OCR
Oxford Cambridge and RSA

A Level Biology B (Advancing Biology)

H422/01 Fundamentals of biology

Practice paper – Set 1

Time allowed: 2 hours 15 minutes

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

First name										
Last name										
Centre number						**Candidate number**				

INSTRUCTIONS
- 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 **110**.
- 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 40 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**, is a meiotic process that does **not** give rise to genetic variation?

A crossing over of non-sister chromatids

B crossing over of sister chromatids

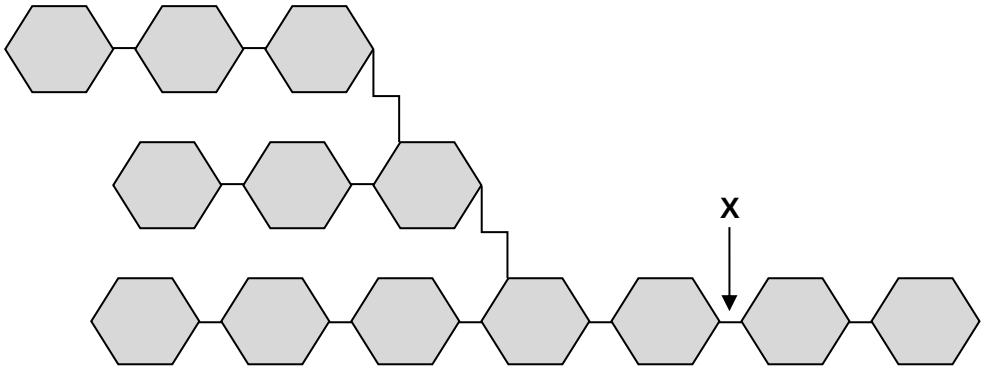
C independent assortment of chromatids

D independent assortment of chromosomes

Your answer ☐

[1]

2 The diagram below represents the structure of a glucose polymer.



Which of the options, **A** to **D**, correctly describes the bond labelled **X**?

A 1,4-glycosidic bond, formed during a condensation reaction

B 1,4-glycosidic bond, formed during a hydrolysis reaction

C 1,6-glycosidic bond, formed during a condensation reaction

D 1,6-glycosidic bond, formed during a hydrolysis reaction

Your answer ☐

[1]

3 The Na^+/K^+ pump helps to maintain the resting potential across the membrane of a neurone.

Which of the statements about the pump's activity, **A** to **D**, is correct?

A for every three Na^+ ions that enter the cell, two Ca^{2+} ions leave

B for every three Na^+ ions that leave the cell, two Ca^{2+} ions enter

C for every three Na^{2+} ions that enter the cell, two K^+ ions leave

D for every three Na^{2+} ions that leave the cell, two K^+ ions enter

Your answer ☐

[1]

4 The total blood volume of a human adult is 4.8 dm^3. The heart rate for this adult during intense exercise was 200 bpm.

At this heart rate, the blood completed **six** full circulations of the body in one minute.

Which of the options, **A** to **D**, is the correctly calculated stroke volume of the left ventricle for this adult?

A 24 cm^3

B 82 cm^3

C 144 cm^3

D 184 cm^3

Your answer ☐

[1]

5 Gram staining is a technique used to distinguish between gram-positive and gram-negative bacteria.

Which of the options, **A** to **D**, is correct?

A gram-positive bacteria stain blue/purple, gram-negative bacteria do not stain

B gram-positive bacteria stain blue/purple, gram-negative bacteria stain pink/red

C gram-positive bacteria stain pink/red, gram-negative bacteria do not stain

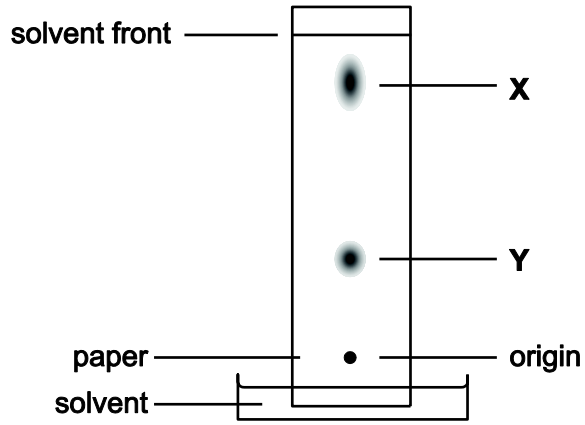
D gram-positive bacteria stain pink/red, gram-negative bacteria stain blue/purple

Your answer ☐

[1]

6 Amino acids **X** and **Y** were separated from a solution by paper chromatography.

The resulting chromatogram is shown below.



Which of the following statements is/are correct?

Statement 1: **X** has a greater R_f value than **Y**.

Statement 2: The rates at which **X** and **Y** migrate are determined by their relative affinities for the paper and the solvent.

Statement 3: The pH of the solvent influences the rates at which **X** and **Y** migrate.

A 1, 2 and 3 are correct

B Only 1 and 2 are correct

C Only 2 and 3 are correct

D Only 1 is correct

Your answer ☐

[1]

7 Which of the options, **A** to **D**, is **not** a coenzyme?

A ATP

B FAD

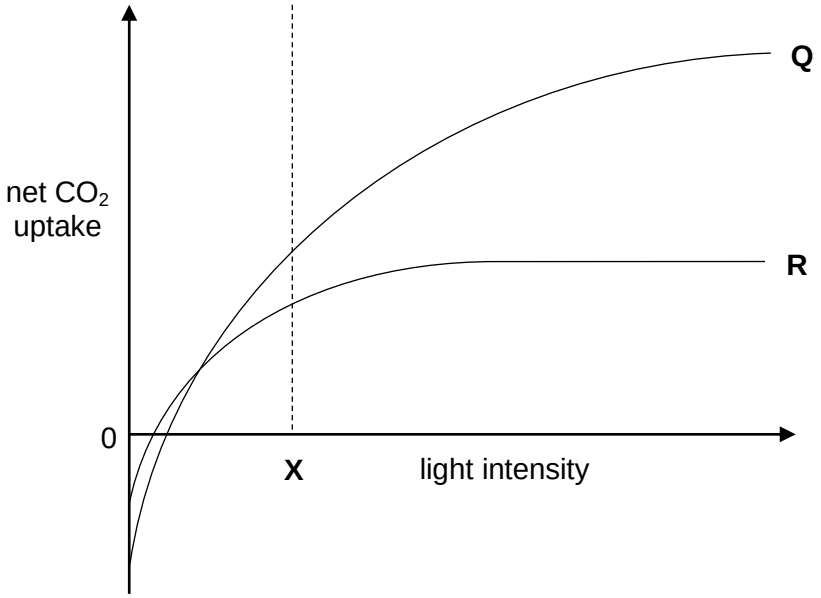
C NAD

D NADP

Your answer ☐

[1]

8 The graph below shows the effect of light intensity on the net CO_2 uptake of two vegetable crops, **Q** and **R**.



Which of the following statements is/are correct?

Statement 1: At light intensity **X**, crop **Q** must use stored carbohydrate as a respiratory substrate.

Statement 2: For both crops, when net CO_2 uptake is zero, the rate of respiration equals the rate of photosynthesis.

Statement 3: Crop **R** is better adapted to shaded conditions than crop **Q**.

A 1, 2 and 3 are correct

B Only 1 and 2 are correct

C Only 2 and 3 are correct

D Only 1 is correct

Your answer ☐

[1]

9 A length of template DNA has the following sequence: GATACTCCTAG.

Which of the options, **A** to **D**, is the mRNA sequence that would be transcribed from this length of DNA?

