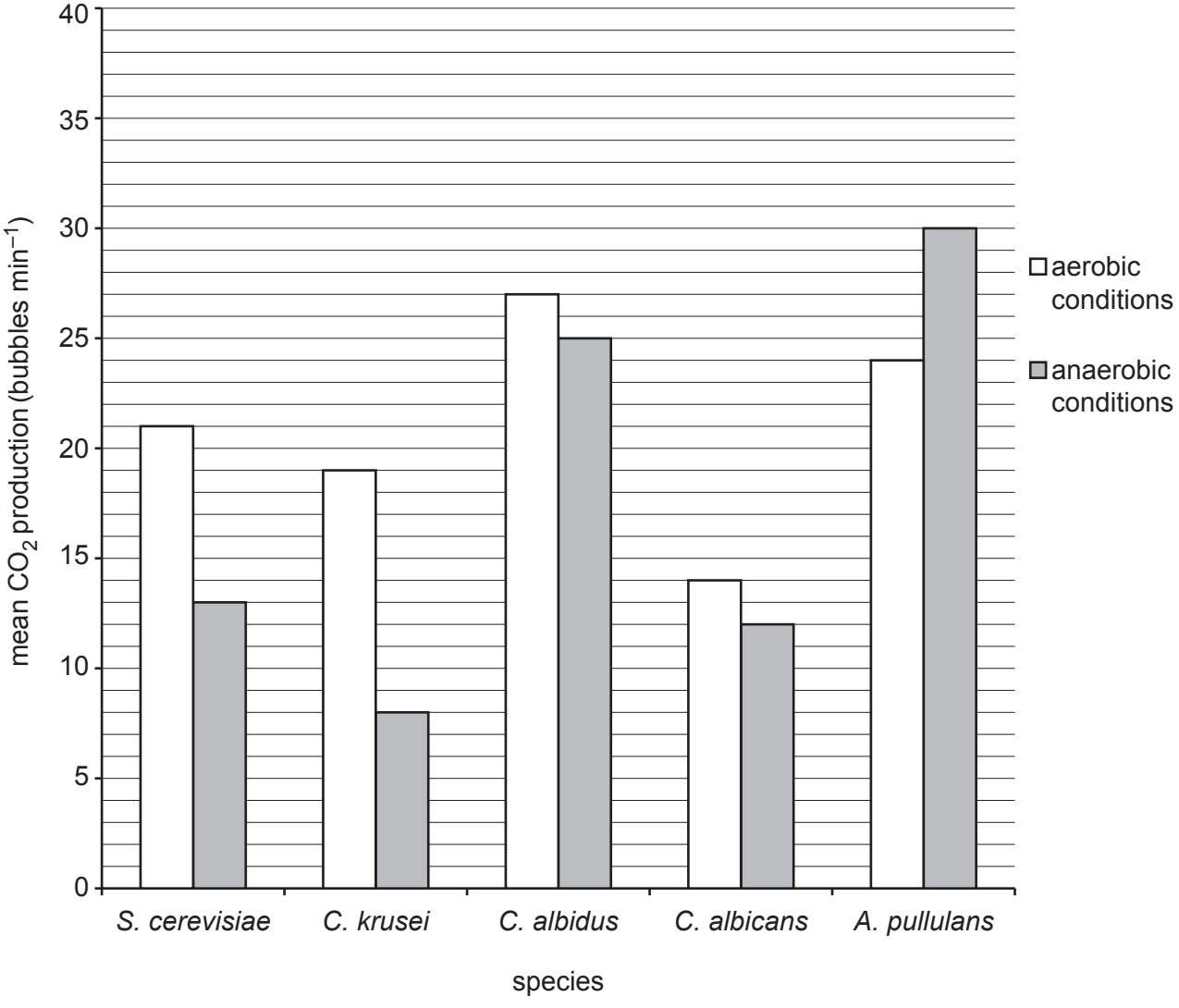



**Fig. 20**

Plot the standard deviations for all data on Fig. 20.

*[Answer on Fig. 20]* **[2]**

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**(c)** Calculate the mean percentage change in $CO_2$ production for *S. cerevisiae* when moving from anaerobic to aerobic respiration. Give your answer to **four** significant figures.

