Oxford Cambridge and RSA

Wednesday 7 June 2023 – Afternoon

A Level Biology B (Advancing Biology)

H422/01 Fundamentals of biology

Time allowed: 2 hours 15 minutes

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

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

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

First name(s) _____

Last name _____

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 image shows an erythrocyte after being placed in a solution.

Which option explains the appearance of the erythrocyte?

A The solution was distilled water.

B The water potential of the solution is equal to the water potential of the cytoplasm of the erythrocyte.

C The water potential of the solution was less negative than the cytoplasm of the erythrocyte.

D The water potential of the solution was more negative than the cytoplasm of the erythrocyte.

Your answer ☐

[1]

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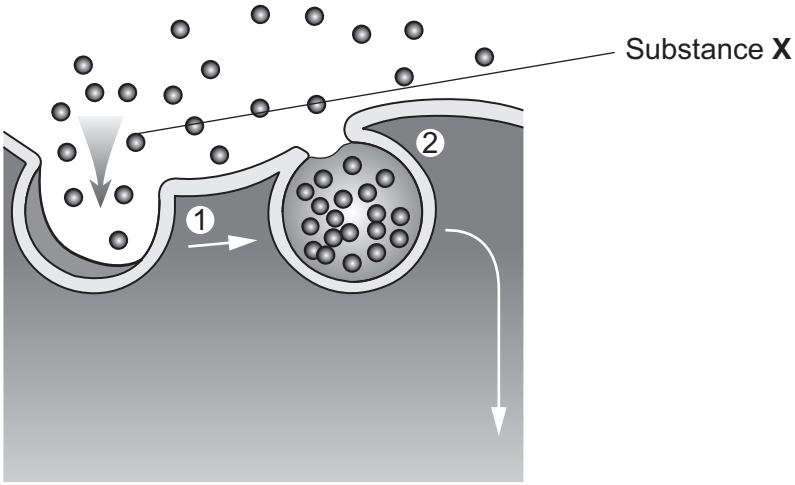
2 The diagram shows substance **X** being transported across a cell membrane.



Which transport mechanism is being used to transport substance **X**?

A Active transport

B Endocytosis

C Exocytosis

D Facilitated diffusion

Your answer ☐

[1]

3 Which option explains why mammals need a mass transport system?

A Diffusion distances are too short to supply sufficient oxygen to cells.

B They have a double circulatory system.

C They have a large surface area to volume ratio.

D They have high metabolic demands.

Your answer ☐

[1]

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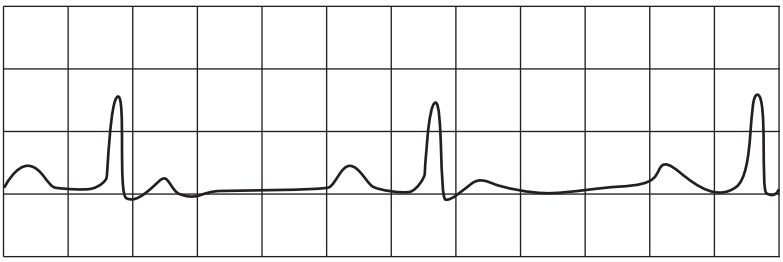
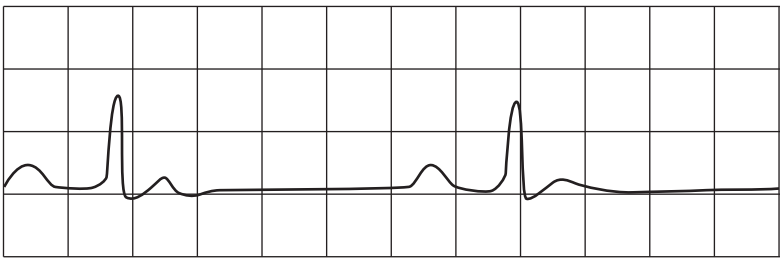
4 Doctors monitor the heart activity of their patients by using electrocardiograms (ECGs).