A CTAGGAGTATC

B CUAGGAGUAUC

C CTATGAGGATC

D CUAUGAGGAUC

Your answer ☐

[1]

10 Plants exchange gases through stomata. The opening and closing of stomata is controlled by guard cells.

Which of the sequences, **A** to **D**, would result in **open** stomata?

A K^+ enters guard cells. The water potential of the cells is decreased. The cells take in water.

B K^+ leaves guard cells. The water potential of the cells is increased. Water leaves the cells.

C K^+ enters guard cells. The water potential of the cells is increased. The cells take in water.

D K^+ leaves guard cells. The water potential of the cells is decreased. Water leaves the cells.

Your answer ☐

[1]

11 Germination is the process in which a seed begins to grow into a plant.

Which of the statements, **A** to **D**, is an early event in germination?

A glucose in the endosperm is polymerised into starch

B glucose in the embryo is polymerised into starch

C starch in the endosperm is broken down into glucose

D starch in the embryo is broken down into glucose

Your answer ☐

[1]

12 Kwashiorkor is a disease that results from severe protein deficiency.

Which of the options, **A** to **D**, is a pressure decrease that causes an accumulation of tissue fluid in a person with kwashiorkor?

A oncotic pressure of blood plasma

B oncotic pressure of interstitial fluid

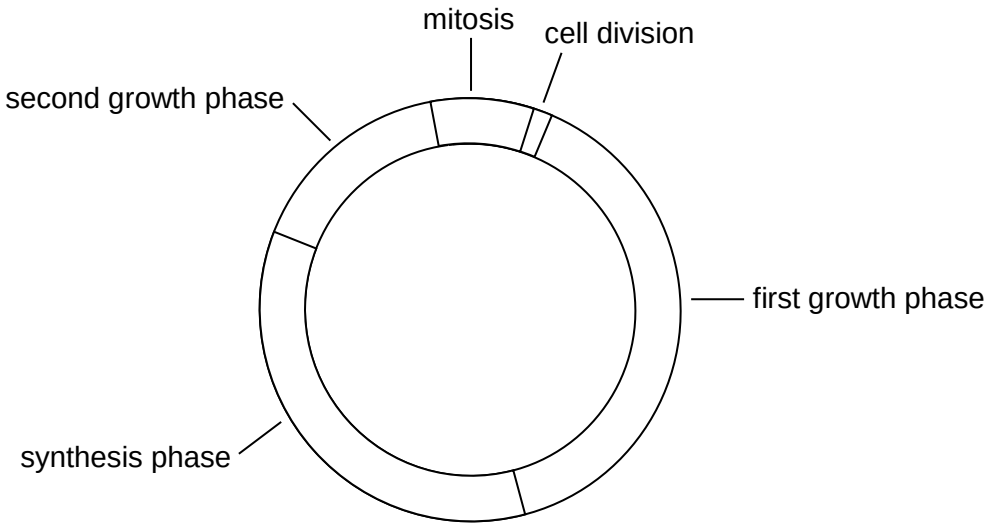
C hydrostatic pressure of blood plasma

D hydrostatic pressure of interstitial fluid

Your answer ☐

[1]

13 The diagram below represents the cell cycle in eukaryotes.



Which of the options, **A** to **D**, is the phase in which spontaneous mutations are most likely to arise?

A mitosis

B first growth phase

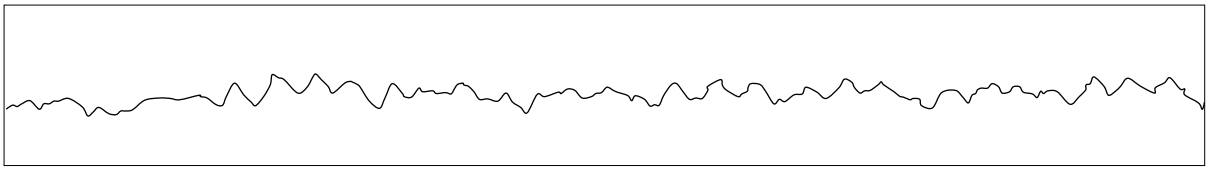
C synthesis phase

D second growth phase

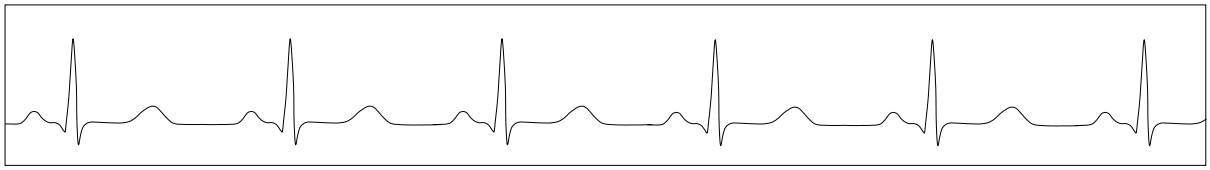
Your answer ☐

[1]

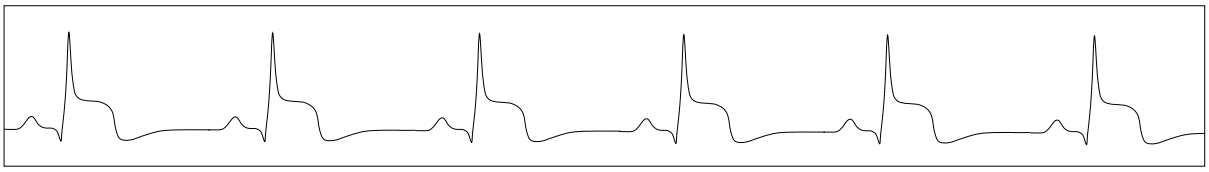
14 Four electrocardiogram (ECG) traces labelled **A** to **D** are shown below.



