Oxford Cambridge and RSA

Wednesday 5 June 2024 – Afternoon

A Level Biology B (Advancing Biology)

H422/01 Fundamentals of biology

Time allowed: 2 hours 15 minutes

You must have:
- the Insert (inside this document)
- 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 **40** pages.

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

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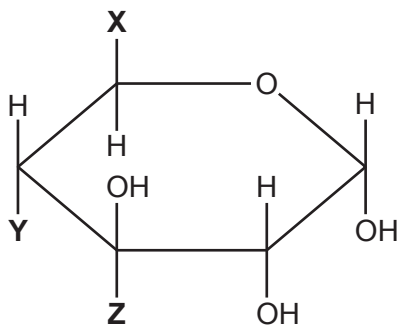
Section A

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

Write your answer for each question in the box provided.

1 The diagram shows a molecule of α-glucose.



The table below shows chemical groups **X**, **Y** and **Z** labelled on the diagram.

	Chemical group		
	X	**Y**	**Z**
A	OH	CH_2OH	H
B	CH_2OH	OH	H
C	H	OH	CH_2OH
D	H	CH_2OH	OH

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

Your answer B

[1]

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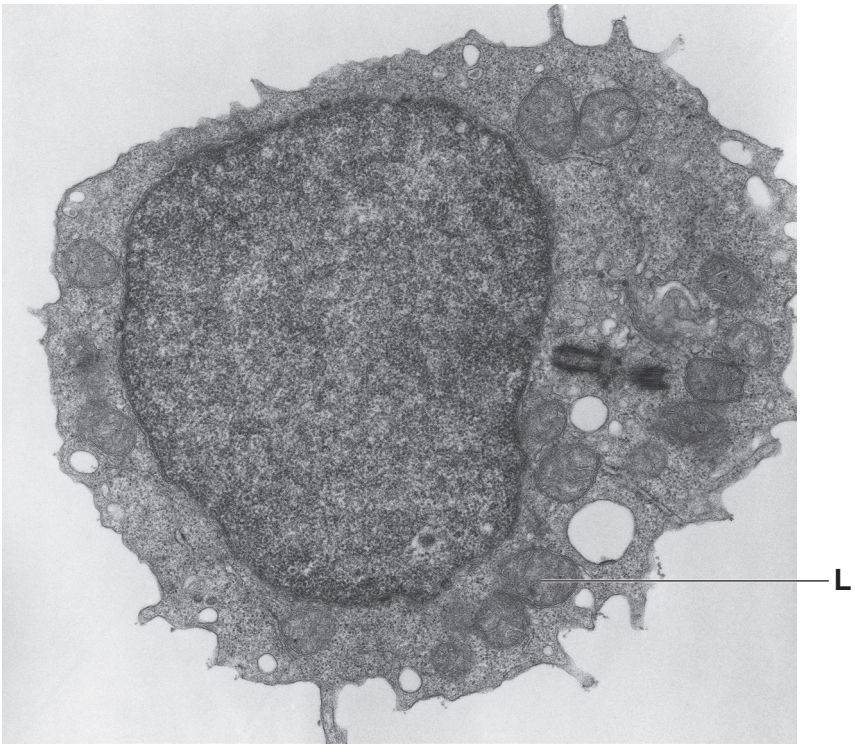
This is an electron micrograph of the ultrastructure of a leucocyte.



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Use the electron micrograph to answer questions **2** and **3**.

2 Which of the options identifies the leucocyte in the electron micrograph?

A Lymphocyte

B Macrophage

C Monocyte

D Neutrophil

Your answer A

[1]

3 What is the role of the organelle labelled **L**?

A Aerobic respiration

B Lipid synthesis

C Protein synthesis

D Transport

Your answer A

[1]

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4 Which of the statements about the blood clotting process is **not** correct?

A Fibrinogen fibres form a mesh to trap red blood cells.

B Platelets are activated and release thromboplastin.

C Thrombin hydrolyses a soluble plasma protein into insoluble protein fibres.

D Thromboplastin requires calcium ion cofactors.

Your answer A

[1]

5 The following statement describes a feature of the genetic code:

The same codon codes for the same amino acid in almost all species.

Which feature of the genetic code is being described?

A Degenerate

B Non-overlapping

C Triplet

D Universal

Your answer D

[1]

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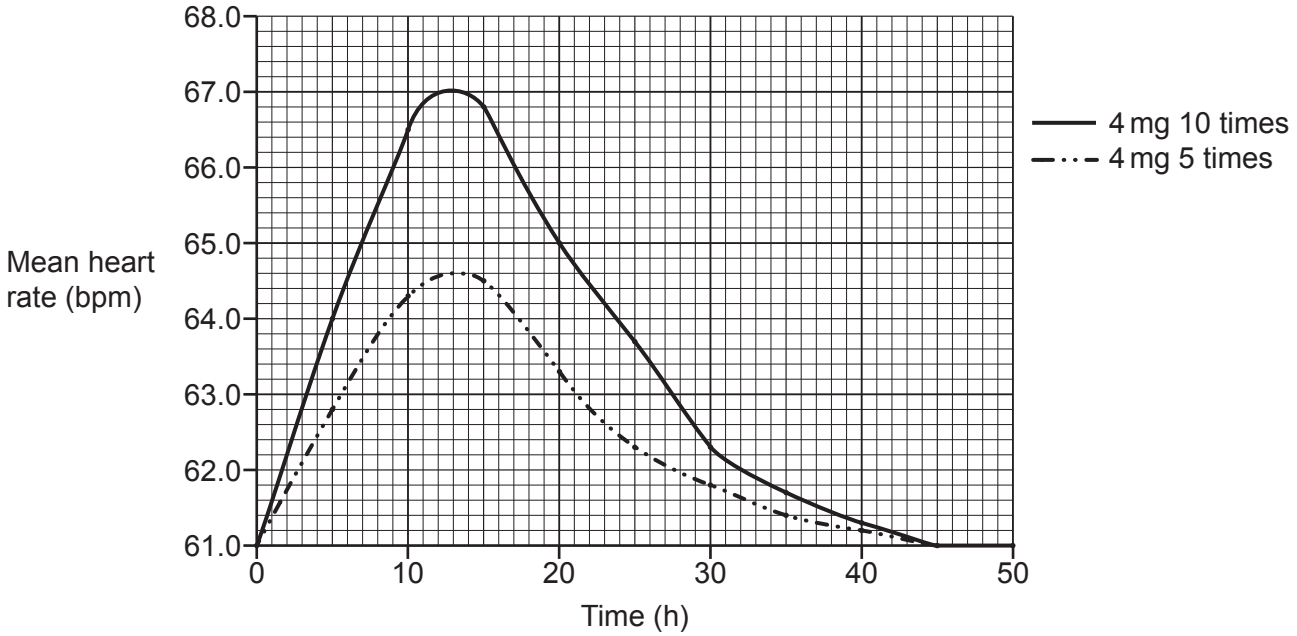
6 Researchers studied the effect of nicotine on heart rate.

Nicotine patches containing 4 mg of nicotine were placed on the skin of volunteers.

