OCR
Oxford Cambridge and RSA

Thursday 5 June 2025 – Afternoon

A Level Biology B (Advancing Biology)

H422/01 Fundamentals of biology

Time allowed: 2 hours 15 minutes

You must have:
- a ruler (cm/mm)

You can use:
- a scientific or graphical calculator

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name *StemUp Model Solution*

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **110**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **44** pages.

ADVICE
- Read each question carefully before you start your answer.

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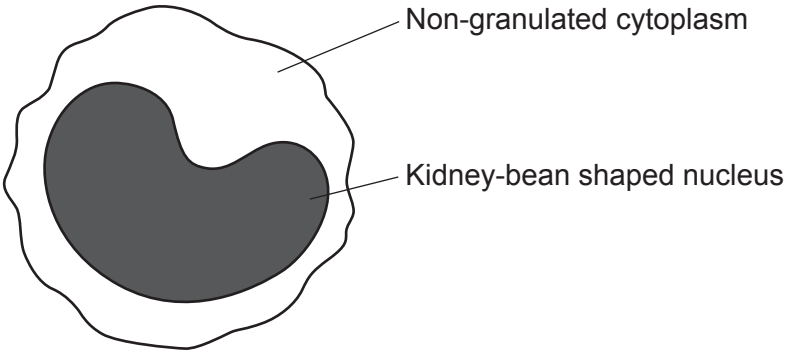
Section A

You should spend a **maximum** of **40 minutes** on this section.

Write your answer for each question in the box provided.

1 Which type of blood cell is shown in the annotated drawing?



A Erythrocyte

B Lymphocyte

C Monocyte

D Neutrophil

Your answer C **[1]**

2 Which technique uses fluorescent markers to tag cells so they can be counted and identified when passed through a laser beam?

A Differential staining

B Flow cytometry

C Gel electrophoresis

D Haemocytometry

Your answer B **[1]**

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3 Which statement about ATP is **not** correct?

A It can be hydrolysed to form AMP.

B It contains the pentose sugar, ribose.

C It contains the pyrimidine nitrogenous base, adenine.

D It is a phosphorylated nucleotide.

Your answer C **[1]**

4 The percentage base composition of DNA from a species of octopus is shown in the table.

Base	**Adenine**	**X**	**Y**	**Z**
% base composition of DNA	33.2	17.6	17.5	31.7

Which option correctly identifies bases **X**, **Y** and **Z**?

A Base **X** is cytosine, **Y** is guanine and **Z** is thymine.

B Base **X** is cytosine, **Y** is guanine and **Z** is uracil.

C Base **X** is thymine, **Y** is cytosine and **Z** is guanine.

D Base **X** is uracil, **Y** is cytosine and **Z** is guanine.

Your answer A **[1]**

5 A student calculated cardiac output (CO) using the equation:

CO = heart rate × stroke volume.

What unit of measurement is appropriate for cardiac output?

A bpm cm^{-3}

B cm^3 bpm

C dm^{-3} min^{-1}

D dm^3 min^{-1}

Your answer D **[1]**

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6 Which of the following statements about the advantages of a closed circulatory system is/are correct?

1 Deoxygenated and oxygenated blood are separated.

2 Higher blood pressure is maintained in both pulmonary and systemic circuits.

3 Low blood volumes can maintain movement in the circulatory system.

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 B **[1]**

7 Alveoli are structures found in the mammalian gaseous exchange system.

Which cells would be present in the walls of alveoli?

A Ciliated epithelial cells

B Goblet cells

C Muscle cells

D Squamous epithelial cells

Your answer D **[1]**

8 The surface area provided by a single alveolus is approximately 300 000 μm^2.

A person was estimated to have 250 million alveoli in each lung.

What is the estimated gas exchange surface area in m^2 for this person?

A 7.5×10^1

B 1.5×10^2

C 7.5×10^7

D 1.5×10^8

Your answer B **[1]**

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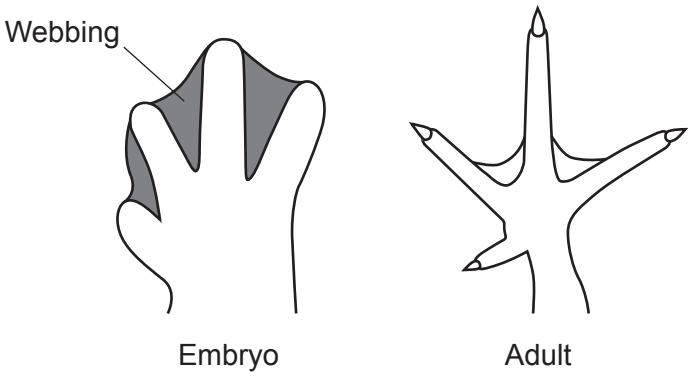
9 The diagram shows the feet of a chicken embryo and an adult chicken.



What process ensures that webbing between the toes of the chicken is removed during development?

A Apoptosis

B Cytokinesis

C Differentiation

D Mitosis

Your answer A **[1]**

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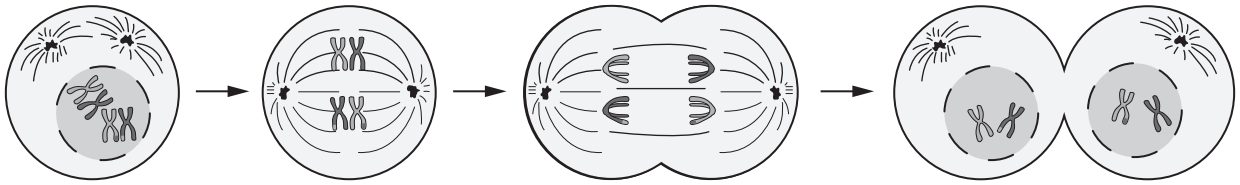
10 The diagram shows four consecutive phases of meiosis in an animal cell.



Phase 1 Phase 2 Phase 3 Phase 4

Which of the following statements is/are correct?

1 The cell is undergoing the first meiotic division.

2 Chiasmata formation starts taking place during phase 2.

3 Independent assortment of chromosomes is taking place during phase 1.

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 D **[1]**

11 Evolutionary relationships between species can be shown using phylogenetic trees.

Which statement about phylogenetic trees is correct?

A Branches for extant species end before the present day.

B Nodes at branching points represent common ancestors.

C Species with the most recent common ancestors have more distant evolutionary relationships.

D They cannot be constructed from fossil evidence.

Your answer B **[1]**

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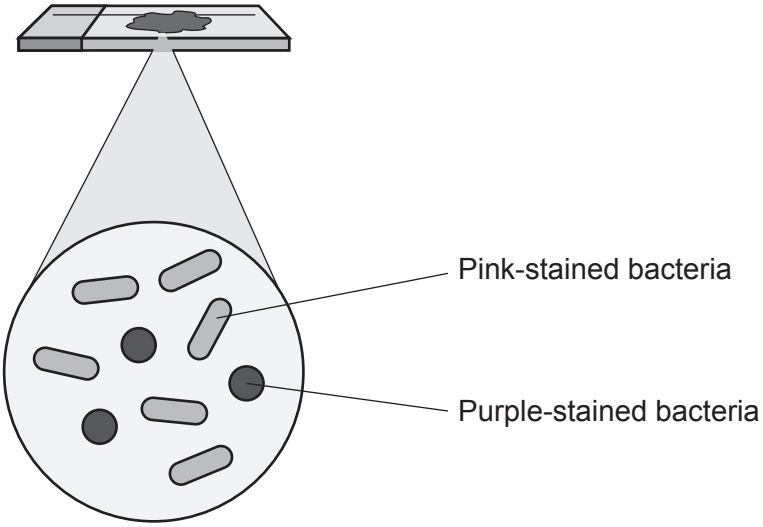
12 The diagram shows bacterial colonies after Gram-staining procedure.