A



B



C

D

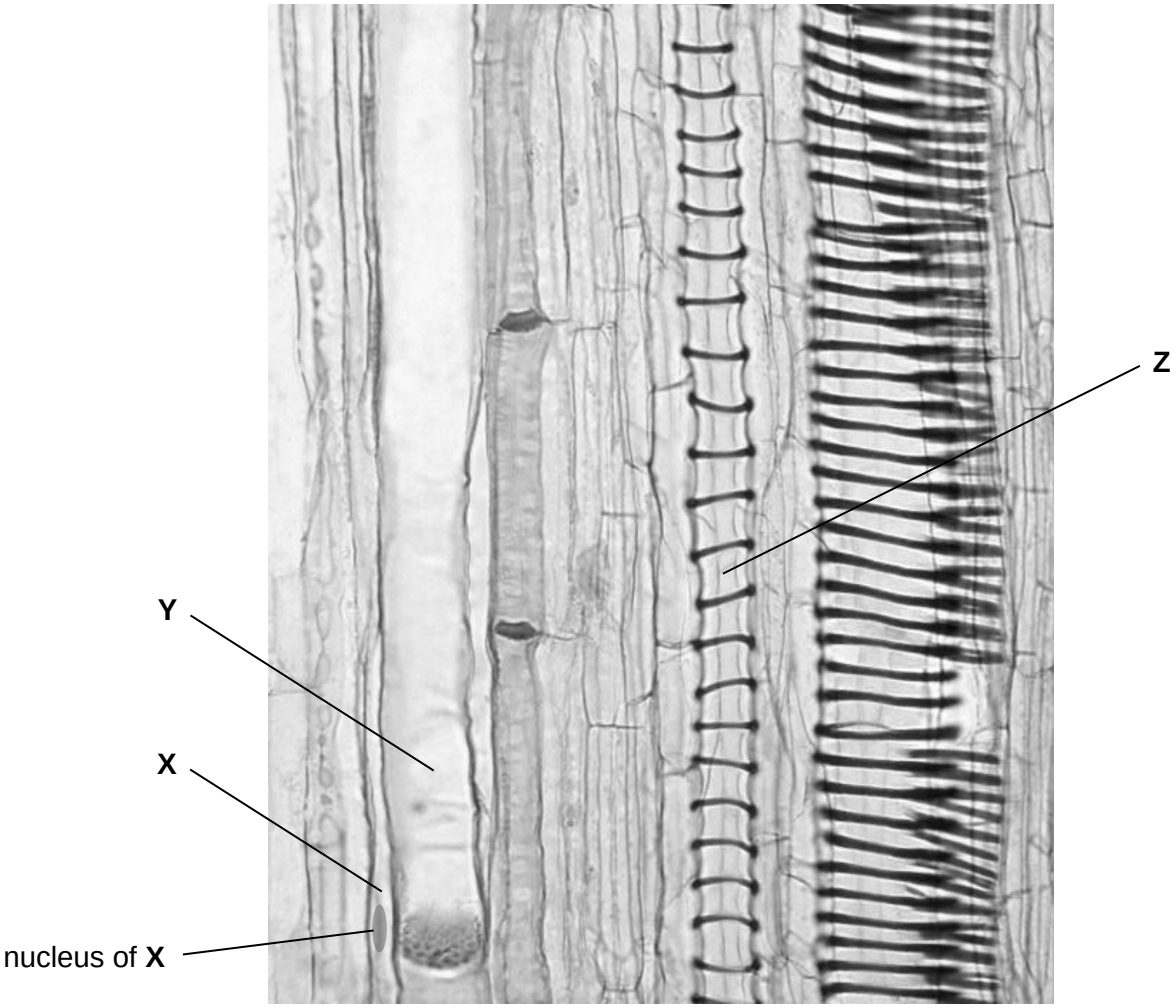
Which of the traces, **A** to **D**, shows evidence of S-T elevation?

Your answer ☐

[1]

15 The photomicrograph below shows a longitudinal section through a plant stem.

Three structures found in the vascular tissue have been labelled **X**, **Y** and **Z**.



Which of the following statements is/are correct?

Statement 1: **X** and **Y** are connected by plasmodesmata.

Statement 2: Protein synthesis **cannot** occur in **X**.

Statement 3: The dark horizontal bands in **Z** are cellulose.

A 1, 2 and 3 are correct

B Only 1 and 2 are correct

C Only 2 and 3 are correct

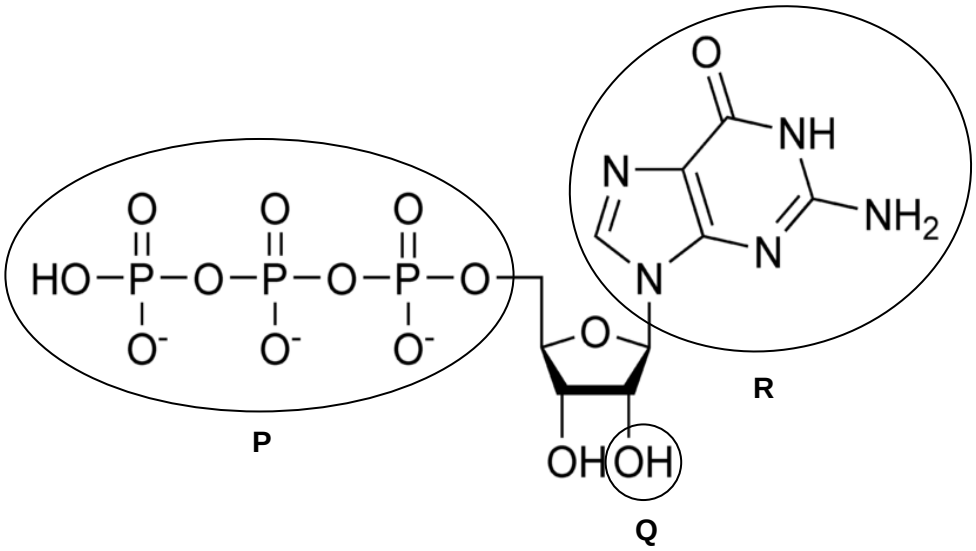
D Only 1 is correct

Your answer ☐

[1]

16 The structure of a guanosine triphosphate (GTP) molecule is shown below.

Three regions of the molecule have been circled and labelled **P**, **Q** and **R**.



Which of the options, **A** to **D**, gives the regions that are structurally different to an adenosine monophosphate (AMP) molecule?

A P, Q and R

B P and Q

C P and R

D Q and R

Your answer ☐

[1]

17 Radiotherapy is a widely-used method of cancer treatment.

Cancer cells are more sensitive to radiotherapy than healthy cells.

Which of the options, **A** to **D**, is a property of cancer cells that causes increased sensitivity to radiotherapy?

A faster division rate than healthy cells

B faster mutation rate than healthy cells

C altered metabolic pathways

D impaired oxygen uptake

Your answer ☐

[1]

18 The polymerase chain reaction (PCR) is used to produce multiple copies of a desired DNA sequence.

A DNA sequence encoding a gene was amplified from a single copy.

Which of the options, **A** to **D**, would be the theoretical number of copies of the gene after **12 cycles** of heating and cooling?

A 13

B 24

C 144

D 4096

Your answer ☐

[1]

19 The following statement describes a clinical trial that reached completion in 2009.

> The trial was a randomised, single-blind trial which aimed to compare a new drug, ustekinumab, with the standard-of-care drug, etanercept, for the treatment of a skin disease.

Which of the following statements is/are correct?

Statement 1: The doctors, but not the patients, knew which patient received which drug.

Statement 2: The trial was in phase 3.

Statement 3: Ustekinumab was given to patients over a range of doses in order to determine the safest dose.

A 1, 2 and 3 are correct

B Only 1 and 2 are correct

C Only 2 and 3 are correct

D Only 1 is correct

Your answer ☐

[1]

20 The sympathetic and parasympathetic nervous systems affect heart rate.

Which of the options, **A** to **D**, would lead to a **decrease** in heart rate?

A activation of the vagus nerve, releasing noradrenaline

B activation of the vagus nerve, releasing acetylcholine

C activation of the accelerator nerve, releasing noradrenaline

D activation of the accelerator nerve, releasing acetylcholine

Your answer ☐

[1]

21 The ABO blood group system in humans has three alleles for the antigen found on the cell surface membrane of erythrocytes. The three alleles are: I^O, I^A and I^B.

A male with the genotype I^AI^O and a female with the genotype I^BI^O have a child.

Which of the options, **A** to **D**, is the probability that this child will have a codominant genotype?

A 0.25

B 0.50

C 0.75

D 1.00

Your answer ☐

[1]

22 In human fertilisation, a spermatozoon penetrates an ovum and forms a diploid cell known as a zygote.

Which of the options, **A** to **D**, correctly describes the zygote?