During the first day of the study, over a 10-hour period, ten volunteers were given a new nicotine patch every 2 hours and another ten volunteers were given a new nicotine patch every hour.

Each volunteer had mobile heart monitors that measured their heart rate automatically over a 48-hour period starting from the time they were given their first nicotine patch.

The graph shows data from the study.



Which of the following statements about these data is/are correct?

1 Mean heart rate of volunteers given 10 nicotine patches increased and decreased at a faster rate.

2 Mean heart rate of both groups started to decrease immediately after the last nicotine patch had been given.

3 Mean heart rate of volunteers given 10 nicotine patches reaches a maximum in a shorter time.

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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7 What would result in an increase in the formation of tissue fluid?

A Decrease in hydrostatic pressure at arteriole end of capillary

B Decrease in hydrostatic pressure at venule end of capillary

C Increase in hydrostatic pressure at arteriole end of capillary

D Increase in oncotic pressure at arteriole end of capillary

Your answer C

[1]

8 Which of the statements about the transport of water in the apoplast pathway is correct?

A The apoplast pathway is only used to move water from root hair cells to xylem.

B Water is blocked by the Casparian strip.

C Water is transported between cells through plasmodesmata.

D Water is transported from cell to cell through the cytoplasm.

Your answer B

[1]

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9 The sentences below are about the events in apoptosis.

Inside the cell the nucleus shrinks in a process called .....**1**..... . The cytoskeleton and the nucleus are then broken down and the .....**2**..... changes to form blebs. The cell fragments are packaged into .....**3**..... and engulfed by .....**4**..... .

Which of the rows, **A** to **D**, shows the correct words to complete the sentences?

	1	**2**	**3**	**4**
A	karyorrhexis	cell surface membrane	vesicles	macrophages
B	karyorrhexis	cytoplasm	vacuoles	neutrophils
C	pyknosis	cell surface membrane	vesicles	macrophages
D	pyknosis	cytoplasm	vesicles	neutrophils

Your answer C

[1]

10 Mitosis and meiosis occurs during gametogenesis.

Which of the cells produced during gametogenesis is diploid?

A Ovum

B Secondary oocyte

C Spermatid

D Spermatogonium

Your answer D

[1]

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11 Hormone replacement therapy (HRT) is used to relieve the symptoms of menopause.

What is **not** an advantage of taking HRT during menopause?

A Preventing hot flushes

B Reduced risk of osteoporosis

C Reduced risk of stroke

D Reduction in mood swings

Your answer C

[1]

12 Hormones control events that take place during the human menstrual cycle.

Which hormone results in ovulation and stimulates the formation of a corpus luteum?

A Follicle-stimulating hormone

B Luteinising hormone

C Oestrogen

D Progesterone

Your answer B

[1]

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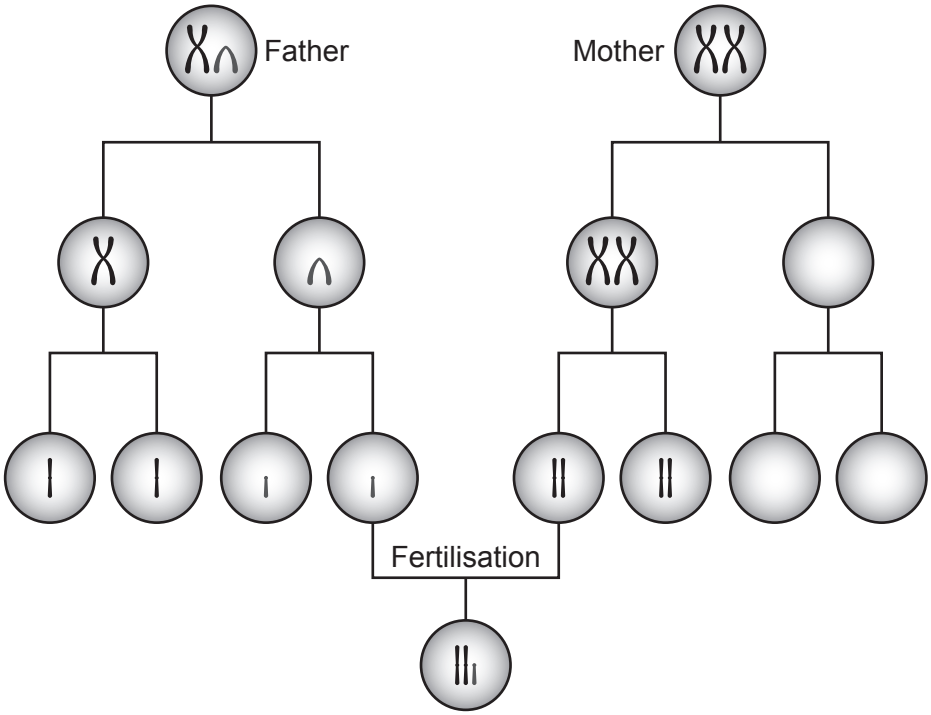
13 The diagram shows how a chromosome mutation results in a child having a syndrome.



Which of the statements about the diagram is correct?

A Non-disjunction occurs resulting in a child with Klinefelter's syndrome.

B Non-disjunction occurs resulting in a child with Turner's syndrome.

C Translocation occurs resulting in a child with Klinefelter's syndrome.

D Translocation occurs resulting in a child with Turner's syndrome.

Your answer A

[1]

14 Which of the statements about different respiratory pigments is correct?

A Adult haemoglobin has a higher affinity for oxygen than fetal haemoglobin.

B Myoglobin has a lower affinity for oxygen than adult haemoglobin.

C The dissociation curve of fetal haemoglobin is shifted to the left of the adult haemoglobin curve.

D The dissociation curve of myoglobin is shifted to the right of the adult haemoglobin curve.

Your answer C

[1]

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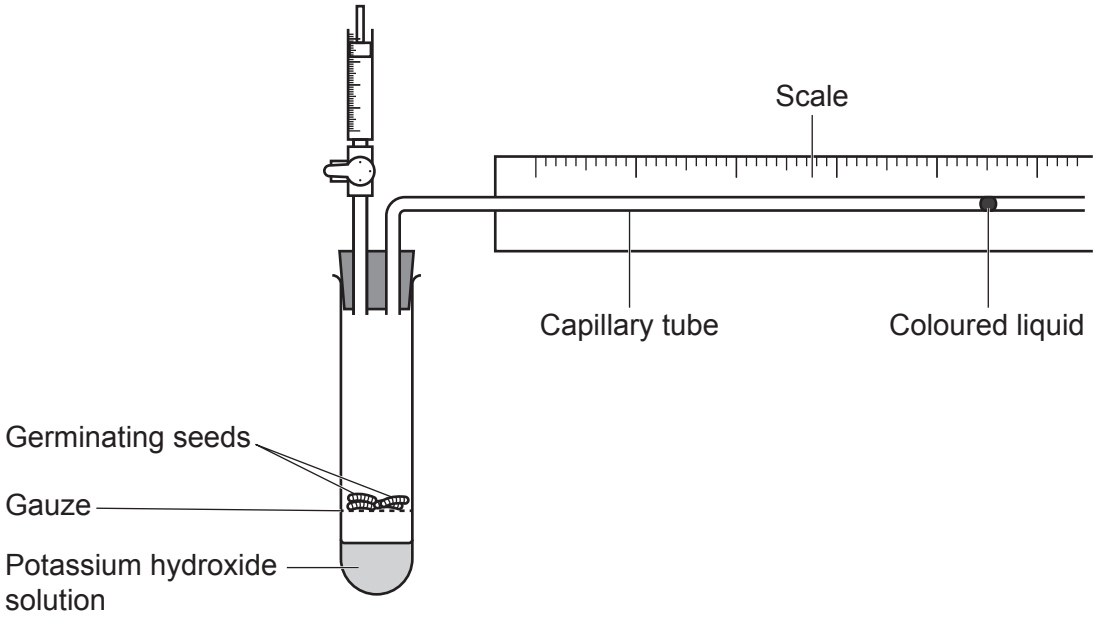
15 The diagram shows a piece of apparatus used in an investigation.