Show your working.

Answer = ..... **[3]**

**(d)** **(i)** The student drew the following conclusions:

| | |
|---|---|
| 1 | All the yeast I investigated produced more $CO_2$ during aerobic respiration than anaerobic respiration. |
| 2 | There is a significant difference between the $CO_2$ production in aerobic and anaerobic conditions in *C. albidus*. |

For each conclusion, state and explain whether the student is correct.

1 .....

.....

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2 .....

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.....

**[2]**

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**(ii)** The student found the following definitions of errors in a text book:

**Random errors:**

mistakes during measurements caused by low-resolution equipment

**Systematic errors:**

repeated inaccurate measurements in the same direction caused by problems with equipment

Which type of error is suggested by the student's data? Justify your answer.

.....

.....

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

**(e)** Anaerobic respiration in yeast cells requires enzymes.

Which organelle is responsible for synthesising these enzymes?

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

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**21** Plant hormones affect the growth of plant tissues in different ways.

One such effect is to promote the formation of seedless fruit.

Cytokinins are a group of plant hormones.

A commercial plant hormone firm carried out research into three different cytokinins: kinetin, zeatin and diatin.

The firm investigated the effect of adding different volumes of each cytokinin on the production of seedless fruit.

The cytokinins were sprayed on the flowers of different plants. Over time, the mass of seedless fruits produced by the plants was measured.

Fig. 21 is a summary of their results.