A multipotent

B pluripotent

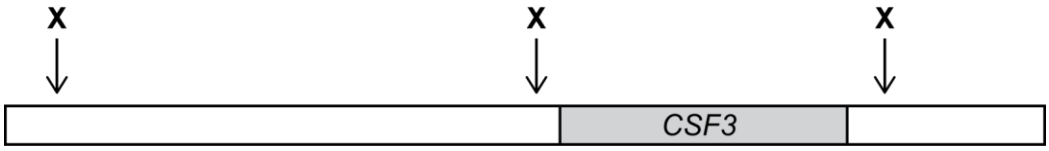
C totipotent

D unipotent

Your answer ☐

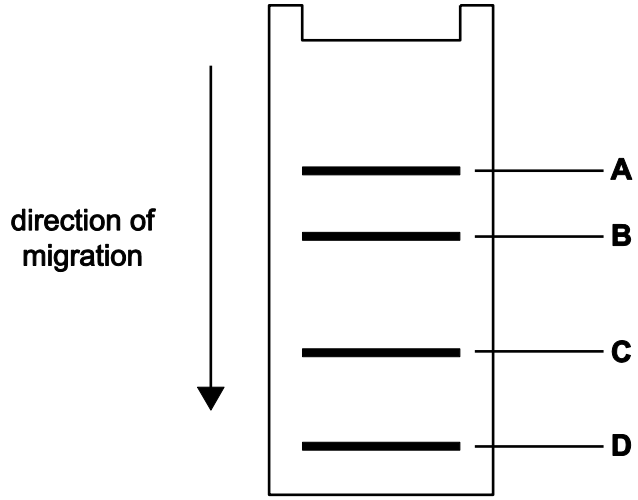
[1]

23 The diagram below represents an **isolated** length of DNA containing the gene, *CSF3*.



- *EcoRI* is a restriction enzyme that recognises specific sequences, labelled **X**, within the DNA.
- The DNA was cut at every point **X** with *EcoRI,* and the fragments separated by gel electrophoresis.

The result is shown below.



Which of the DNA bands, **A** to **D**, contains the gene, *CSF3*?

Your answer ☐

[1]

24 Benedict's solution can be used to detect reducing sugars in urine.

Which of the options, **A** to **D**, is the colour that you would expect to see after testing the urine of a diabetic person?

A blue

B blue-black

C brick-red

D purple

Your answer ☐

[1]

25 Which of the options, **A** to **D**, is a biological molecule that contains ester bonds?

A amylase

B cellulose

C lipid

D ribulose bisphosphate

Your answer ☐

[1]

26 The statements below relate to biological characteristics of the respiratory pigments.

Which of the following statements is/are correct?

Statement 1: At any partial pressure of oxygen, myoglobin has a lower oxygen saturation level than adult haemoglobin.

Statement 2: The oxygen dissociation curves for fetal and adult haemoglobin are sigmoidal due to the cooperative binding of oxygen.

Statement 3: Haemoglobin releases oxygen more readily at low pH.

A 1, 2 and 3 are correct

B Only 1 and 2 are correct

C Only 2 and 3 are correct

D Only 1 is correct

Your answer ☐

[1]

27 The statements below describe the response to light by a rod cell in the retina.

Which of the following statements is/are correct?

Statement 1: The plasma membrane becomes hyperpolarised.

Statement 2: Rhodopsin is broken down.

Statement 3: Glutamate is released from a rod cell, causing depolarisation of a connecting bipolar cell.

A 1, 2 and 3 are correct

B Only 1 and 2 are correct

C Only 2 and 3 are correct

D Only 1 is correct

Your answer ☐

[1]

28 Ventilation is increased during exercise to meet the increased oxygen demand of the body.

One way of increasing ventilation is to exchange a larger volume of air with each breath.

Which of the options, **A** to **D**, is a respiratory measurement that could detect this increase?

A forced expiratory volume

B residual volume

C tidal volume

D vital capacity

Your answer ☐

[1]

29 A study was conducted to determine the effect of alcohol on reaction time.

Twenty participants were asked to respond as fast as possible to visual cues, before and after drinking a fixed quantity of alcohol. Two data sets were produced.

Which of the options, **A** to **D**, would be the appropriate statistical method for analysing the data from this study?

A chi squared test

B paired Student's t-test

C unpaired Student's t-test

D Spearman's rank correlation coefficient

Your answer ☐

[1]

30 The gene, *FOXP3*, encodes a transcription factor that drives the differentiation of immature T cells into a specific cell type.

Mutations in *FOXP3* can interrupt the function of the transcription factor and lead to autoimmunity.

Which of the options, **A** to **D**, is the T cell type driven by this transcription factor?

A T helper cell

B T killer cell

C T memory cell

D T regulatory cell

Your answer ☐

[1]

SECTION B

Answer **all** the questions.

31 A traumatic brain injury is caused by an external force to the head, such as during a traffic accident.

Fig. 31.1 is a diagram showing a cross-section of the human brain with regions labelled **A** to **F**.

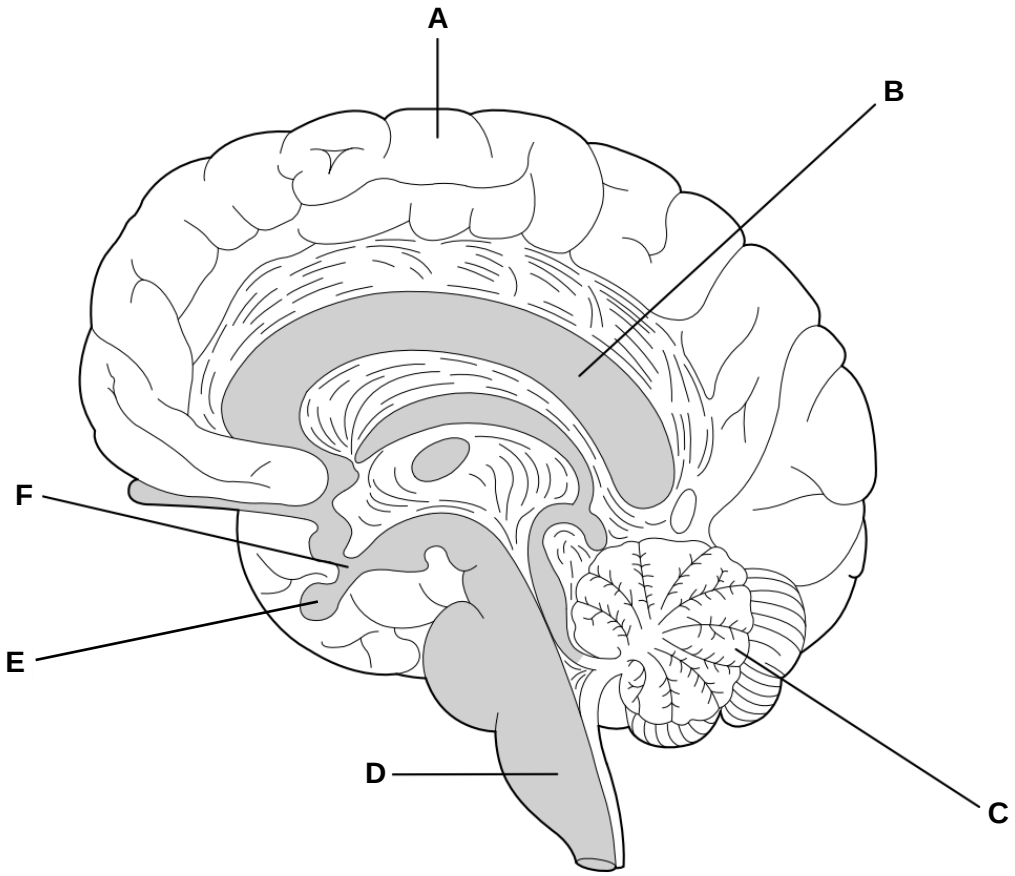


Fig. 31.1

(a) Complete each blank in the paragraph below by inserting the letter corresponding to the appropriate brain region from Fig. 31.1.