Which of the statements about the apparatus is correct?

A It is a potometer used to measure water uptake.

B It is a respirometer used to measure carbon dioxide uptake.

C It is a respirometer used to measure oxygen uptake.

D It is a spirometer used to measure oxygen uptake.

Your answer C

[1]

16 Which of the following statements about oxidative phosphorylation is/are correct?

1 Electrons passing down electron transport chains release energy for ATP production.

2 It occurs in both chloroplasts and mitochondria.

3 Protons are pumped through ATP synthase to provide energy to phosphorylate ADP.

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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17 Which of the options is a F.I.T.T. factor that is considered when designing fitness programmes?

A Age

B Exercise duration

C Gender

D VO_2 max

Your answer B

[1]

18 Which of the following statements about the control of heart rate is/are correct?

1 Cardiovascular control centre is located in the medulla oblongata.

2 Parasympathetic nervous system decreases heart rate when high blood pressure is detected.

3 Sympathetic nervous system increases heart rate in times of stress.

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 A

[1]

19 Which technique uses X-rays to construct images of internal structures to assess damage to the brain?

A Computed tomography (CT)

B Electroencephalography (EEG)

C Magnetic resonance imaging (MRI)

D Positron emission tomography (PET)

Your answer A

[1]

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20 Scientists studying the effect of Alzheimer's disease on the human brain found Tau protein filaments forming tangles with an average diameter of 3.3×10^{-9} m.

Which of the measurements is the diameter of the tangle in nm?

A 0.0000000033

B 3.3

C 3300

D 330 000

Your answer B

[1]

21 Which statement about the Calvin cycle is correct?

A ATP is produced using reduced NADP.

B GP is converted to TP using reduced NADP.

C Reduced NADP is produced using ATP.

D TP is converted to GP using reduced NADP.

Your answer B

[1]

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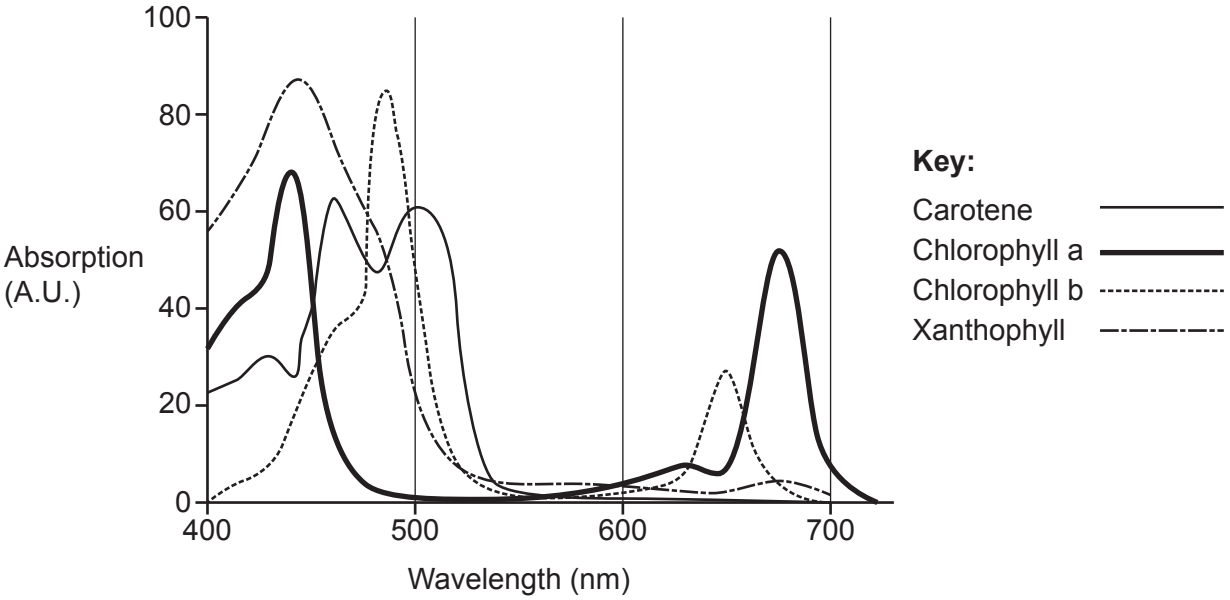
22 The diagram shows absorption spectra for different photosynthetic pigments.



Which of the following statements is/are correct?

1 Carotene appears red or orange in colour because it does not absorb red light wavelengths.

2 Chlorophyll a has the highest percentage absorption of red light wavelengths.

3 Xanthophyll is a primary pigment because it has the highest percentage absorption of blue light wavelengths.

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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23 Knockout mice are developed as model organisms for studying conditions such as diabetes.

Which statement about the features of knockout mice is correct?

A An artificial sequence of deoxyribonucleotides replaces the target gene.

B The target gene is activated by inserting an artificial sequence of deoxyribonucleotides.

C The target gene is knocked out using an artificial sequence of ribonucleotides.

D The target gene is transcribed to form pre-mRNA.

Your answer A

[1]

24 What is assessed using the Hardy-Weinberg principle?

A Analysing observed and expected phenotypic ratios to see if there is a difference between them

B Analysing the genotypes in a population to calculate the frequency of alleles within the population

C Analysing two different variables to see if they are correlated in a linear fashion on a scatter graph

D Analysing two sets of data with normal distribution to see if there is a difference in the means

Your answer B

[1]

25 The table shows the roles of some of the bacteria involved in the nitrogen cycle.

	Role of bacteria in the nitrogen cycle		
	Azotobacter	***Nitrobacter***	***Rhizobium***
A	denitrification	nitrification	nitrogen fixation
B	nitrification	denitrification	nitrification
C	nitrogen fixation	nitrification	denitrification
D	nitrogen fixation	nitrification	nitrogen fixation

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

Your answer D

[1]

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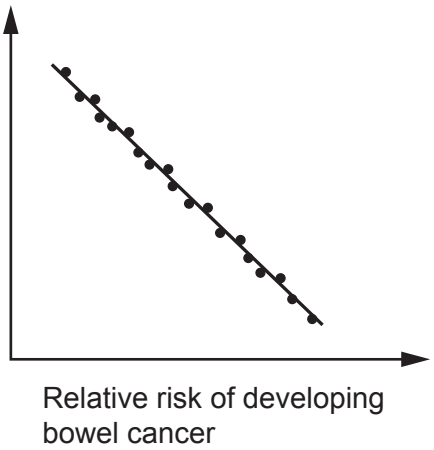
26 Scientists investigated the effect of daily fibre intake on the relative risk of developing bowel cancer.