Which statement about the Gram-staining procedure is correct?

A The purple-stained bacteria are Gram positive as the safranin counterstain bound to their thick cell walls.

B The purple-stained bacteria are Gram negative as crystal violet-iodine stain bound to their thick cell walls.

C The pink-stained bacteria are Gram positive as safranin counterstain bound to their thin cell walls.

D The pink-stained bacteria are Gram negative as safranin counterstain bound to their thin cell walls.

Your answer D **[1]**

13 Amoxicillin is an antibiotic that can be used to treat bacterial infections in young children.

A one-year-old child with a mass of 10 kg requires 40 mg kg^{-1} of amoxicillin per day to treat an ear infection.

The amoxicillin is provided in a suspension of 400 mg per 5 cm^3 and is given to the child in twice daily doses.

What is the correct dose of amoxicillin given to the child?

A 0.25 cm^3

B 0.50 cm^3

C 2.50 cm^3

D 5.00 cm^3

Your answer C **[1]**

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14 A patient is undergoing treatment for a brain tumour. The treatment accurately targeted and destroyed the actively growing cells in the tumour by damaging their DNA.

What therapy is used to treat the patient's brain tumour?

A Chemotherapy

B Hormone-related therapy

C Immunotherapy

D Radiotherapy

Your answer D **[1]**

15 Which disease is **not** an example of a chronic condition?

A Asthma attack

B Bowel cancer

C Emphysema

D Lung cancer

Your answer A **[1]**

16 Which molecule is used to donate electrons to the electron transport chain during oxidative phosphorylation?

A ADP

B ATP

C Reduced NAD

D Reduced NADP

Your answer C **[1]**

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17 An athlete used carbohydrate loading prior to a race to enhance their performance.

The athlete has a body mass of 75 kg and consumed 1100 g of carbohydrates over two days prior to the race.

What mass of carbohydrates was consumed each day per kg of body mass?

A 7.3 g

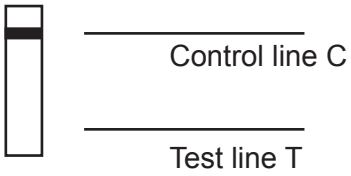
B 14.7 g

C 68.2 g

D 136.4 g

Your answer A **[1]**

18 The diagram shows the result of a pregnancy test. The test was carried out using a pregnancy testing kit containing monoclonal antibodies.



Which of the following statements is/are correct?

1 A negative result is shown by this pregnancy test.

2 At test line T there are no antibodies with hCG attached to bind to the immobilised antibodies.

3 At control line C antibodies with hCG attached bind to the immobilised antibodies.

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 B **[1]**

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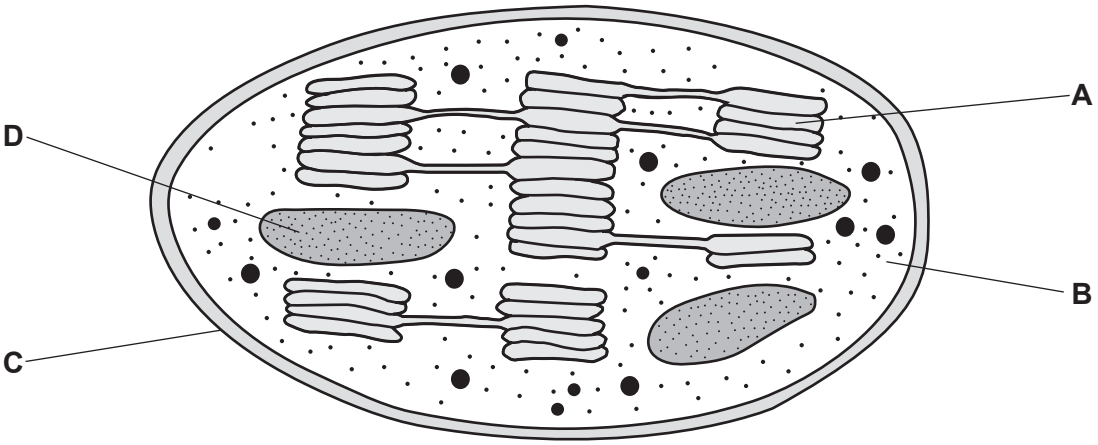
19 The diagram shows the ultrastructure of a chloroplast.



What is the site of light-independent reactions?

Your answer B **[1]**

20 A student uses paper chromatography to separate a mixture of photosynthetic pigments.

The student allows the solvent to run 6.5 cm up the paper.

They measure the distance travelled by carotene pigment and calculate the R_f value of carotene as 0.95.

What is the distance measured by the student to the nearest mm for carotene?

A 6

B 7

C 62

D 68

Your answer C **[1]**

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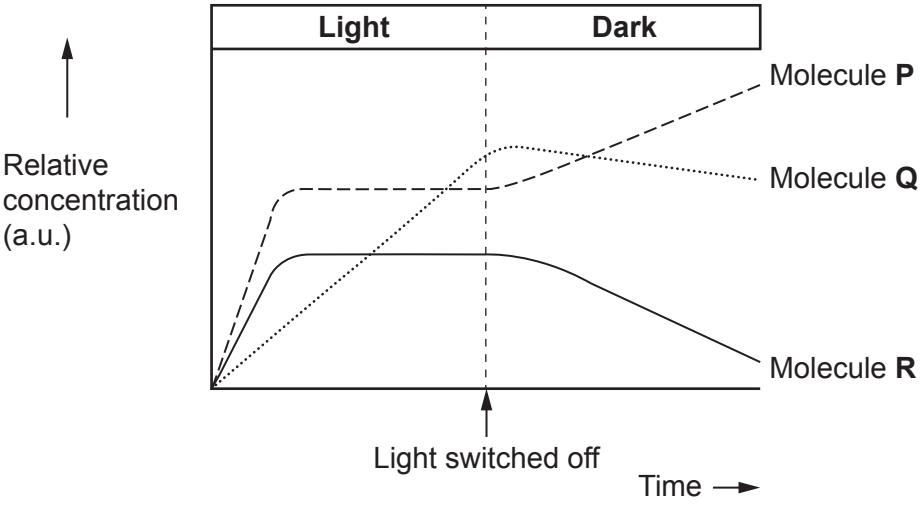
21 The diagram shows the results of an investigation into the effect of periods of light and dark on photosynthesising cells.

The relative concentrations are shown for glucose, glycerate-3-phosphate (GP) and ribulose bisphosphate (RuBP) over time.

These have been labelled on the diagram as molecules **P**, **Q** and **R**.



The table shows possible identities for molecules **P**, **Q** and **R**.