The symptoms of a traumatic brain injury are dependent on the region(s) of the brain affected. Damage to …… may lead to the release of hormones such as ADH and oxytocin into the blood. Damage to …… may cause a poor regulation of body temperature. Motor function may be affected if there is damage to …… .

Brain death is confirmed if there is a permanent loss of function in …… .

[4]

(b) Functional magnetic resonance imaging (fMRI) can identify regions of brain damage by measuring brain activity.

(i) Explain how fMRI measures brain activity.

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

(ii) Suggest **two** advantages of fMRI over computed tomography (CT) for the measurement of brain activity.

1. .....

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2. .....

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[2]

(iii) Another imaging method can identify regions of brain damage by measuring electrical activity across the brain. Name this method.

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

32 The Abert's squirrel, *Sciurus aberti*, and the Kaibab squirrel, *Sciurus aberti kaibabensis*, are two biological species that live in the mountainous Grand Canyon region of North America.

(a) (i) What is meant by the term biological species?

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

(ii) Complete Table 32.1 below to show the full biological classification of *S. aberti*.

Domain	……
Kingdom	Animalia
……	Chordata
Class	Mammalia
Order	Rodentia
Family	Sciuridae
Genus	*Sciurus*
Species	*S. aberti*

Table 32.1

[2]

(b)* The Grand Canyon divides what was once a continuous area of land.

Around 20 million years ago, the Colorado River began to carve into the land to form a deep valley. This valley separated the former continuous land into the North Rim and South Rim.

S. aberti and *S. aberti kaibabensis* form two populations, as shown in Fig. 32.1.

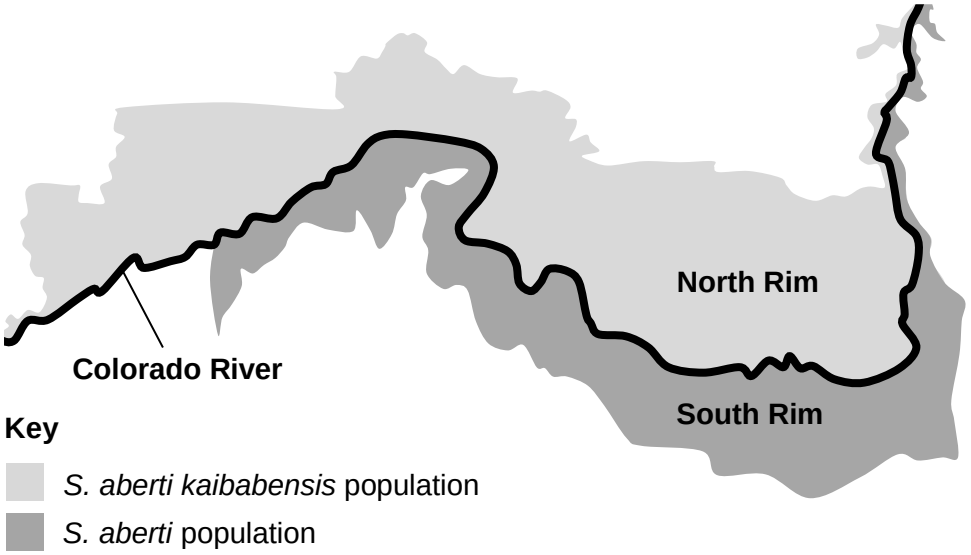

Fig. 32.1

Scientists think that *S. aberti kaibabensis* evolved as a distinct subspecies of *S. aberti*.

Using Fig. 32.1, explain how *S. aberti kaibabensis* could have evolved from *S. aberti*.

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

33 Fig. 33.1 shows the structure of a kidney nephron in a mammal.

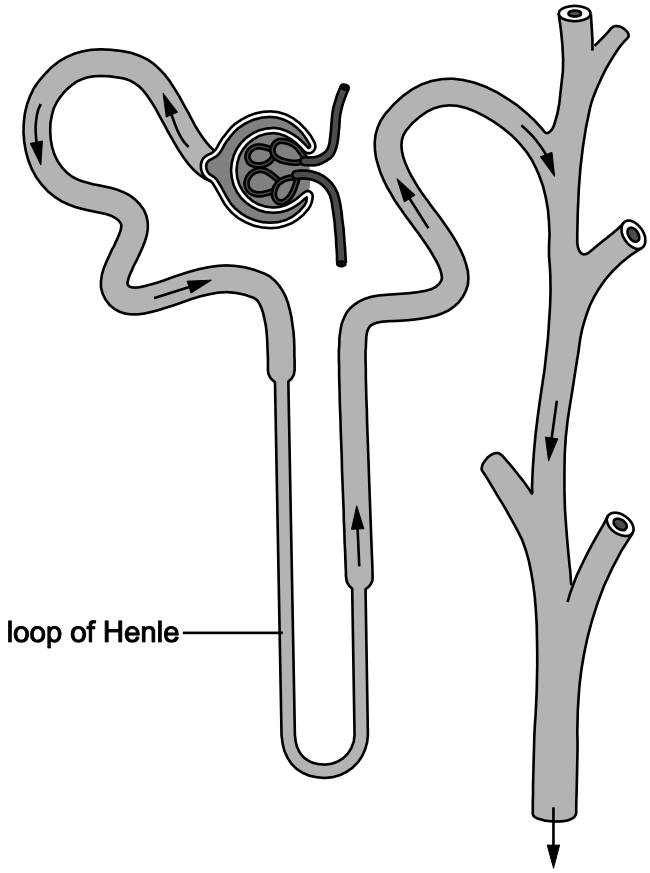

Fig. 33.1

(a) Explain how the loop of Henle performs its role in the production of urine.

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

(b) High blood pressure is a major cause of chronic kidney disease (CKD).

Progression of the disease can be slowed by controlling blood pressure. Enalapril is a drug used for this purpose.

The blood pressure of a CKD patient during treatment with enalapril is shown in Fig. 33.2.