The ECG traces below show normal heart activity and the heart activity of a patient with a heart condition recorded over the same time period.

Normal heart activity



Heart activity of patient



Which heart condition is shown by the patient's ECG?

A Bradycardia

B Fibrillation

C Heart attack

D Tachycardia

Your answer ☐

[1]

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5 Four athletes were found to have the same resting cardiac output of 4000 $cm^3 min^{-1}$.

The athletes then started mild exercise and their heart rates and stroke volumes were recorded.

The results are shown in the table.

Athlete	Heart rate (bpm)	Stroke volume (cm^3)
A	90	40
B	90	80
C	100	32
D	100	80

Which athlete increased their cardiac output by 80% during mild exercise?

Your answer ☐

[1]

6 VO_2 max is an indicator of aerobic fitness.

Which of the units is appropriate when measuring VO_2 max?

A $dm^3 min^{-1}$

B $dm^{-3} min^{-1}$

C $min\, dm^{-3}$

D $min\, kg^{-1}$

Your answer ☐

[1]

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7 An investigation was carried out to measure respiratory quotient (RQ) values using a respirometer.

A respiratory substrate was provided to the respiring organisms and the RQ value was measured after 20 minutes and again after 40 minutes.

The RQ value was measured at 1.0 after 20 minutes, and then increased to over 3.0 after 40 minutes.

Which option explains the change in RQ value?

A The organism is respiring glucose and then starts to respire anaerobically.

B The organism is respiring glucose and then starts to respire proteins.

C The organism is respiring lipids and then starts to respire anaerobically.

D The organism is respiring lipids and then starts to respire glucose.

Your answer ☐

[1]

8 Which of the statements about transport systems in plants is correct?

A Carbon dioxide needs to be transported from leaves to other organs for photosynthesis.

B Glucose is moved through phloem sieve tubes by translocation.

C Separate transport systems are needed for mass transport of water and sugars.

D Water moves through xylem vessels by osmosis.

Your answer ☐

[1]

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9 Which of the statements about the mechanism that results in the opening of stomata is / are correct?

1 The concentration of K^+ ions and sucrose inside guard cells decreases.

2 The water potential of guard cells decreases.

3 Turgidity of guard cells increases.

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]

10 The flowers of the tree lupin, *Lupinus arboreus*, show typical adaptations for insect pollination.

Which of the statements about the flowers of *L. arboreus* is / are correct?

1 Feathery stigmas hang outside the flowers.

2 They contain nectaries.

3 They produce large, sticky pollen grains.

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]

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11 The table shows the levels of hierarchy for the common fig plant, *Ficus carica*.

Domain	Eukaryota
↓	Plantae
	Spermatophyta
	Dicotyledonae
	Urticales
	Moraceae
Genus	*Ficus*

Which option is the phylum taxon that *F. carica* belongs to?

A Dicotyledonae

B Moraceae

C Spermatophyta

D Urticales

Your answer ☐

[1]

12 What bond joins adjacent nucleotides to form a polynucleotide chain?

A Ester

B Hydrogen

C Ionic

D Phosphodiester

Your answer ☐

[1]

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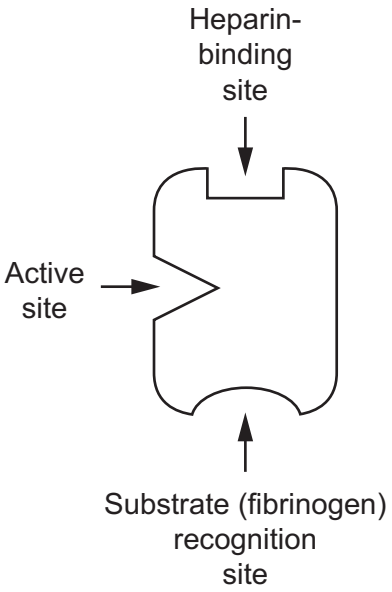
13 Heparin is a drug used to prevent blood clots. It binds to the enzyme that converts fibrinogen to fibrin during the blood clotting process.