	Molecule **P**	Molecule **Q**	Molecule **R**
A	glucose	GP	RuBP
B	GP	RuBP	glucose
C	GP	glucose	RuBP
D	RuBP	glucose	GP

Which row is correct?

Your answer C **[1]**

22 Which of the following factors will **not** directly affect the size of the human global population?

A Advances in medical technology

B Control of communicable disease

C Food security

D Immigration

Your answer D **[1]**

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23 A group of students were investigating the effect of temperature on the germination of cress seeds.

Ten cress seeds were placed in a Petri-dish containing wet cotton wool. The Petri-dish was then placed in an incubator at 5 °C and observed for signs of germination.

This procedure was repeated for incubation temperatures of 10, 15, 20 and 25 °C.

What is the most appropriate dependent variable for this investigation?

A Number of seeds germinating in 48 hours.

B Temperature of each incubator.

C Time taken for all ten seeds to germinate.

D Volume of water used to soak the cotton wool in each Petri-dish.

Your answer A **[1]**

24 A sequence of nucleotide bases in a DNA coding strand is shown below.

TCA-TGG-CTG-GGC-CTC-GCC-TCC

Which of the following statements is/are correct?

1 A substitution mutation of A would result in a change to subsequent triplet codes.

2 A substitution mutation of A could result in the same sequence of amino acids.

3 A deletion mutation of A will result in frameshift change to the sequence.

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 C **[1]**

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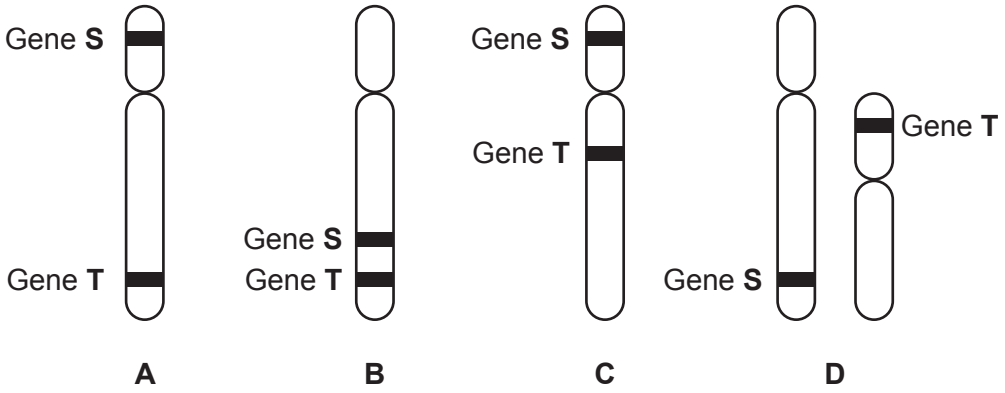
25 The diagrams of chromosomes show the positions of genes **S** and **T**.



Which of the diagrams shows autosomal linkage of genes **S** and **T** that would be most likely to result in them being inherited together?

Your answer B **[1]**

26 Cicadas are large insects. Two species of cicada live in the same habitat. Members of the two species are capable of interbreeding.

- The breeding season of one species occurs every 13 years.
- The breeding season of the other species occurs every 17 years.

Which of the following statements is/are correct?

1 The two species are reproductively isolated.

2 The two species are geographically isolated.

3 The cicadas are actually two populations because they can still interbreed.

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 D **[1]**

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27 The Hardy-Weinberg principle uses the two equations below.

$p + q = 1.0$

$p^2 + 2pq + q^2 = 1.0$

Which statement about the Hardy-Weinberg equations is correct?

A p is the frequency of the recessive allele.

B p^2 is the frequency of the dominant allele.

C q^2 is the frequency of the homozygous recessive phenotype.

D q^2 is the frequency of the homozygous recessive genotype.

Your answer D **[1]**

28 The retina is a light-sensitive layer in the eye.

Which option describes a feature of the retina?

A It has cone cells that contain vesicles of the light-sensitive pigment, rhodopsin.

B It has highly pigmented cells to prevent internal reflection.

C It has photoreceptor cells that convert light energy to chemical energy.

D It has rod cells to allow colour vision.

Your answer C **[1]**

29 Which statement about the methods of measuring core body temperature is correct?

A Axillary measurements are most accurate because the thermometer placed under the armpit is close to the blood supply of the thermoregulatory system.

B Axillary measurements are always much higher than actual core body temperature.

C Oral measurements are most accurate because the thermometer is placed under the tongue.

D Tympanic measurements are most accurate because the thermometer is placed near the eardrum which shares a blood supply with the thermoregulatory system.

Your answer D **[1]**

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30 There are two types of diabetes mellitus, type I and type II.

Which option is true for both type I **and** type II diabetes mellitus?

A If left untreated, they result in the presence of glucose in the urine.

B They are caused by destruction of β cells in the liver.

C They are caused by reduced sensitivity of β cells to insulin.

D They are known as insulin-dependent diabetes.

Your answer A **[1]**

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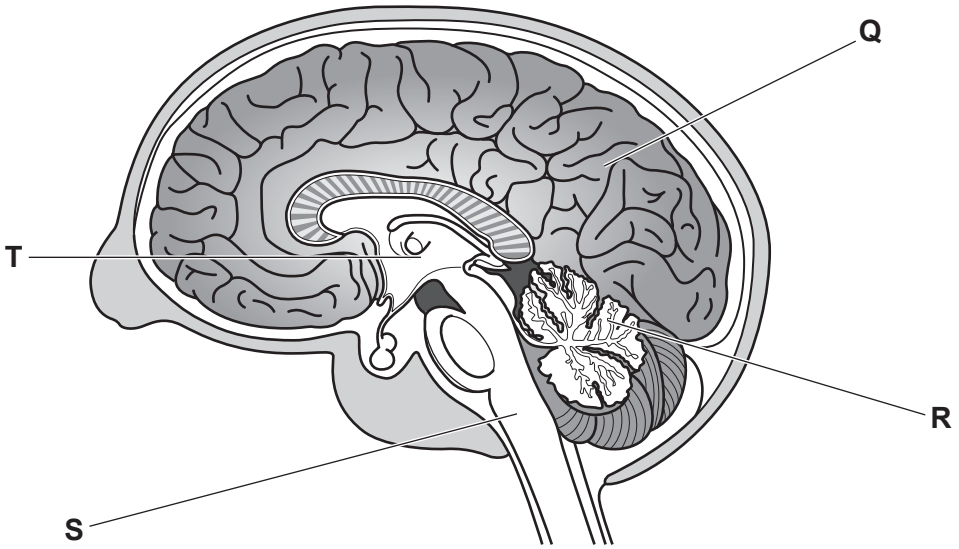
Section B

31 The human brain is divided into structures which have specific functions.

This is a diagram of a section through the human brain. Some structures of the brain have been labelled.



(a) Use the diagram to complete the table about some of the structures of the human brain and their functions.