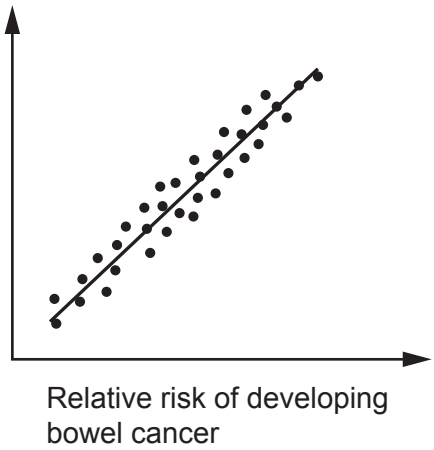
The relative risk of developing bowel cancer was the dependent variable in their investigation.

The scientists plotted a graph of their data and concluded that there was evidence to show a strong negative correlation between the relative risk of developing bowel cancer and daily intake of dietary fibre.

A

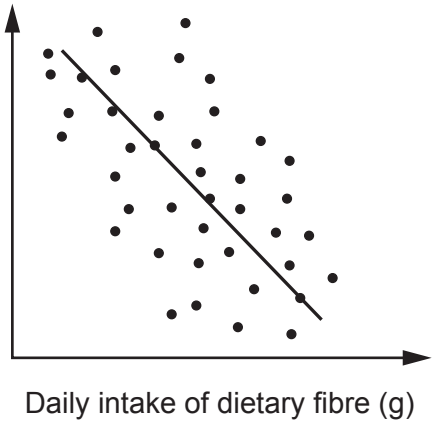


B



C

D



Which of the graphs, **A** to **D**, would result in the scientists' conclusion?

Your answer C

[1]

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27 The following statements describe features of a respiratory disease:

- Alveoli are damaged and enlarged.
- Elastin in alveolar walls is broken down.
- Normal elastic recoil of the alveoli is prevented.

What respiratory disease is being described?

A Asthma

B Chronic bronchitis

C Emphysema

D Lung cancer

Your answer C

[1]

28 Which of the options is **not** a method used by antibodies to destroy pathogens?

A Agglutination

B Coagulation

C Neutralisation

D Opsonisation

Your answer B

[1]

29 What is an advantage of live-attenuated vaccines?

A Can be given to people with compromised immune systems

B Can trigger the production of antitoxins as they contain toxoids

C Do not need to be refrigerated as they are inactivated by chemicals

D Triggers a strong immune response with long lasting immunity

Your answer D

[1]

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30 The table shows details of what takes place during different phases of a clinical trial in the development of a new medicinal drug.

	Details of what takes place	
	Phase 1	**Phase 2**
A	Involves healthy volunteers to establish a safe dose.	Involves large number of patients to compare new drug with current drug.
B	Involves patients and use of a placebo to assess effectiveness.	Involves healthy volunteers to establish a safe dose.
C	Involves large number of patients to compare new drug with current drug.	Involves patients and use of a placebo to assess effectiveness.
D	Involves healthy volunteers to establish a safe dose.	Involves patients and use of a placebo to assess effectiveness.

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

Your answer D

[1]

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Section B

31 The kidney has a role in the excretion of urea.

(a) Complete the sentences about urea using the most appropriate word(s).

Ammonia is produced when excess amino acids are ...deaminated..... in the liver. Ammonia is then combined with ...carbon..... ...dioxide..... to form urea in a series of reactions called the ..ornithine..... cycle. Urea is removed from the body in urine.

[3]

(b) The composition of urine can be investigated using 'mock' urine samples.

Three 'mock' urine samples were provided to a group of students for analysis. The students were instructed how to test each sample using Combur^{7} Test ® strips.

The test strips were dipped in each urine sample for 3 seconds and then left for 60 seconds. After 60 seconds the resulting colours on each test strip were compared to a reference chart.

The reference chart and the results are shown in **Fig. 31**, **on the Insert**.

(i) Sample **X** was prepared to match the control colours.

Using **Fig. 31** outline how samples **Y** and **Z** were **prepared** to give the results shown by 'mock' urine samples.

..Both were made by dissolving named solutes in water, with a buffer added to.....
..give pH 5 (as shown on the strip).....
..Sample Y had glucose added (to give 2+, about 100 mg/dL).....
..Sample Z had protein (e.g. albumin) added to give 1+, and erythrocytes (red.....
..blood cells) added to give 2+.....
..Yellow colouring was added to look like urine, and each sample was checked.....
..against a Combur strip.....
..... **[3]**

(ii) Suggest why it was important to store 'mock' urine sample **Z** at 4 °C.

..Sample Z contains erythrocytes and proteins, so the cold prevents the blood.....
..proteins and enzymes from denaturing..... **[1]**

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(iii) The students concluded that 'mock' urine sample **Y** represented the urine of a patient with untreated diabetes.

One of the students suggested that a colorimeter could be used to provide evidence to support their conclusion.

Outline how a colorimeter could be used to support the students' conclusion for 'mock' urine sample **Y**.

Heat sample Y with Benedict's solution. Zero (calibrate) the colorimeter using distilled water and use a red filter.
Measure the absorbance (or transmission) of light for Benedict's solution heated with known concentrations of glucose, to produce a calibration curve.
Measure the absorbance of sample Y and compare it on the calibration curve to find its glucose concentration, giving a quantitative result.

[3]

(c) Once diagnosed, a patient with diabetes is treated and then monitored by a team of health care professionals.

(i) Explain **one** method of treating **Type 2** diabetes.

Eat a controlled diet with reduced intake of refined sugar and increase exercise, to lose weight.
This avoids excess intake of glucose into the blood, and during exercise cells take up more glucose, lowering blood glucose concentration.

[2]

(ii) Explain how a biosensor is used to monitor the effectiveness of diabetes treatments.

A drop of blood is put in contact with the biosensor strip, which has the enzyme glucose oxidase on it.
The enzyme converts glucose to gluconolactone, producing a small electric current that is measured, giving the blood glucose concentration.