The diagram shows heparin binding to the enzyme.



Which of the statements about heparin is correct?

A Heparin is a competitive inhibitor of the enzyme thrombin.

B Heparin is a competitive inhibitor of the enzyme thrombokinase.

C Heparin is a non-competitive inhibitor of the enzyme thrombin.

D Heparin is a non-competitive inhibitor of the enzyme thrombokinase.

Your answer ☐

[1]

14 Which of the statements about the production of ATP during photophosphorylation is correct?

A Each turn of the Calvin cycle produces 3 molecules of ATP.

B It occurs during the light-dependent stage of photosynthesis.

C It occurs in the stroma of chloroplasts.

D NAD is needed as the final electron acceptor.

Your answer ☐

[1]

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15 Smoking during pregnancy can affect the growing fetus.

What is the most likely effect of tobacco smoke on a growing fetus?

A Inability to synthesise enzymes.

B Inability to synthesise structural proteins.

C Increased risk of a genetic defect.

D Poor lung development.

Your answer ☐

[1]

16 Parents with a genetic disorder in either family are advised to undergo a pre-conceptual analysis so that genetic counsellors can assess the probability of their children inheriting the disorder.

Which option is **not** used during a pre-conceptual analysis to assess the probability of a child inheriting a genetic disorder?

A Carrier testing to determine the presence of chromosome mutations.

B Carrier testing to determine the presence of disease-causing recessive alleles.

C Chorionic villus sampling and karyotyping to determine the presence of chromosome mutations.

D Constructing a pedigree chart to determine inheritance patterns in families.

Your answer ☐

[1]

17 The table below contains information about acquired immunodeficiency disease (AIDS).

	Pathogen	**Means of transmission**	**Principal treatment**
A	Bacteria	Body fluids in direct contact	Antibiotics
B	Bacteria	Droplet infection in close contact	Antibiotics
C	Virus	Body fluids in direct contact	Antiviral drugs
D	Virus	Droplet infection in close contact	Antibiotics

Which of the rows about AIDS is correct?

Your answer ☐

[1]

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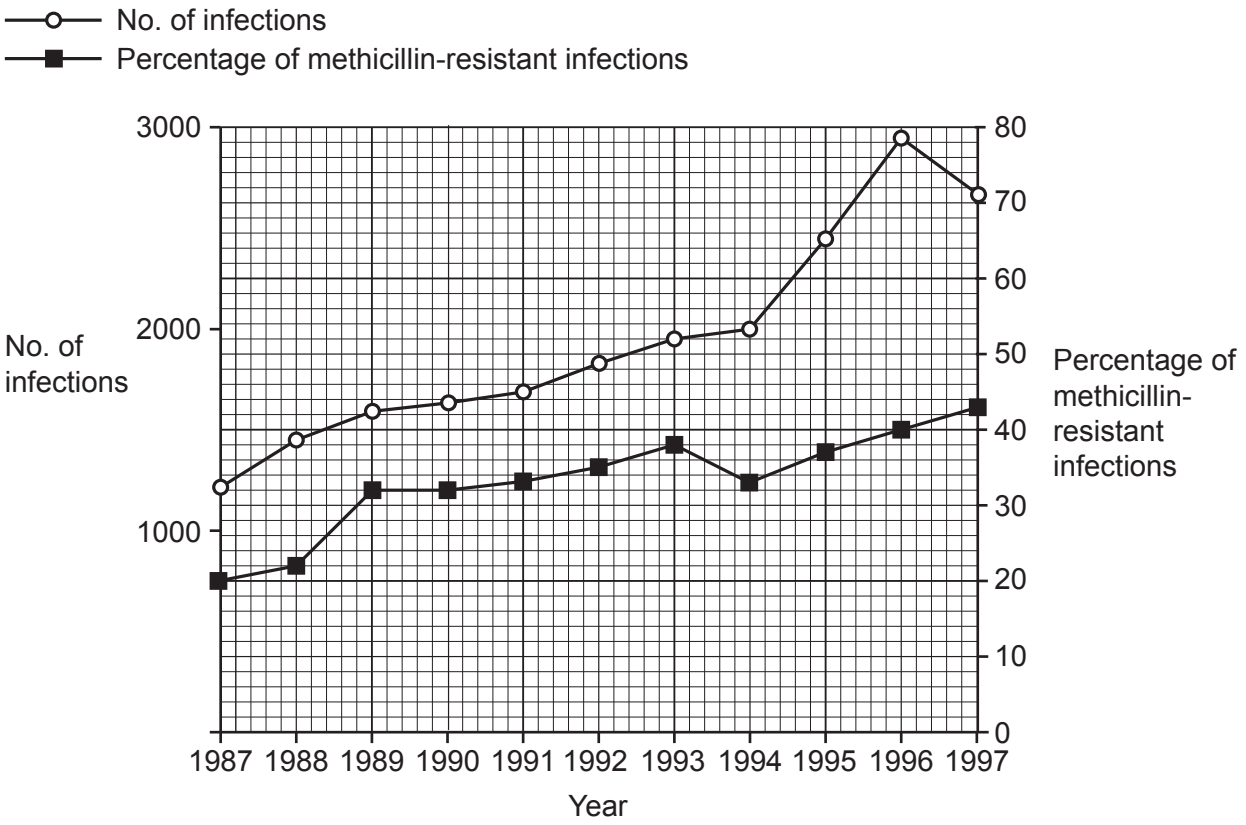
18 The graph shows data for *Staphylococcus aureus* infections in a population over a 10-year period.