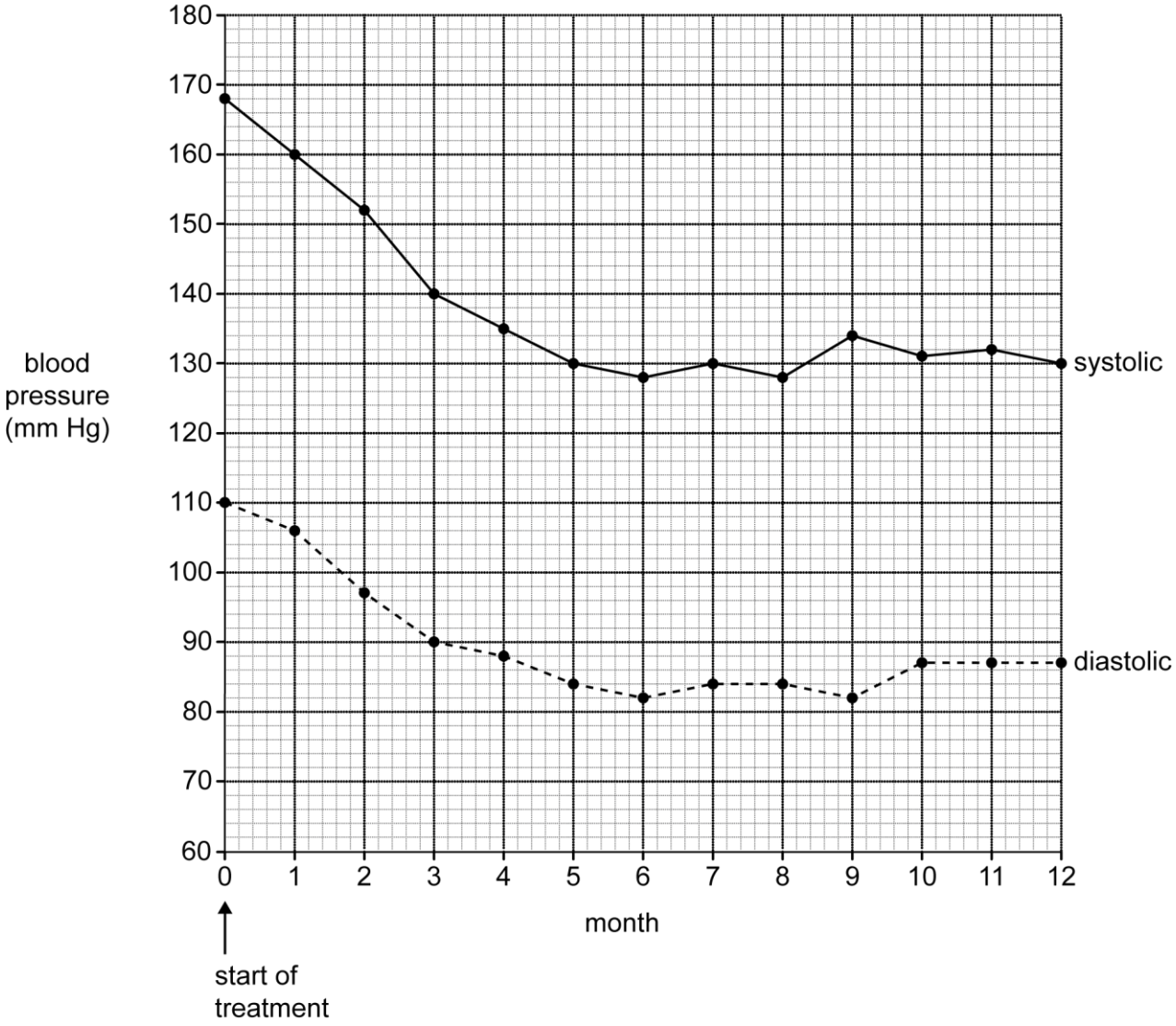

Fig. 33.2

(i) Calculate the percentage decrease in **diastolic** blood pressure after the first **three** months of treatment. Show your working.

Answer = ... % **[2]**

(ii) Outline how blood pressure can be measured manually.

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

(c) Glomerular filtrate rate (GFR) is a measure of renal function.

High urinary protein levels and reduced GFR have independently been associated with an increased risk of death among patients with CKD.

A study was conducted to determine the combined influence of urinary protein level and GFR on the risk of death.

Data were drawn from 331 hospital admissions of patients with CKD. Death risk was recorded as the percentage of patients who died within a year of their CKD evaluation on admission to hospital.

The results are shown in Fig. 33.3.

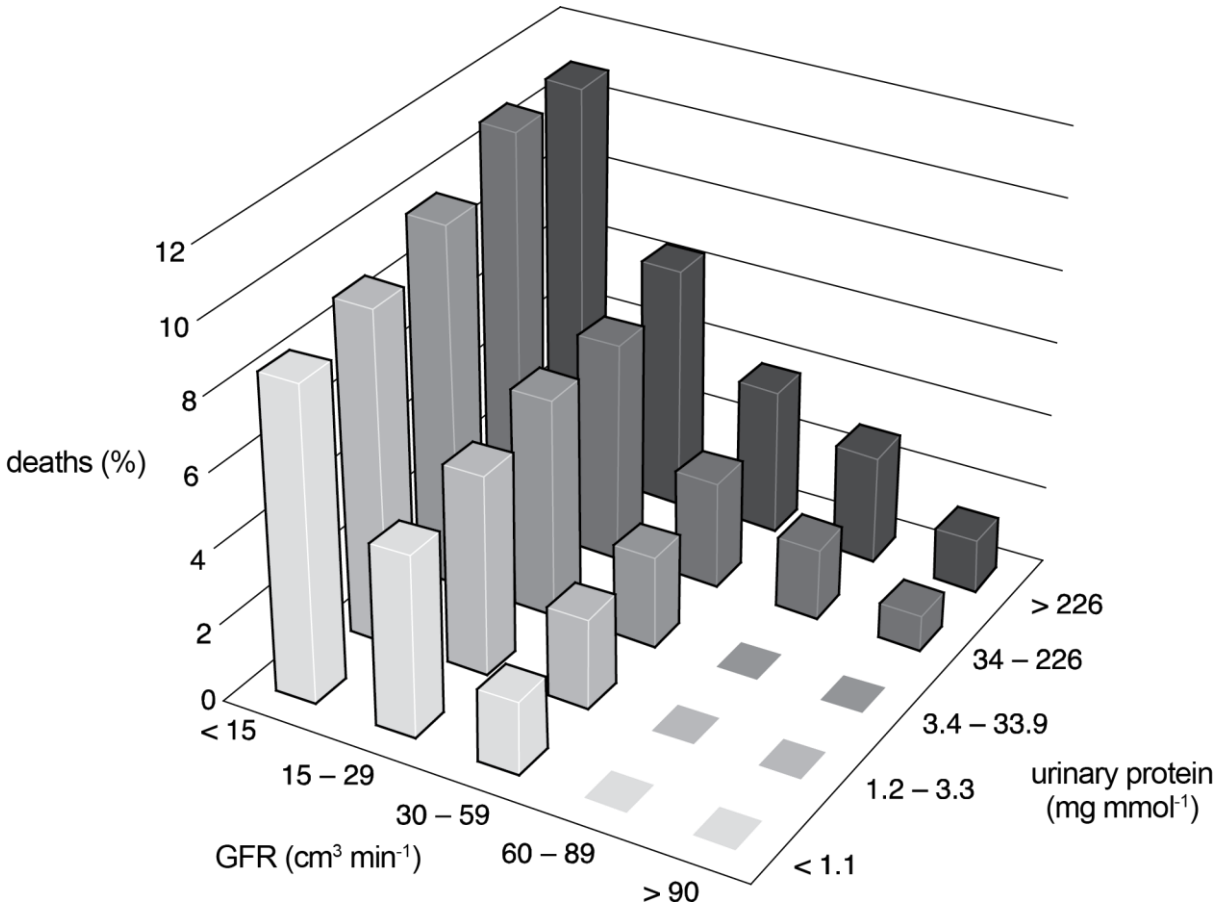

Fig. 33.3

(i) Using the data in **Fig. 33.3**, comment on the apparent influence of urinary protein level **and** GFR on the risk of death in patients with CKD.

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

(ii) Discuss the **validity** of the conclusions that could be drawn from the study described.

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

(iii) Suggest **one** way in which the study could be improved.