[2]

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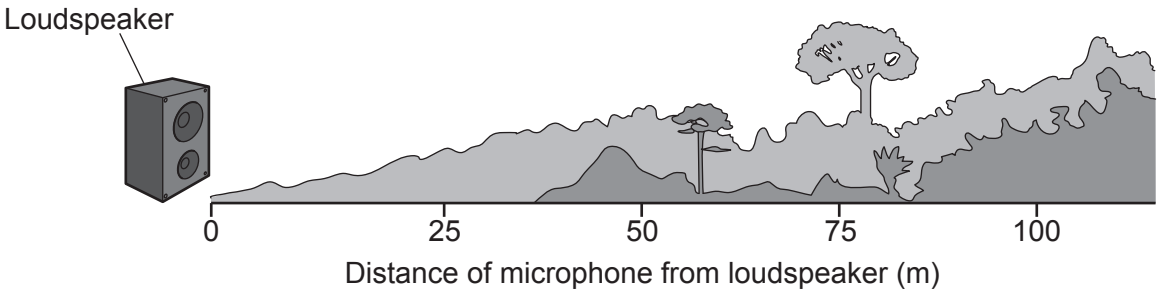
32 Researchers used orangutans to study human language development because they have a complex and developed language system and are the only ape-like species to use consonant and vowel-like sounds when communicating.

(a) In a recent *in vivo* study, calls with either consonant or vowel-like sounds were recorded from individuals from two different species of orangutan.

These recorded calls were then played back from a loudspeaker. A microphone was used to pick up the recordings and measure the loudness of the sounds at increasing distances from the loudspeaker. This is shown in **Fig. 32.1**.

Fig. 32.1



(i) The sound level at 25 m from the loudspeaker was measured at 80 decibels (dB).

The researchers estimated that for every doubling of the distance from the loudspeaker the sound level dropped by 6 dB.

Estimate the sound level recorded at 100 m from the loudspeaker.

25 m to 50 m (one doubling): 80 − 6 = 74 dB

50 m to 100 m (second doubling): 74 − 6 = 68 dB

Estimated level of sound = ...68..... dB **[1]**

(ii) State **one** advantage and **one** disadvantage of completing this study *in vivo*.

Advantage ..It is in the orangutans' natural habitat, so it is close to real life.....

.....

Disadvantage ..Transmission of sound is affected by the forest (trees), and other.....

..sounds may interfere.....

[2]

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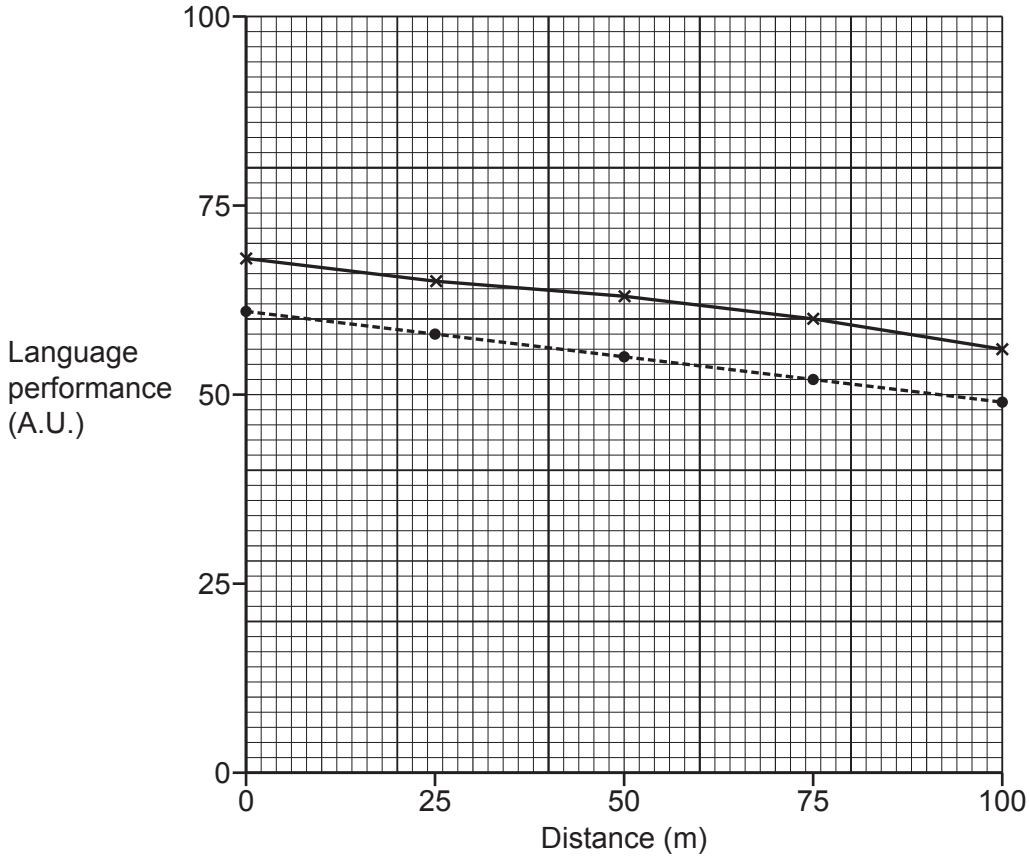
(b) Even though sound levels decrease with distance, the language may still be understood.

Language performance indicates how well the language is understood over distance.

Fig. 32.2 shows some of the data for language performance from the study.

Fig. 32.2



Key:

—×— Species 1
---●--- Species 2

(i) Calculate the percentage loss in language performance for **Species 1** over 100 m.

Species 1: 68 at 0 m, 56 at 100 m

(68 − 56) ÷ 68 × 100 = 17.6

Percentage loss = ...17.6..... % **[2]**

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(ii) From the data in **Fig. 32.2** the researchers concluded:

Orangutans are able to communicate with each other over long distances.

Discuss the validity of this conclusion.

Valid: there is only a small loss in language performance over 100 m (species 1: 68 to 56, a 17.6% loss; species 2: 61 to 49, about 19.7%), so the language can still be understood.

Invalid: only two species were used, and different species may use different sounds or language. There is also insufficient data, as only distances up to 100 m were tested.

[3]

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(c)* The orangutan species in the study and human species, *Homo sapiens*, are classified as belonging to the Hominidae family. They evolved from a common ancestor.

Evaluate the use of fossil and anatomical evidence for classifying members of the Hominidae family.

Fossil and anatomical evidence let organisms be classified on morphological similarities, such as the same shape of skull, teeth and limb bones, and the evidence can be seen directly.

Fossils are useful for studying extinct hominids, and there is an abundance of hominid fossils. Fossils can be dated (e.g. carbon dating) and show evolutionary relationships and the distance from the common ancestor. DNA can sometimes be extracted for molecular analysis.

However, fossils are often damaged, weathered or have missing parts, and DNA does not preserve well, so it is difficult to extract from old fossils. Fossils are limited to skeletal features, so tissues, organs and hair colour cannot be seen, and different interpretations arise, so relationships can only be estimated.

Anatomical evidence from living hominids shows features that do not fossilise, such as hair colour and length, and the full structure with no missing parts.

However, it does not use DNA or molecular analysis.

For both, members of the same species can look very different, and different **[6]**

Extra answer space if required.

species may be classified together because of similar (homologous) structures or convergent evolution. So this evidence is useful but should be supported by DNA evidence.