Structure	Function	Letter
Cerebellum	Coordination of muscle movement and balance	R
Medulla oblangata	Controls activities such as heart rate and blood pressure.	S
Hypothalamus	Thermoregulation and osmoregulation (homeostasis)	T

[3]

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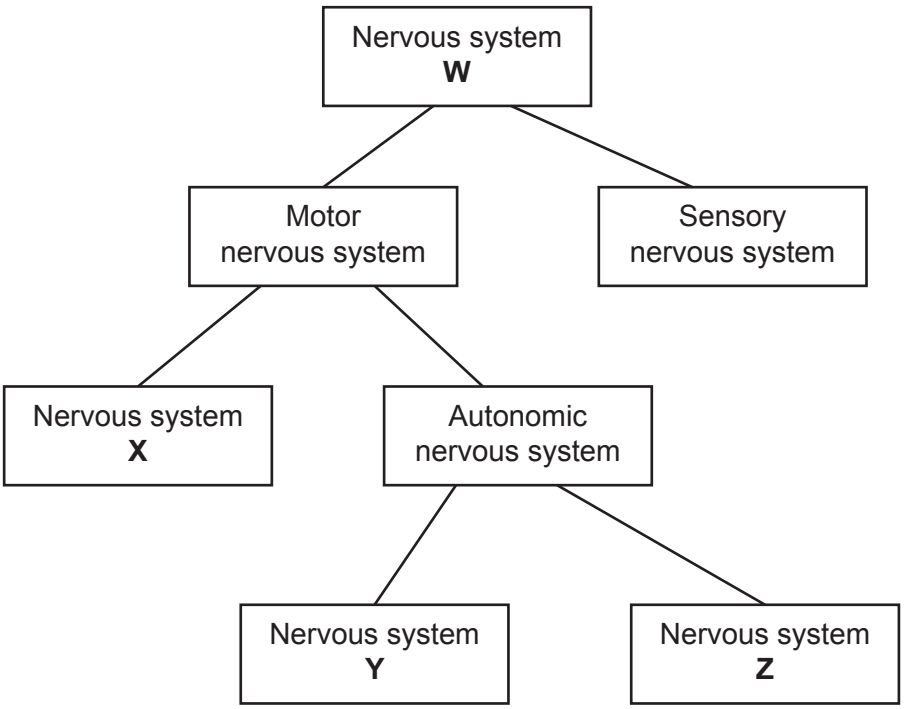
(b) A group of students are making revision notes about nervous control in humans.

One of the students draws the flow diagram below showing the organisation of part of the nervous system in humans.



(i) Identify nervous systems **W** and **X** in the flow diagram.

W peripheral nervous system

X somatic nervous system

[1]

(ii) In the autonomic nervous system, motor neurons carry impulses to smooth muscle and endocrine glands, whereas in nervous system **X** impulses are carried to skeletal muscles.

Using your knowledge, state **two other** ways in which the autonomic nervous system differs from nervous system **X**.

1 The autonomic system has two neurones (with a ganglion) linking the CNS to the effector, whereas X has only one.

2 The autonomic system uses two neurotransmitters, acetylcholine and noradrenaline, whereas X uses only acetylcholine.

[2]

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(iii) The branches of the autonomic nervous system, **Y** and **Z**, are antagonistic.

Using your knowledge and an appropriate example(s), explain how this feature helps to maintain a constant internal environment.

Y and Z are the sympathetic and parasympathetic nervous systems, which have opposite effects on the same effector, so they act by negative feedback. The parasympathetic system is active during rest and relaxation, whereas the sympathetic system is active in stressful (fight or flight) situations. For example, the sympathetic system increases heart rate and the parasympathetic system slows it, so heart rate is returned to normal. Similarly the sympathetic system dilates the bronchioles and the parasympathetic constricts them. So any change can be reversed, keeping conditions close to the set point.

[3]

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32 Mothers infected with the human immunodeficiency virus (HIV) are usually discouraged from breastfeeding as the virus can be transmitted from mother to baby during breastfeeding.

(a) Apart from breastfeeding, suggest **and** explain **one other** way in which HIV can be transmitted from an HIV-positive mother to their baby.

During birth: the mother's blood comes into contact with the baby's blood, so HIV in the mother's blood can enter the baby.

[2]

(b) The role of breastfeeding in providing temporary immunity against other diseases is recognised as being extremely beneficial to newborn babies.

In 2010, the World Health Organisation (WHO) issued guidelines recommending the breastfeeding of babies born to HIV-positive mothers for at least one year, using antiretroviral therapy (ART) to minimise the risk of transmission.

(i) Name the type of immunity acquired by breastfeeding.

Natural passive immunity **[1]**

(ii) ART involves taking a combination of medicines every day. These medicines often include an inhibitor of the enzyme reverse transcriptase.

Explain how this inhibitor can minimise the risk of HIV transmission.

HIV cannot reverse transcribe its RNA to produce viral DNA (cDNA), so viral DNA cannot be integrated into the host cell DNA. So viral proteins cannot be produced and the virus cannot replicate, so less virus is present in the mother's body fluids (milk) to be transmitted.

[2]

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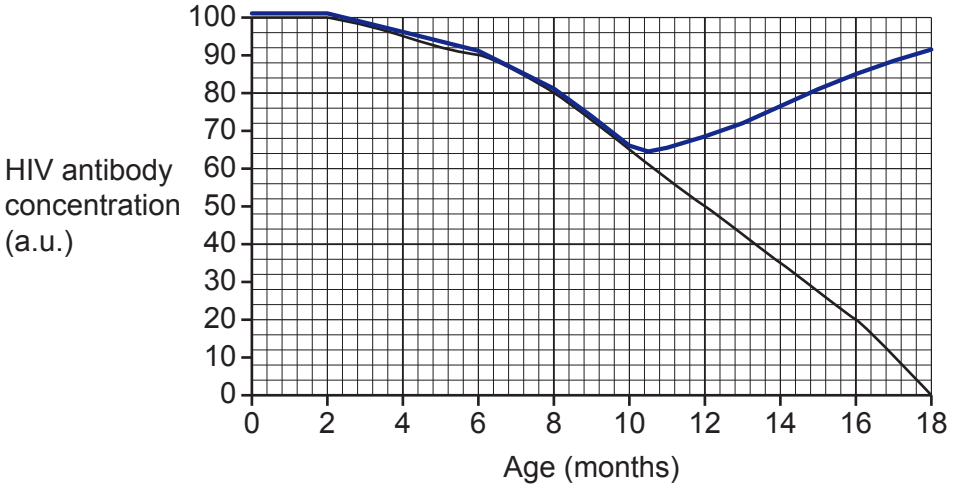
(c) HIV testing can be used to determine the presence of HIV.

The graph shows the results for an HIV-exposed baby who is born without HIV infection and remains uninfected throughout breastfeeding.



(i) Outline a method used to test for HIV infection.

A blood test (e.g. finger prick) or a rapid, point of care test, such as an ELISA.

This detects HIV antibodies or the HIV antigen p24 in the blood.

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

(ii) Calculate the mean rate of decrease in HIV antibody concentration, per day, for the first year after being exposed to HIV.

Give your answer to **2** significant figures.

At 0 months = 100 a.u.; at 12 months = 50 a.u.

Decrease = 50 a.u. in 365 days

50 ÷ 365 = 0.137 a.u. per day

Mean rate = ...0.14..... a.u. per day **[2]**

(iii) Sketch a line **on the graph** to suggest the expected HIV antibody concentration for an HIV-exposed baby who is **not** infected with HIV at birth but was infected during breastfeeding at 10 months of age.