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

34 A population of nitrogen-fixing bacteria was isolated from a root nodule of the leguminous plant, *Pisum sativum*.

The bacteria were then cultured *in vitro* and viewed using an electron microscope.

The resulting photomicrograph is shown in Fig. 34.1.

Magnification 32 000x

Fig. 34.1

(a) (i) Name the **genus** of nitrogen-fixing bacteria seen in Fig. 34.1.

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

(ii) Calculate the **actual** width of the bacterium labelled **X**. Show your working.

Answer = ... µm **[2]**

(b) (i) Iron is essential for the activity of the nitrogen-fixing enzyme, nitrogenase.

Iron is present as ions in soil water but is not taken up by root nodules directly.

Describe how iron ions in soil water reach the root nodules.

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

(ii) *P. sativum* provides the nitrogen-fixing bacteria with a four-carbon molecule that can be oxidised to produce oxaloacetate and reduced NAD.

State the metabolic pathway in which oxaloacetate is an intermediate.

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

(c)* Farmers provide nitrates to crops in the form of chemical fertilisers. However, excess nitrates can pollute nearby lakes and streams, interrupting their ecosystems.

Cyanobacteria are aquatic organisms. Scientists have genetically engineered a species of cyanobacteria to produce an enzyme that generates luminescence (light) in the presence of nitrate (NO_3^-). This strain is termed a **biosensor**.

A dilution series of known nitrate concentrations was prepared. Each nitrate sample was mixed with the biosensor and the emission of light was recorded using a light meter.

The standard curve produced from the dilution series is shown in Fig. 34.2.

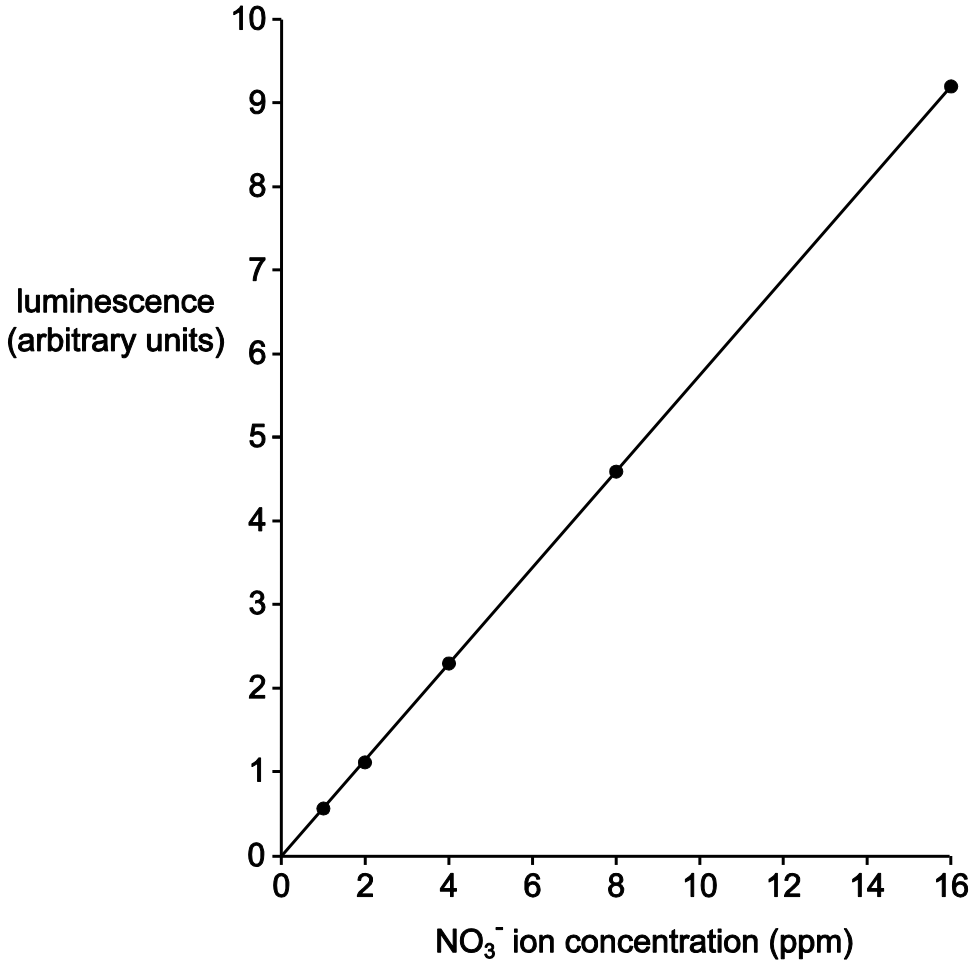

Fig. 34.2

A NO_3^- ion concentration **greater** than **10 ppm** is regarded as harmful to aquatic ecosystems.

Using the information provided, discuss how the biosensor could be used to provide **valid** data for **monitoring** the concentration of nitrates in a lake or stream.

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

35 Follicle-stimulating hormone (FSH), gonadotropin-releasing hormone (GnRH) and luteinising hormone (LH) have a role in the development and release of female gametes.

FSH is a globular protein. Fig. 35.1 shows another typical globular protein.

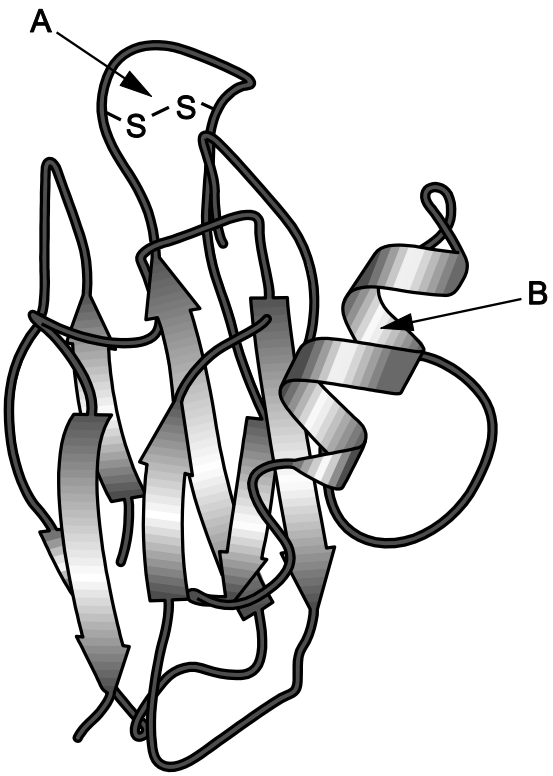

Fig. 35.1

(a) (i) Identify **and** describe the structural features labelled **A** and **B** in Fig. 35.1.

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

(ii) FSH is a glycoprotein.

After synthesis, the polypeptides of FSH are folded in the lumen of the endoplasmic reticulum.

Describe how FSH is processed further and then secreted from a pituitary cell.

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.....

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

Question 35 continues on page 32

(b) Mice with a knockout of the gene encoding GnRH are infertile.

A study was carried out with GnRH-knockout mice to compare the effectiveness of two treatments for infertility.

Three groups each containing five females were treated from birth with weekly injections of:

- sodium chloride (**S**)
  or
- synthetic FSH and LH (**FL**)
  or
- synthetic GnRH (**G**).

The mice treated with sodium chloride were used as controls.

One fertile male was housed with each group of **five** females. Fertility was measured as the number of successful pregnancies (becoming pregnant and producing young) for each female (1 to 5) over the course of 120 days.

The results are shown in Table 35.1.