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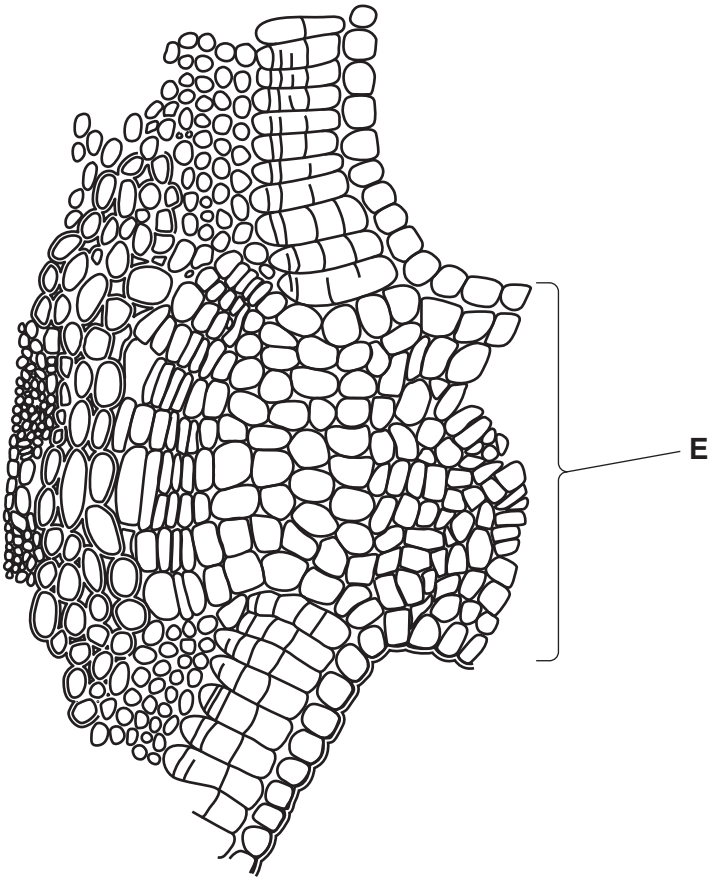
33 A student observes a microscope slide of a section through the woody stem of a plant.

(a) A diagram drawn by the student from their observations is shown below. The structure where gas exchange takes place in the stem is labelled **E**.



(i) Name the structure labelled **E**.

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

(ii) Compare gas exchange in this part of the stem with gas exchange in the underside of a leaf.

In the stem, gas exchange at the lenticel is through loosely packed cells and is not controlled, so it happens all the time.

In the underside of a leaf, gas exchange uses stomata controlled by guard cells, so the pores can open and close and gas exchange occurs mainly during the day (less at night).

Gas exchange in the leaf is faster, as the underside of the leaf has a larger surface area for gas exchange.

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

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(b) The structures labelled **E** can also be found on the surface of fruit such as apples.

The mean number of these structures found on a variety of apple was calculated at 1.2 per cm^2 of surface.

The variety of apple has a mean diameter of 9 cm.

Calculate the mean number of these structures found on one apple.

Assume the apples are spherical and use the equation:

Surface area of a sphere = $4\pi r^2$

$r = 9 \div 2 = 4.5$ cm

Surface area $= 4 \times \pi \times 4.5^2 = 254.5$ cm^2

Mean number $= 254.5 \times 1.2 = 305.4$

Mean = ...305..... **[2]**

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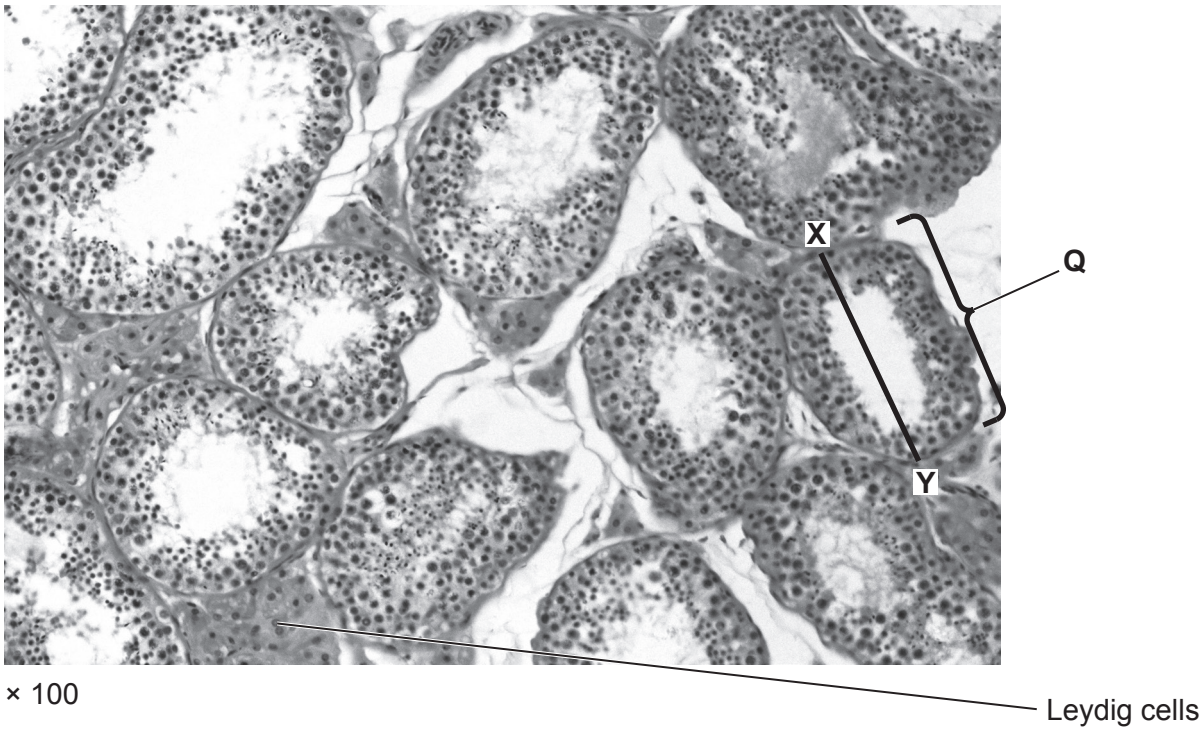
34

(a) **Fig. 34.1** is a photomicrograph of tissues in a human testis.

Fig. 34.1



× 100

Spermatogenesis takes place in the part of the testis labelled **Q**.

(i) Identify the part of the testis labelled **Q**.

seminiferous tubule ..... **[1]**

(ii) Calculate the actual length of **Q** between points **X** and **Y**.

Image length X to Y = 30 mm = 30 000 μm

Actual length = 30 000 ÷ 100 = 300 μm

Actual length = ...300..... μm **[2]**

(iii) State the role of Leydig cells labelled on **Fig. 34.1**.

To secrete (produce) testosterone.