[1]

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(iv) Research shows that HIV testing cannot be used to definitively diagnose infection in young babies and that babies under 18 months of age may record a false-positive test for HIV infection.

Explain why a false-positive test may be recorded in babies under 18 months of age.

The baby has the mother's HIV antibodies in its blood, which crossed the placenta (or came from breast milk), so the test detects these even though the baby is not infected. **[1]**

(d)* Developing a vaccine that can prevent HIV infection in uninfected people is the highest HIV research priority given its potential for controlling and ultimately ending the HIV/AIDS pandemic.

Discuss the biological **and** ethical issues associated with the development and use of vaccines for preventing diseases such as those caused by HIV infection.

Biological issues in development: pathogens such as HIV have a high mutation rate, so there is variation in the surface antigens (viral protein coat) and new strains appear. Antibodies already produced may no longer bind to the new antigens, as with new strains of the influenza virus, so a vaccine may only be effective in one geographical location.

Sterile conditions are needed during development and production, to avoid contamination with live pathogens. Ethical issues in development: vaccines are tested on animals, and development is time-consuming with high costs.

Biological issues in use: some vaccines use live (attenuated) pathogens. Storage and transport are difficult, as refrigeration is hard for some countries, and poor diets weaken immune systems so the vaccine may not be effective for some people.

Ethical issues in use: unknown side-effects, parental consent for childhood vaccines, the right to refuse, and data protection.

So these issues must be overcome before a vaccine can control the pandemic. **[6]**

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Extra answer space if required.

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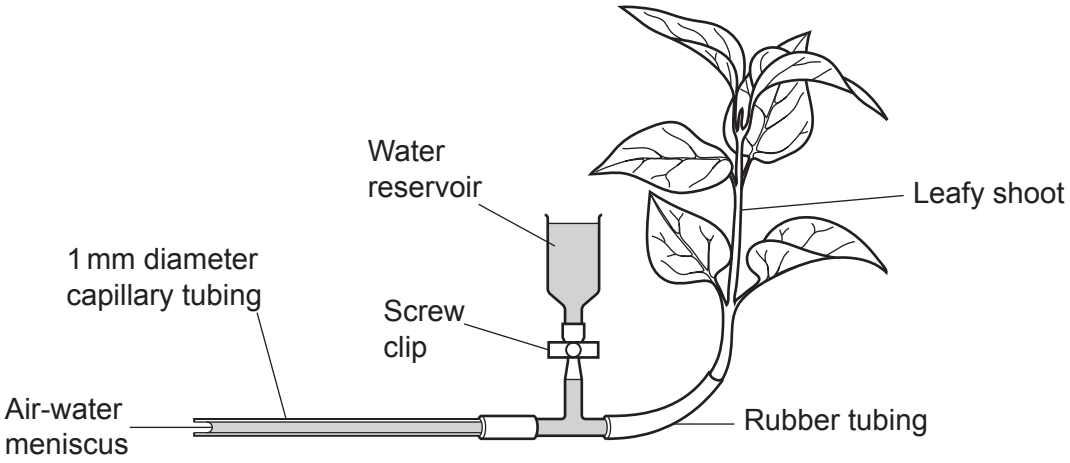
33

(a) The diagram shows the apparatus used to estimate the rate of transpiration in plants.



(i) A student wants to use the apparatus to investigate the effect of wind speed on the rate of transpiration.

Explain **two** modifications to the apparatus that will enable the student to obtain data and estimate the rate of transpiration in their investigation.

1 Use a fan at a set speed, moved to different distances from the plant (measured with a metre ruler), to change wind speed.

2 Place a ruler alongside the capillary tubing to measure the distance moved by the meniscus in a set time.

[2]

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(ii) This is the raw data recorded by the student.

Results after 30 minutes

20 cm	1) 15 mm Mean = 15.0	2) 16 mm	3) 14 mm
40 cm	1) 13 mm Mean = 13.0	2) 14 mm	3) 12 mm
60 cm	1) 10 mm Mean = 9.3	2) 9 mm	3) 9 mm
80 cm	1) 8 mm Mean = 7.3	2) 7 mm	3) 7 mm
100 cm	1) 5 mm Mean =	2) 6 mm	3) 4 mm

In the space below present the data in a suitable table with appropriate headings.

Include the missing mean value in your table.

Distance from fan / cm	Distance moved by meniscus in 30 minutes / mm			
	Trial 1	Trial 2	Trial 3	Mean
20	15	16	14	15.0
40	13	14	12	13.0
60	10	9	9	9.3
80	8	7	7	7.3
100	5	6	4	5.0

[4]

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(iii) Use the information from the student's investigation and the equation below to estimate the mean rate of transpiration from the results at 20 cm.

Use the formula: Volume of cylinder = $\pi r^2 h$

Radius = 1 ÷ 2 = 0.5 mm; h = mean distance moved = 15.0 mm

Volume in 30 min = $\pi \times 0.5^2 \times 15.0 = 11.78$ mm^3

Rate per hour = 11.78 × 2 = 23.6

Mean rate of transpiration = ...23.6..... mm^3hr^{-1} **[2]**

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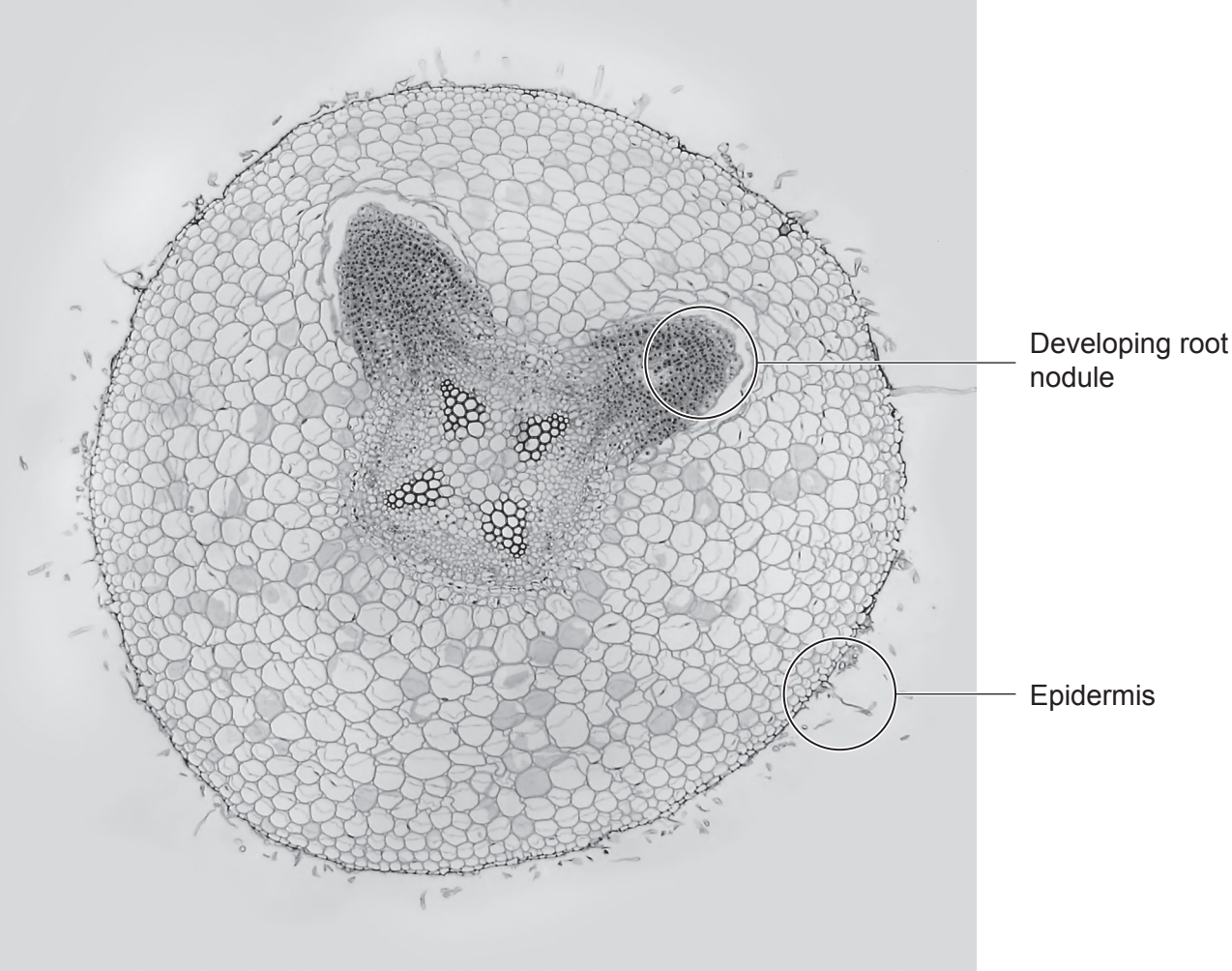
(b) Plant species take in water through their roots.