What is the number of methicillin-resistant infections reported in 1996?

A 43

B 79

C 1106

D 1180

Your answer ☐

[1]

19 Which option is **not** a risk factor for lung cancer?

A Ageing

B Asbestos fibres

C Ionising radiation

D Obesity

Your answer ☐

[1]

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20 Which of the statements about allergic reactions is correct?

A Allergens bind to antigens on mast cells.

B Allergens trigger a primary immune response.

C Allergic reactions result in long-term immunity.

D The allergens that cause allergic reactions are pathogenic.

Your answer ☐

[1]

21 Which of the statements about allele mutations is / are correct?

1 They always cause a change in the DNA sequence.

2 They always cause a change to the sequence of amino acids.

3 They always result in the production of non-functional proteins.

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]

22 Which statement about post-transcriptional modification of mRNA is correct?

A Both introns and exons code for amino acid sequences.

B Introns are found in the mature mRNA strand.

C Introns are removed from the initial mRNA strand.

D The process only occurs in prokaryotes.

Your answer ☐

[1]

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23 The sentences below are about the principles of RNA interference (RNAi).

In RNAi, gene expression is .....**1**..... and protein synthesis is blocked. It involves molecules of siRNA and .....**2**....., both derived from .....**3**.....-stranded RNA. siRNA binds to a specific sequence of complementary .....**4**..... on mRNA which is then broken becoming non-functional.

Which row shows the correct words to complete the sentences?

	1	2	3	4
A	inhibited	miRNA	double	nucleotides
B	inhibited	tRNA	single	nucleotides
C	inhibited	tRNA	double	amino acids
D	promoted	miRNA	single	amino acids

Your answer ☐

[1]

24 Which option is **not** a feature of a homeostatic control system?

A Feedback loop

B Negative feedback

C Positive feedback

D Set point

Your answer ☐

[1]

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25 A condition caused by the loss of a homeostatic control mechanism results in the following symptoms:

- confusion
- shallow breathing
- shivering
- weak pulse.

What condition is being described?