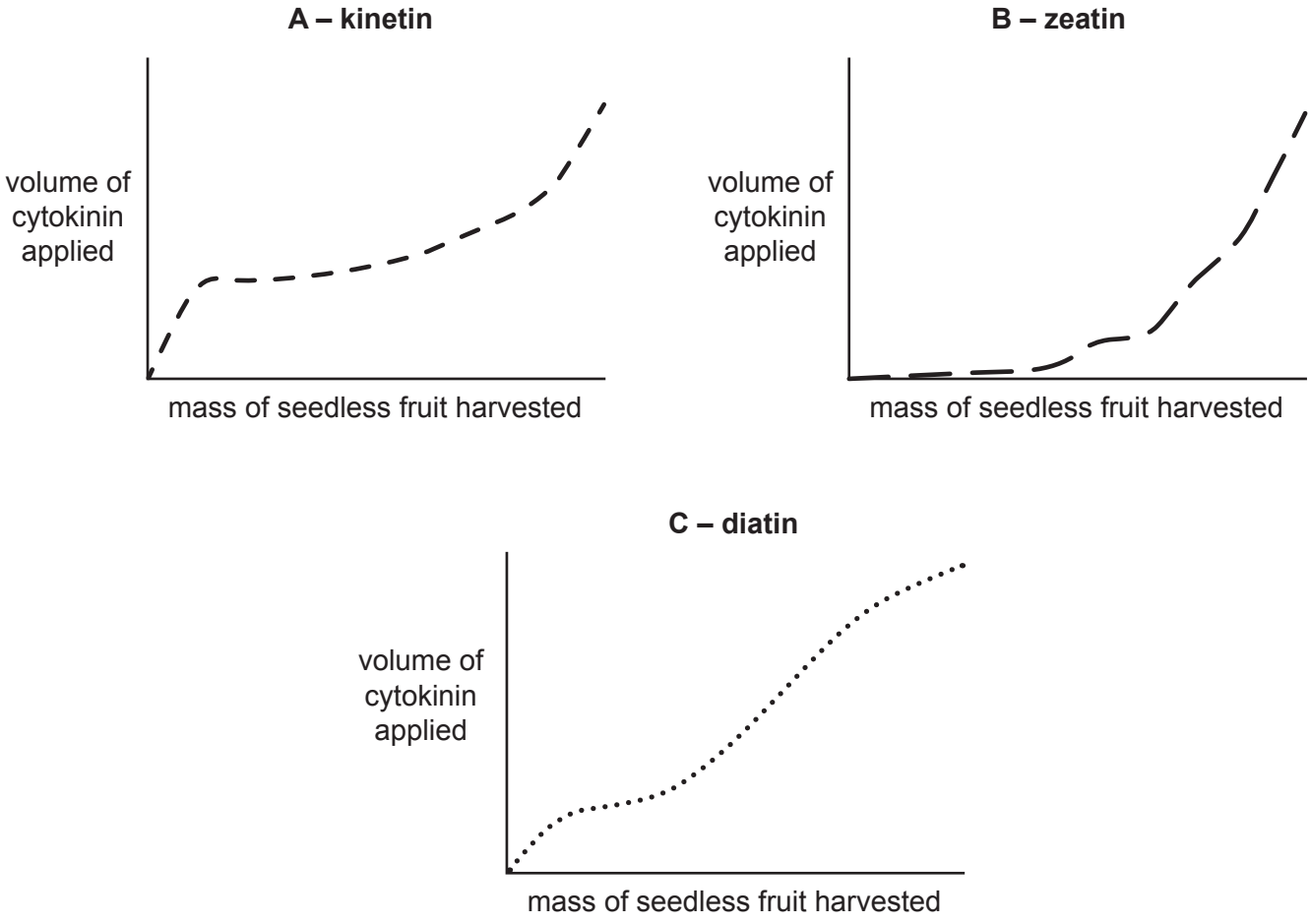



**Fig. 21**

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On the basis of these results, the firm decided to use diatin in their new plant spray.

The firm made the following claim on their packaging:

*Diatin is scientifically proven to cause production of seedless fruit when applied to flowers.*

**(a)*** Evaluate the firm's claim, using the evidence in Fig. 21.

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**(b)** Another response affected by plant hormones is phototropism.

A student completed an investigation into phototropism in cress seeds.

This was the method used:

- Place 50 cress seeds (*Lepidium sativum*) on a sterile paper towel in a petri dish.
- Water with 10 $cm^3$ of distilled water.
- Repeat for 3 different sets of seeds:
  - Set 1 is placed in a box to prevent light shining on the seeds.
  - Set 2 is placed in a box with light from above only.
  - Set 3 is placed in a box with light from the right hand side only.
- Keep all 3 sets at 25 °C.
- After 72 hours, remove 20 of the seedlings from each set and count how many have bent.

Identify **two** limitations of the student's method.

For each limitation, explain how it limits the validity of conclusions that can be drawn **and** suggest an improvement that would improve the validity of conclusions made.

limitation 1:

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explanation:

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improvement:

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limitation 2:

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explanation:

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improvement:

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**[6]**

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**22** **(a)** Fig. 22.1, **on the insert**, is a cross section of part of the cortex of a mammalian kidney.

**(i)** Which letter identifies the region with the highest hydrostatic pressure?

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

**(ii)** Which **two** letters identify regions that **do not** contain plasma proteins?

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

**(b)** Studies of the cell surface membranes of the **distal** convoluted tubule have provided the following evidence:

- Sodium-potassium pumps:
  - move potassium ions from the blood to the tubule fluid
  - move sodium ions from the tubule fluid to the blood
  - use ATP in these processes.

- Sodium-calcium co-transport proteins:
  - move calcium ions from the tubule fluid to the blood
  - move sodium ions into the tubule fluid
  - use the electrochemical gradient of sodium ions to drive this process.

**(i)** Using this information and your own knowledge, compare the processes occurring in the **proximal** and **distal** convoluted tubules.

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**(ii)** Nephrogenic diabetes insipidus is a disease of the kidney that affects the regulation of water potential in the blood. One cause is lithium poisoning. Lithium ions enter the kidney tubules through sodium channels.

This prevents the cells of the collecting duct from responding to ADH in the blood.

State and explain **one** symptom you would expect to observe as a result of nephrogenic diabetes insipidus.

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

**(c)** Fig. 22.2 shows a podocyte from the kidney. The many gaps between the microscopic processes form fenestrations in the Bowman's capsule.



**Fig. 22.2**

**(i)** Explain why podocytes are usually unable to undergo mitosis.

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

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**(ii)** Studies show that after damage by infection or injury, it is possible for nephron tissues to be regenerated. Adult stem cells are involved in this process.

What features of adult stem cells make them suitable for regeneration of tissues in the kidney?

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

**END OF QUESTION PAPER**

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## ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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