This is a photomicrograph of a transverse section through a root of a soybean plant.



(i) Use the photomicrograph to identify whether the soybean plant is classified as dicotyledonous or monocotyledonous. Explain your choice.

Dicotyledonous, because the xylem is in the centre (core) of the root and forms an X (star) shape.

Also, the entire vascular tissue is surrounded by an endodermis.

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

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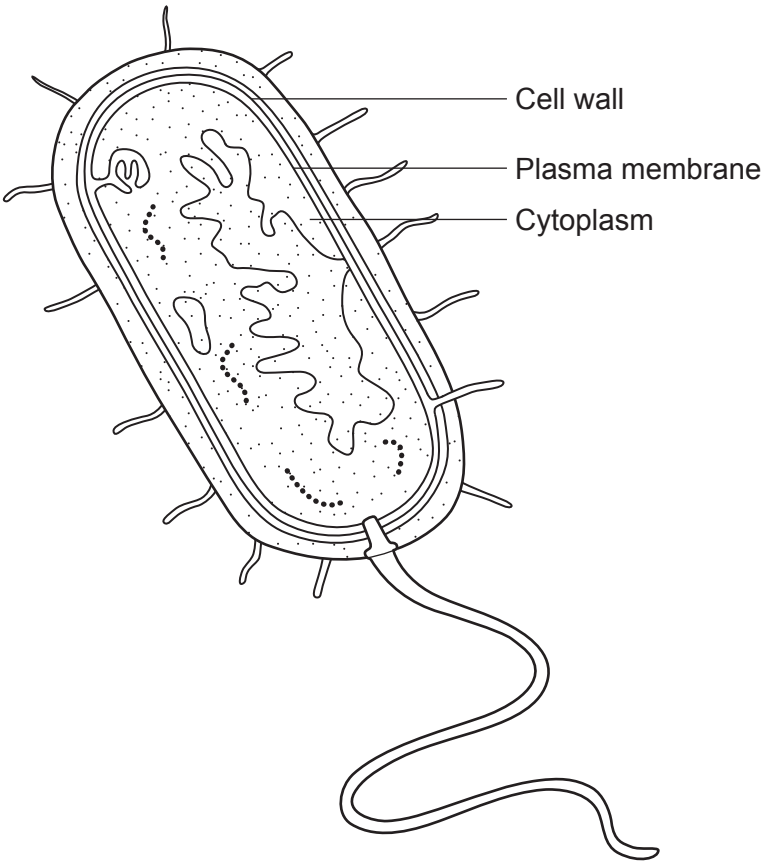
(ii) The diagram below shows a type of cell that was extracted from the developing root nodule labelled in the photomicrograph.



Discuss the similarities and differences in structure between this cell and a root hair cell extracted from the epidermis labelled in the photomicrograph.

Similarities: both cells have a cell wall, a plasma membrane, cytoplasm and ribosomes.

Differences: the root hair cell is eukaryotic but the nodule cell is a prokaryote (bacterium). The root hair cell has its DNA inside a nucleus with histones, whereas the bacterium has naked circular DNA in the cytoplasm. The root hair cell has membrane-bound organelles such as mitochondria; the bacterium has none.

The root hair cell wall is made of cellulose, not peptidoglycan (murein). The root hair cell has 80S ribosomes rather than 70S, and has no plasmids and no flagellum, which the bacterium has. **[4]**

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(c) Explain how soybean plants benefit from having root nodules.

Root nodules contain nitrogen-fixing bacteria (Rhizobium) in a mutualistic (symbiotic) relationship.

The plant gains nitrogen directly, used to make amino acids for protein synthesis, so it does not have to rely on nitrates from the soil.

[2]