Treatment group	Number of successful pregnancies						
	Mouse 1	Mouse 2	Mouse 3	Mouse 4	Mouse 5	Mean	Standard deviation
S (control)	0	0	0	0	0	0	0.0
FL	2	6	7	1	5	4.2	
G	3	1	2	2	1	1.8	0.8

Table 35.1

(i) Explain why a knockout of the gene encoding GnRH causes infertility in female mice.

.....

.....

.....

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

(ii) Using the formula provided, calculate the standard deviation for the data in the **FL** treatment group in Table 35.1.

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

Standard deviation = ...**[2]**

(iii) Using your standard deviation and the data in **Table 35.1**, evaluate the relative effectiveness of the two hormone treatments for the restoration of fertility in GnRH-knockout mice.

.....

.....

.....

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

(iv) State **one** variable that should have been controlled during this investigation to ensure the **validity** of the conclusions.

.....

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

36 Fig. 36.1 shows the structure of a mitochondrion.

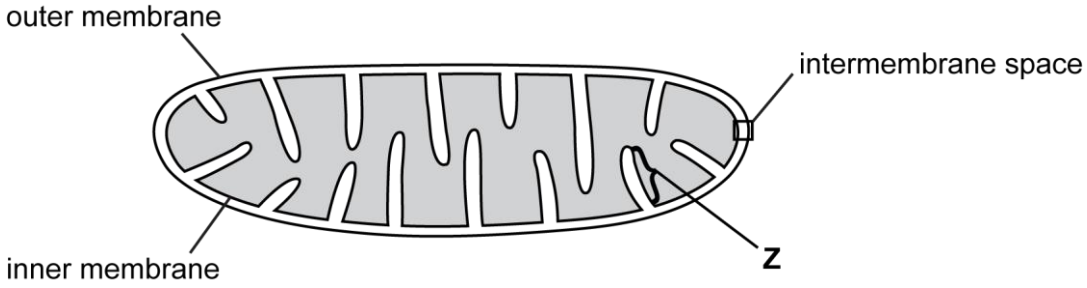

Fig. 36.1

(a) (i) Identify **Z** in Fig. 36.1 **and** outline its role in the function of the mitochondrion.

.....

.....

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

(ii) State the importance of the intermembrane space for mitochondrial function.

.....

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

(b) The paragraph below, extracted from a biology textbook, is about the role of cytochrome C and the mitochondrion in the process of apoptosis.

Cytochrome C is an electron carrier in the electron transport chain.

The mitochondrion plays a role in apoptosis, as follows:

- Proteins are inserted into the outer membrane of the mitochondrion.
- The proteins assemble to form large, open pores through which protons can diffuse.
- Cytochrome C moves out of the intermembrane space and into the cytoplasm.
- Cytochrome C activates proteins that mediate apoptotic events.

Questions **(b) (i)** to **(iii)** should be answered using the information in the paragraph and your knowledge of respiration.

(i) Explain why chemiosmosis stops during apoptosis.

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

(ii) Suggest why the electron transport chain is interrupted during apoptosis.

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

(iii) Suggest why apoptosis has **no** effect on the oxidation of reduced NAD and reduced FAD.

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

37 Coronaviruses are a large family of viruses, some of which can infect the human respiratory system.

In 2002, a coronavirus caused an outbreak of Severe Acute Respiratory Syndrome (SARS) in China. Within several months, outbreaks were reported in a further 36 countries and the incidence rates were tracked.

Table 37.1 shows data for cases of SARS in four countries between November 2002 and June 2003.

Country	Number of cases	Number of deaths
Canada	251	41
China	5237	349
Singapore	238	33
Taiwan	665	180

Table 37.1

(a) (i) What is meant by the term incidence rate?

.....

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

(ii) Suggest reasons why **valid** conclusions relating to incidence and mortality **cannot** be made from the data in Table 37.1.

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

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Question 37 continues on page 38

(b) Middle East Respiratory Syndrome (MERS) is caused by another type of coronavirus.

An outbreak of MERS was reported in South Korea in 2015.

Fig. 37.1 shows the **cumulative** data relating to this outbreak.

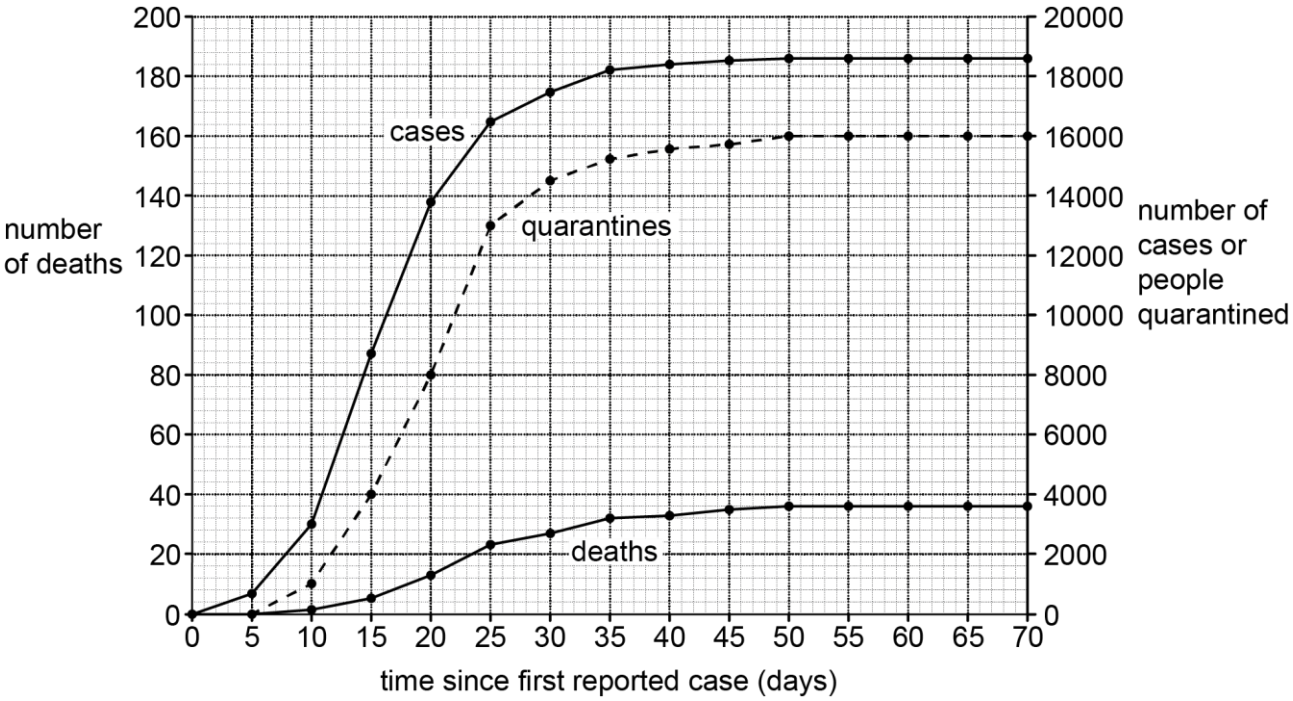

Fig. 37.1

(i) Quarantine data are shown as the dashed line in Fig. 37.1.

Calculate the **approximate rate** at which people were quarantined between **day 10** and **day 25**.

Answer = ... people/day **[2]**

(ii) Analyse the data shown in Fig. 37.1 **and** evaluate the effectiveness of quarantine on preventing further cases of MERS.

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer 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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