A Alzheimer's

B Diabetes

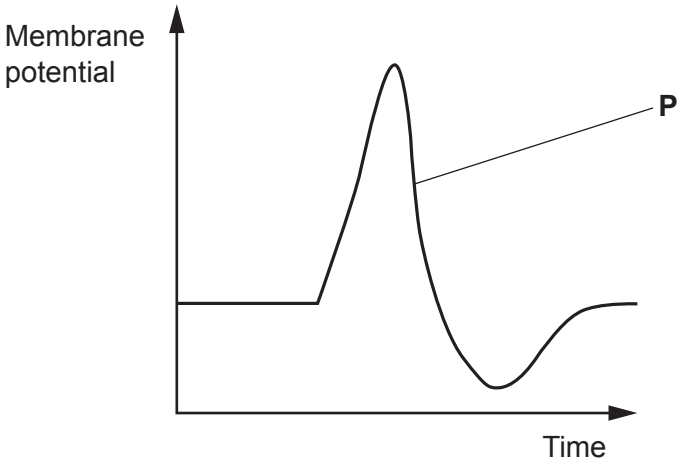
C Hyperthermia

D Hypothermia

Your answer ☐

[1]

26 The graph shows the changes in membrane potential of an axon during an action potential.



Which option describes what is happening at point **P** on the graph?

A Voltage-gated K^+ channels are closed, preventing the diffusion of K^+ out of the axon down a concentration gradient.

B Voltage-gated K^+ channels are open, allowing the diffusion of K^+ out of the axon down a concentration gradient.

C Voltage-gated Na^+ channels are open, allowing the diffusion of Na^+ into the axon down a concentration gradient.

D Voltage-gated Na^+ channels are open, allowing the diffusion of Na^+ out of the axon down a concentration gradient.

Your answer ☐

[1]

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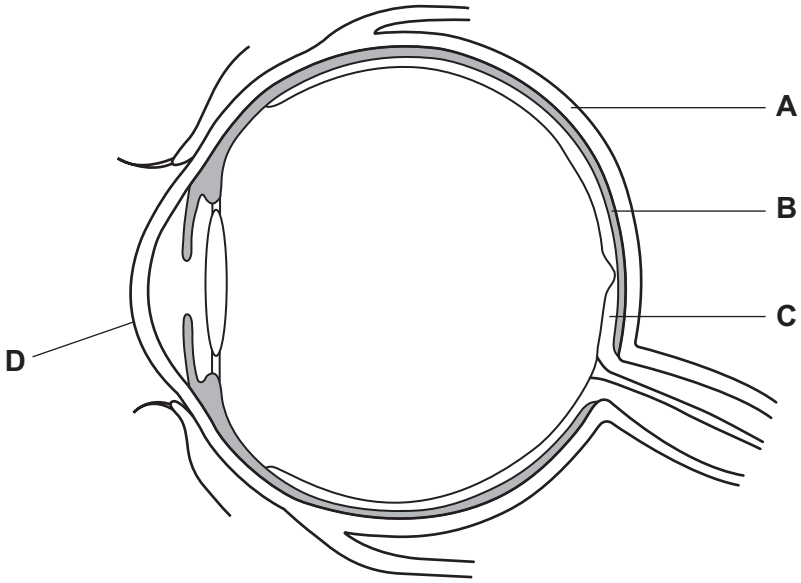
27 The diagram shows the internal structure of the eye.



Which structure on the diagram identifies the choroid?

Your answer ☐

[1]

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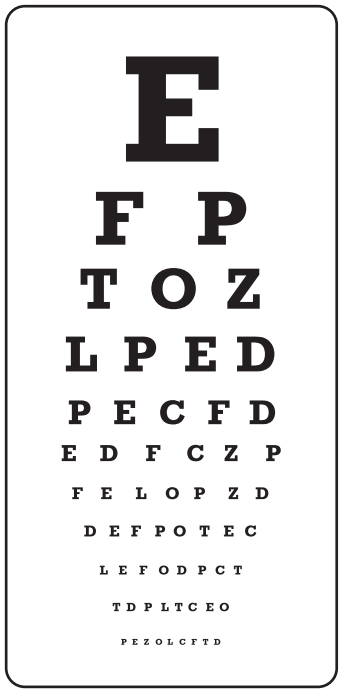
28 A Snellen chart used in routine eye tests is shown below.