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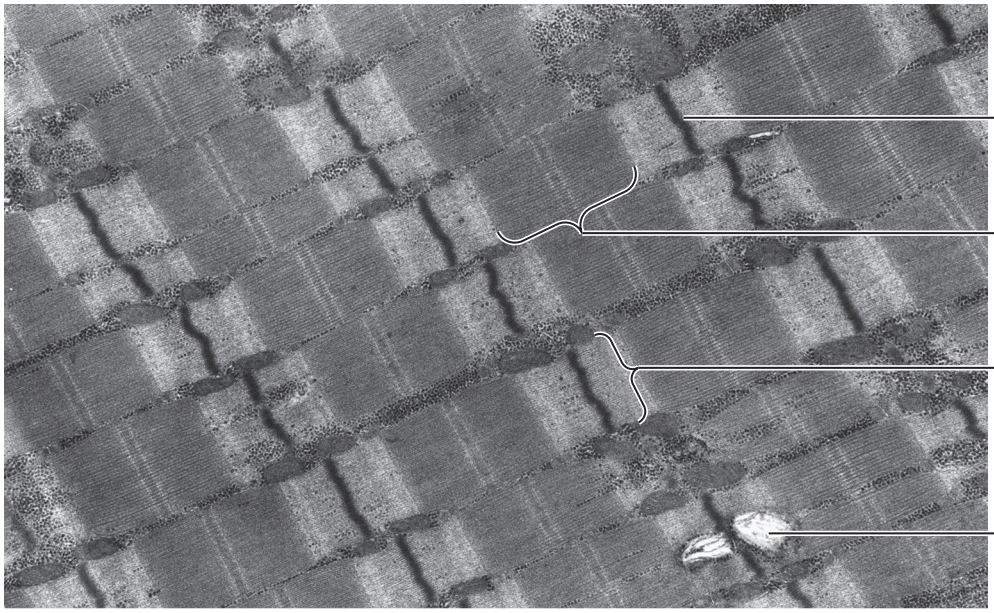
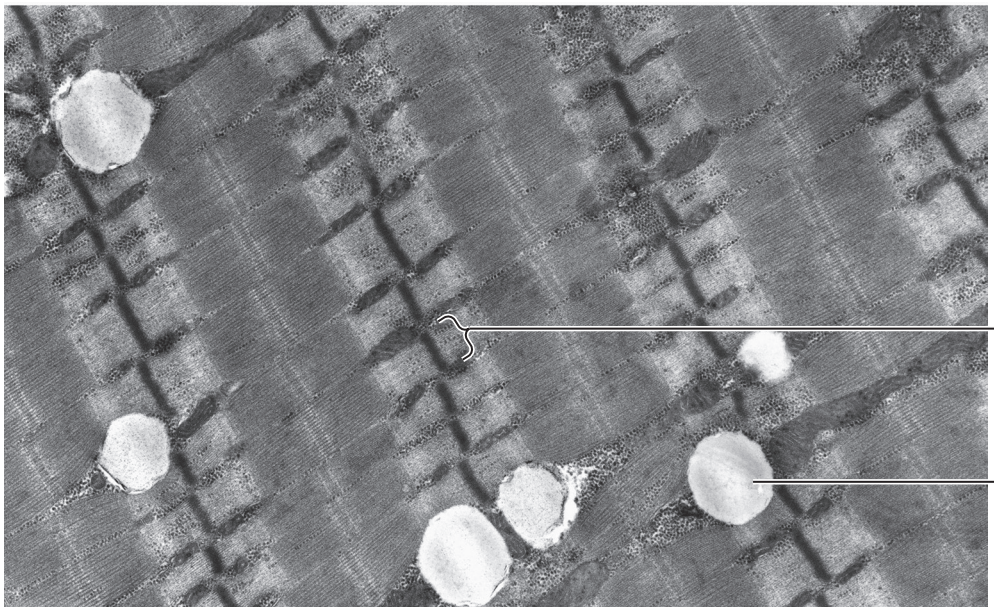
34 Researchers investigating the effects of spaceflight on skeletal muscle prepared samples of muscle tissue for viewing under a transmission electron microscope (TEM).

The two photomicrographs show samples of skeletal muscle taken from an astronaut before and after spaceflight.

Before spaceflight



After spaceflight



Magnification = 10 000×

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(a) The banded pattern shown in the photomicrographs is formed by the arrangement of protein filaments in myofibrils. Some parts of the banded pattern have been labelled on one of the micrographs.

(i) Identify the parts of the banded pattern labelled **E** and **F**.

E Z line

F A band

[2]

(ii) The same myofibril has been labelled **G** on both micrographs.

Calculate the actual diameter of myofibril **G before spaceflight**.

Image diameter of G = 13 mm = 13 000 μm

Actual = 13 000 ÷ 10 000 = 1.3 μm

Diameter = 1.3 μm **[2]**

(iii) Spaceflight is thought to limit the production of RNA in cells.

Explain how limiting RNA production may result in the change to myofibrils seen after spaceflight.

Myofibrils consist of proteins, actin and myosin. With less RNA (mRNA) produced, there is less transcription of DNA and so less translation (protein synthesis). So old, damaged or worn muscle fibres are not replaced, and the diameter (width) of the myofibrils decreases after spaceflight.

[3]

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(iv) Suggest reasons for the changes to fat droplets in the samples of skeletal muscle taken before and after spaceflight.

The number and size of the fat droplets increase after spaceflight. This may be due to muscle degradation (atrophy), with lipids produced instead of protein. Also, the reduction in width of the myofibrils means the fat droplets have space to increase in size.

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

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(b)* The photomicrographs were obtained using a transmission electron microscope (TEM). The researchers also obtained photomicrographs of the skeletal muscle using a light microscope and a scanning electron microscope (SEM).

They stated that the TEM micrographs would be better than both other types of microscopes for studying the protein filaments in the skeletal muscle.

Evaluate this statement.

Supporting, TEM compared with the light microscope: TEM has a much higher magnification and higher resolution, as electrons have a shorter wavelength than light, so individual protein filaments (actin and myosin) and organelles can be seen, which a light microscope cannot resolve.

Supporting, TEM compared with SEM: TEM has a higher resolution, the 2D images produced are easy to interpret, and the inner structures of the myofibrils (bands and filaments) can be seen more clearly, as electrons pass through the thin section.

Not supporting, compared with the light microscope: TEM needs a complex staining procedure, artefacts may occur during preparation, it has high costs and needs very thin samples, and the samples are dead so living muscle contraction cannot be seen.

Not supporting, compared with SEM: TEM does not give detail of the muscle surface or composition, and cannot produce 3D images, whereas SEM produces 3D images; TEM also needs thin samples. **[6]**

Extra answer space if required.

So TEM is better for studying the internal protein filaments, but SEM is better for surface features.

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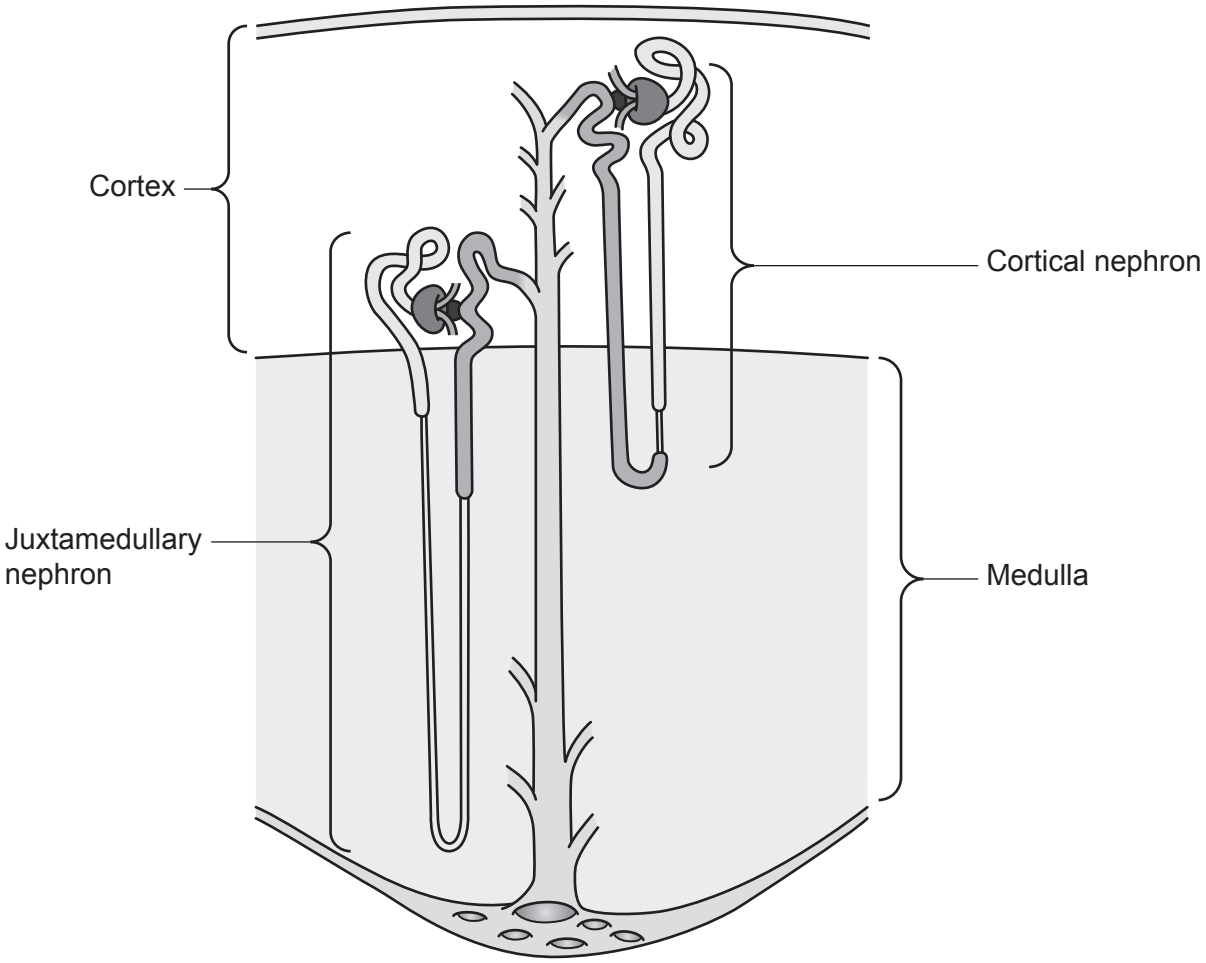
35 The diagram shows two types of nephron found in the mammalian kidney.