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

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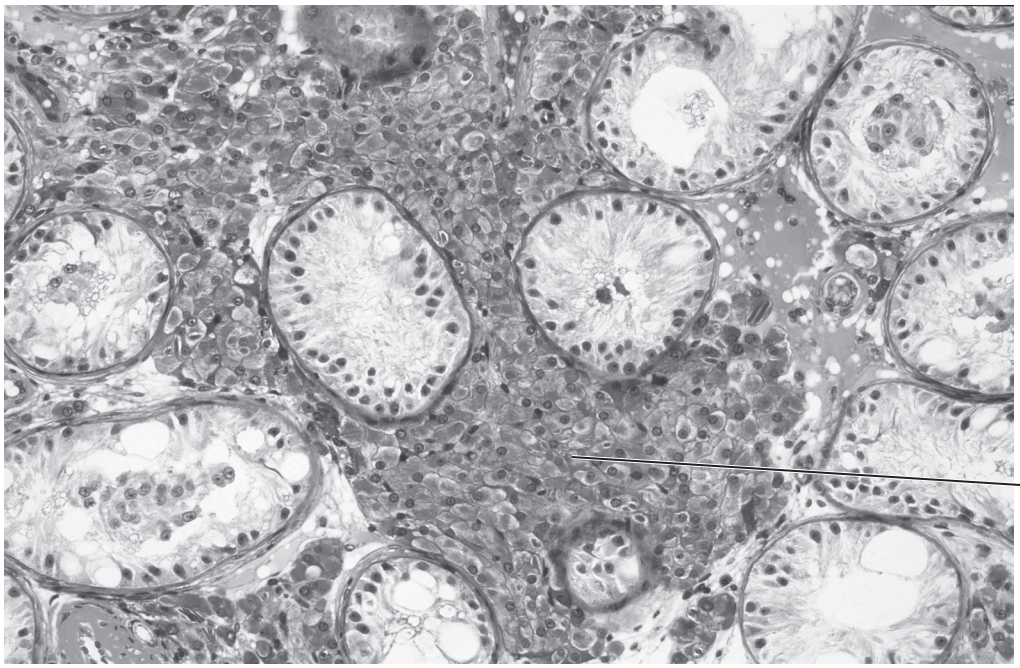
(b) **Fig. 34.2** is a photomicrograph of the same tissues in a testis from a patient with infertility.

Fig. 34.2



× 100

Use **Fig. 34.1** and **Fig. 34.2** to explain reasons for the patient's infertility.

In Fig. 34.2 there are fewer (or no) mature sperm in the tubules, the germinal epithelium layer is thinner and stages of spermatogenesis are absent, with fewer cells undergoing cell division, such as spermatogonia.

There are also more Leydig cells and fewer Sertoli cells, so few or no sperm are produced.

[3]

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(c) Most forms of infertility can be treated.

Describe the most appropriate treatment method that could be used for couples in each of the following cases:

The man produces sperm, but his sperm ducts are blocked

Surgical sperm retrieval: sperm are removed directly from the epididymis using a needle.

This is followed by intrauterine insemination, where the sperm are inserted into the uterus.

Sperm and oocytes are produced but fertilisation does not occur

Intra-cytoplasmic sperm injection (ICSI): a single sperm is injected directly into an oocyte, so fertilisation takes place outside the body in a petri dish.

The fertilised oocyte (embryo) is then implanted into the uterus.

[4]

(d) Explain the importance of spermatogenesis to the process of fertilisation.

Spermatogenesis produces large quantities of gametes (sperm).

The sperm are haploid, as they are formed by meiosis, so at fertilisation the diploid number is restored in the zygote.

This prevents the doubling of the chromosome number in each generation.

[3]

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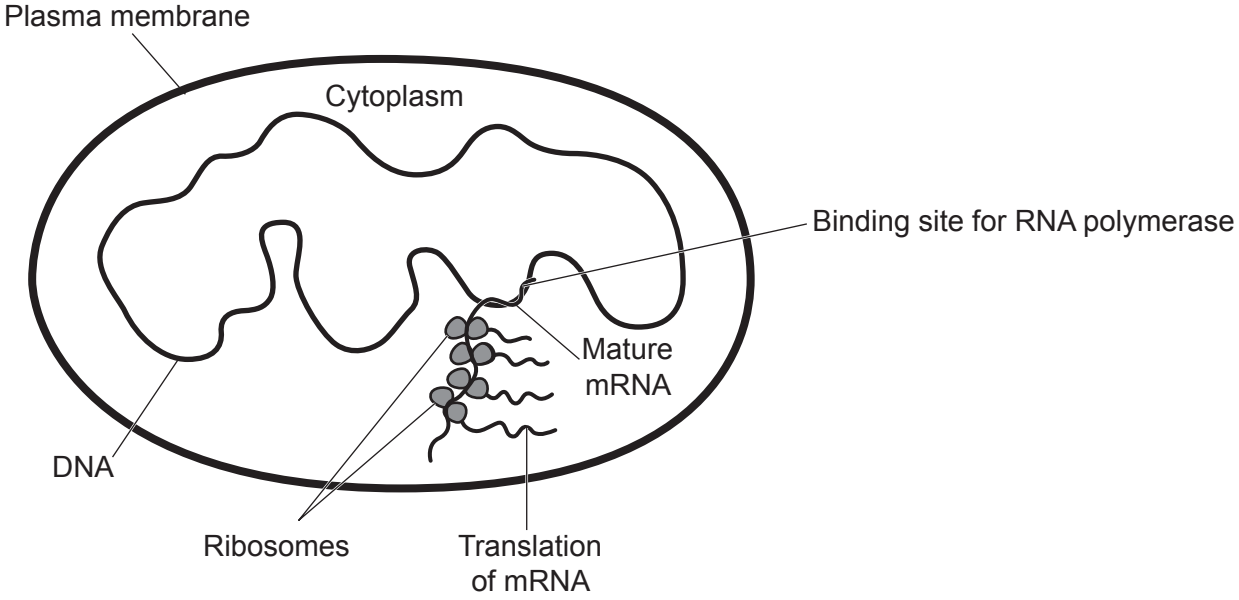
35 Transcription is the process of producing mRNA using a strand of DNA as a template.

The diagram shows a prokaryotic cell producing mature mRNA.



(a)* Compare transcription in the prokaryotic cell with transcription in a human cell.

Similarities: in both, DNA acts as the template and DNA helicase unwinds the DNA by breaking hydrogen bonds between the bases. In both, RNA polymerase binds to a binding site on the DNA, and free ribonucleotides pair with the complementary bases on the template strand. RNA polymerase forms phosphodiester bonds between them, so mRNA is produced in both.

Differences: in humans transcription takes place in the nucleus, but in the prokaryote it takes place in the cytoplasm. Prokaryotic DNA is circular and not bound to histones, whereas human DNA is linear and bound to histones.

In the prokaryote the mRNA made is already mature, so translation by ribosomes happens at the same time as transcription, as shown in the diagram. In humans pre-mRNA is formed, which contains introns; it must be modified (spliced) to remove the introns before the mature mRNA leaves the nucleus, so transcription and translation do not occur simultaneously.

[6]

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Extra answer space if required.

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(b) RNA interference (RNAi) is used by many organisms to control genes.