(a) Ultrafiltration occurs in both types of nephron.

(i) Complete the sentences about how structures in the nephron are adapted for ultrafiltration.

Blood enters the glomerulus via the afferent ..arteriole..... . Endothelial cells lining the glomerulus are separated by narrow gaps, called .fenestrations....., that prevent blood cells leaving the blood. In addition, the .basement..... ...membrane..... of the glomerulus provides a mesh of glycoprotein and collagen to prevent the escape of large plasma proteins. Cells lining the Bowman's capsule, called ..podocytes....., have finger-like extensions to create small gaps for filtration.

[4]

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(ii) Suggest which of the nephrons has a main function in concentrating urine **and** give a reason for your choice.

The juxtamedullary nephron, because its loop of Henle is longer and extends further into the medulla. **[1]**

(iii) In human adults, approximately 85% of nephrons are cortical nephrons.

Calculate the total number of juxtamedullary nephrons present in a human adult with an average of 900 000 nephrons per kidney.

Total nephrons = 900 000 × 2 = 1 800 000

Juxtamedullary = 15% × 1 800 000 = 270 000

Total = 270 000 **[1]**

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(b) Patients with kidney failure need long-term dialysis therapy.

Haemodialysis (HD) and peritoneal dialysis (PD) are the two main forms of dialysis. There are advantages and disadvantages with both HD and PD, but the focus for doctors when choosing dialysis therapy for their patients is survival rate.

However, recent studies show that a priority for patients on long-term dialysis is maintaining their quality of life.

In one study, data was collected using questionnaires given to dialysis patients every 6 months over an 18-month period. Patients were asked to give a score of between 1 and 10 for questions relating to how they felt their dialysis treatment affected the different areas of their life.

The table is an analysis of some of the data showing the mean score with standard deviation shown in brackets for three different categories.

	6 months		**12 months**		**18 months**	
	HD	**PD**	**HD**	**PD**	**HD**	**PD**
Sexual function	7.03 (3.25)	7.45 (3.01)	6.85 (3.02)	7.50 (2.80)	6.12 (3.09)	7.52 (3.15)
Sleep disturbance	6.82 (1.95)	6.90 (1.83)	6.71 (2.02)	6.95 (1.91)	6.65 (1.75)	6.72 (1.80)
Ability to work	2.52 (3.28)	3.70 (3.74)	2.50 (3.35)	3.70 (3.85)	2.37 (3.15)	3.20 (3.80)

(i) State **one** conclusion that can be drawn from the data and outline **two** limitations of the method that could affect the validity of your conclusion.

Conclusion Sexual function was reported as being worse in HD patients than in PD patients, and it declined over time in HD.

Limitation 1 Subjective data were used (self-reported scores), and there is no information on whether 1 or 10 is high.

Limitation 2 No information about the sample size, age or gender of the participants, or whether all completed every questionnaire.

[3]

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(ii) Explain the importance of calculating standard deviation for the data.

Standard deviation measures the spread of the data around the mean (how close values are to the mean); the large values here show the scores are very variable. It can be used in a statistical test (e.g. to see if error bars overlap) to tell if differences are significant, and to assess the repeatability of the data.

[2]

(c) Transplant surgery is also used for kidney failure.

State **one** advantage and **one** disadvantage of transplant surgery.

Advantage Removes the need for dialysis, so improved quality of life and the patient can live independently.

Disadvantage Needs a suitable donor and there is a risk of rejection, so immunosuppressants must be taken.

[2]

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36 Pick's disease or frontotemporal dementia (FTD) is a rare form of dementia.

(a) Symptoms of FTD include memory loss and speech deficits. Studies of brain tissue from FTD patients show the presence of inclusions known as Pick bodies that are similar to the neurofibrillary tangles found in the brain tissue of patients with Alzheimer's disease (AD).

(i) Apart from memory loss and speech deficits, suggest **two other** symptoms that may be associated with FTD.

1 Mood changes (increased anxiety)

2 Confusion and difficulty in decision making

[1]

(ii) Using your knowledge of AD, suggest how the formation of Pick bodies may cause the symptoms associated with FTD.

Pick bodies are (tau) protein deposits, similar to the neurofibrillary tangles in AD, which form inside neurones.
These lead to damage and loss (death) of neurones in the brain, so impulses are not transmitted, causing the symptoms.

[2]

(b) Approximately 40% of patients with FTD reported a family history of dementia.

One group of researchers investigated the role of DNA methylation in the regulation of genes associated with a risk of developing FTD.

(i) Explain why DNA methylation is **not** described as a DNA mutation.

DNA methylation is an epigenetic change, where methyl groups are added to the DNA (cytosine bases).
There is no change to the nucleotide base sequence of the DNA, so the gene structure remains intact.
Methylation is also reversible, whereas a mutation is a permanent change in the base sequence.

[3]

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(ii) Describe the role of DNA methylation in the regulation of genes.

Methylation switches genes off; it prevents transcription, so it decreases gene expression.

[1]

(c) Different scanning techniques are used by researchers and doctors to observe brain tissue and assess damage caused by disease or injury.

Complete the table below by deciding whether the statements about the scanning techniques used to observe brain tissue are **True (T)** or **False (F)**.

Statement	**True (T) or False (F)**
Electrical impulses sent between neurons in the brain can be detected using EEG scans.	T
MRI scans do **not** use X-rays so are safer to use during pregnancy.	T
PET scans use X-rays to construct images of internal structures.	F

[3]

END OF QUESTION PAPER

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EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

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