Two forms of RNA, microRNA (miRNA) and small interfering RNA (siRNA), are involved in the different mechanisms of RNAi.

The table shows statements about the different mechanisms of RNAi.

Complete the table to show whether each statement is **True (T)** or **False (F)**.

Statement	**True (T) or False (F)**
Argonaute proteins allow miRNA to bind to many different mRNA molecules.	T
miRNA and siRNA are both derived from double-stranded RNA molecules.	T
siRNA binds to a specific sequence of complementary DNA nucleotides which allows the Argonaute protein to bind.	F

[3]

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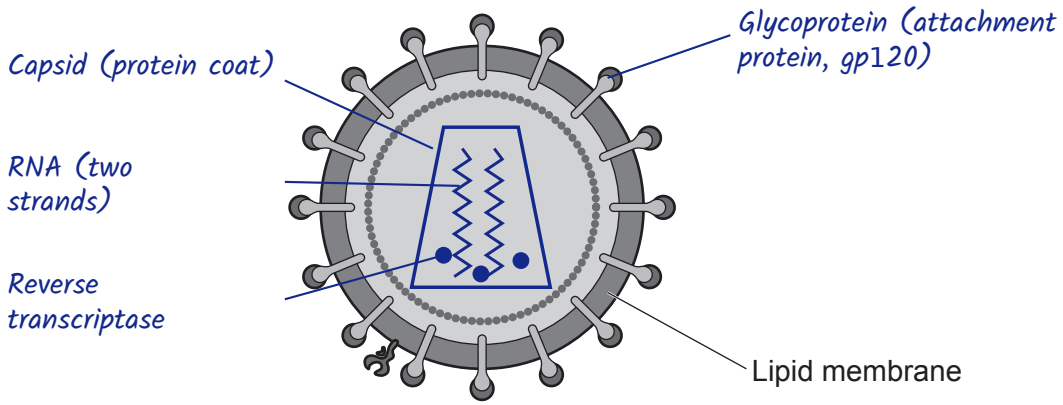
36 A student was making revision notes about the human immunodeficiency virus (HIV).

This is the labelled diagram they started to draw to show the structure of HIV.



(a) Complete the student's diagram including labels to show the main components in the structure of HIV. **[3]**

(b) Saquinavir is used in the treatment of HIV infections.

Saquinavir is a competitive inhibitor of an HIV protease enzyme that breaks down large proteins into smaller polypeptides.

Treatment with saquinavir leads to the formation of non-functional, immature and non-infectious HIV viruses.

(i) Explain how HIV protease enzymes are produced when the virus infects a host cell.

Viral RNA is inserted into the host cell and reverse transcriptase converts it into viral DNA, which is integrated into the host cell DNA. The host cell transcribes this to produce viral mRNA, which is translated by host ribosomes to synthesise the protease. **[2]**

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(ii) Explain the mechanism of inhibition by which saquinavir affects the activity of HIV protease enzymes.

Saquinavir is a similar shape to the substrate (the large proteins), so it binds to the active site of the protease.

This blocks the large proteins from binding, so fewer enzyme-substrate complexes are formed.

The binding of saquinavir is reversible (temporary).

[3]

(iii) Suggest how treatment with saquinavir leads to non-functional, immature and non-infectious HIV viruses.

The protease cannot break down the large proteins to produce smaller polypeptides, so functional viral proteins and enzymes cannot form.

For example, the small polypeptides needed to form the viral protein coat (capsid) are not made.

[2]

(c) HIV causes acquired immunodeficiency syndrome (AIDS).

The World Health Organization is involved in attempts to control and prevent AIDS.

(i) Explain what the term **syndrome** means, using AIDS as an example.

A syndrome is a collection of many symptoms, which may affect different body organs.

In AIDS the suppressed immune system means a range of different diseases occur, e.g. pneumonia and TB.

[2]

(ii) State **two** ways the spread of AIDS can be controlled.

1 Use of antiviral drugs for infected people.

2 Encouraging protected sex (use of condoms).

[2]

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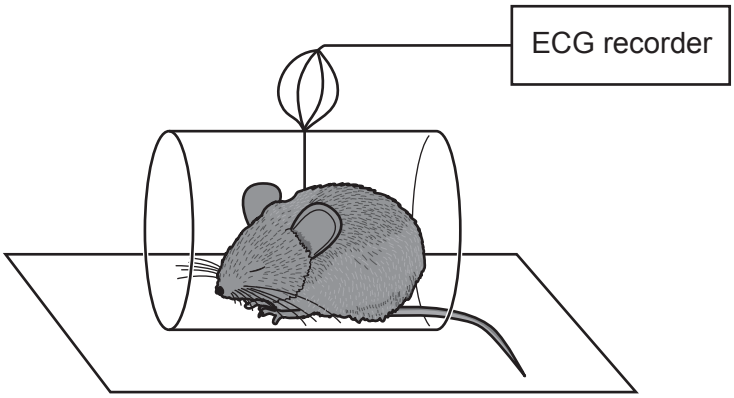
37 Researchers often use mice to study the circulatory system.

(a) One group of researchers studied the effect of different anaesthetics on the heart rate of mice. They measured the heart rate of the mice using the electrocardiography (ECG) method below.



1. Gently place a conscious mouse (no anaesthetic) inside a tunnel mounted on a platform connected to an ECG recorder.
2. Ensure the paws are in contact with the electrodes on the platform.
3. Turn on the system and record the ECG for 5 minutes.
4. Use the ECG trace to calculate heart rate.
5. Repeat the procedure using mice sedated with different anaesthetics.

The table shows analysis of the data.

	Anaesthetic used to sedate mouse			
	None	**Ketamine**	**Isoflurane**	**Pentobarbital**
Heart rate (bpm)	590	148	440	250

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(i) The ECG trace for the mouse sedated with pentobarbital is shown below.

Calculate the heart rate of the mouse sedated with pentobarbital.

Time between R peaks = 0.24 s

Heart rate = 60 ÷ 0.24 = 250

Heart rate = ...250..... bpm **[2]**

(ii) Explain **one** modification to the method that would reduce the effect of random error on the results.

Repeat the procedure at least three times (with more mice) for each anaesthetic, so that a mean heart rate can be calculated, and anomalies can be identified and excluded.

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

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(iii) The researchers concluded:

When using mice for cardiology studies it would be better to sedate them with isoflurane rather than them being conscious.

Suggest **one** supporting argument and **one** non-supporting argument for this conclusion.

Supporting Isoflurane does not reduce heart rate as much as the others (closer to normal) and avoids stress.

Non-supporting Sedation still lowers the heart rate (440 compared to 590 bpm), and there are ethical concerns.

[2]

(b) In humans, the circulatory system is affected by aerobic exercise.

Outline the effects of long-term aerobic exercise on the circulatory system.

Long-term aerobic exercise causes cardiac hypertrophy: the heart enlarges and the ventricle muscle wall thickens, increasing the force of ventricular systole. This increases stroke volume and cardiac output, so resting heart rate decreases (bradycardia) and recovery time after exercise decreases. The number of erythrocytes increases and VO_2 max increases.

[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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