Which of the statements about using the Snellen chart for routine eye tests is / are correct?

1 The chart is used for testing visual acuity.

2 To ensure repeatability, each Snellen chart uses the same letters.

3 To ensure validity, the distance between the patient and the chart is gradually decreased.

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]

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29 Which of the conditions is **not** caused by the effects of ageing on the nervous system?

A Cataracts

B Glaucoma

C Hearing loss

D Menopause

Your answer ☐

[1]

30 Which mammalian hormone causes the release of testosterone in males and the release of a secondary oocyte in females?

A Follicle-stimulating hormone

B Luteinising hormone

C Oestrogen

D Progesterone

Your answer ☐

[1]

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Section B

31 Goat farming has an essential role in food production in North Africa.

(a) The table below shows the mean milk yield for two different breeds of goat used for food production in a region of North Africa.

Breed of goat	**Mean milk yield per goat during lactation period (kg)**	**Standard deviation +/–**
Draa	141.5	6.0
Laaroussi	52.3	23.2

(i) The population of Draa goats in the region was estimated at 200 000 animals.

The goats produce milk during a lactation period of 120 days. The goats have one lactation period per year.

Estimate the mean milk yield per year for this population.

Give your answer in standard form.

Mean milk yield = ... kg yr^{-1} **[2]**

(ii) State a conclusion that can be drawn from the standard deviation values about milk yield in these two breeds.

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

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(b) In recent years, other breeds of domestic goat from Europe have been introduced to North African herds for breeding programmes due to their higher milk yields.

It has been claimed that this practice will improve the outcomes for goat farming in the region.

Discuss the validity of this claim.

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

(c) Laaroussi goats are kept in small herds in the mountainous regions of North Africa where they are important in providing food and income for local people.

The goats graze entirely on forest plants that have a net primary productivity of 350 g m^2 yr^{-1}.

A small herd of 20 goats was able to graze 2000 m^2 of forest and produced a mean annual increase of 7 kg of biomass per goat.

(i) Calculate the efficiency of biomass transfer between the forest plants and the goats.

Efficiency = ... % **[3]**

(ii) Explain **two** ways in which the goat farmer could improve the efficiency of biomass transfer to increase meat production of their goats without introducing other breeds.

1 .....

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2 .....

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[2]

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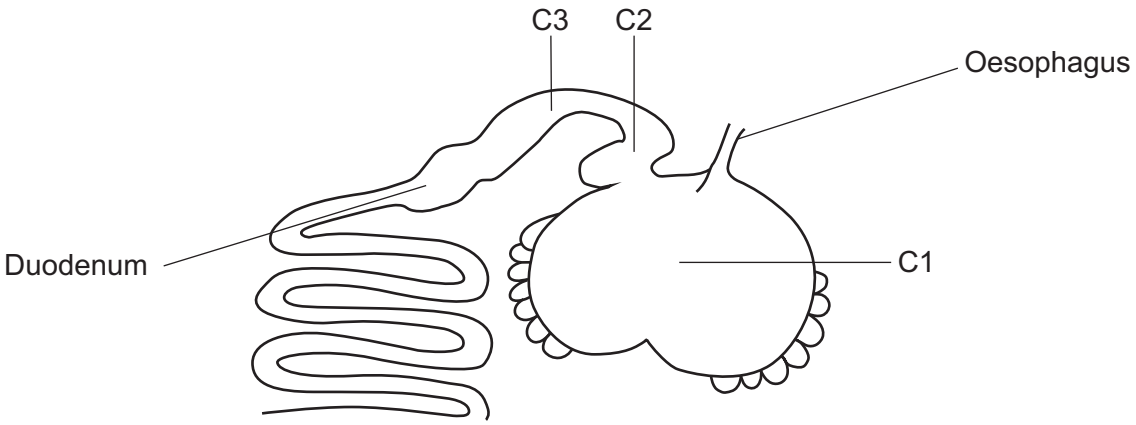
(d) Farm animals such as goats and cows are ruminants.

The alpaca is a type of ruminant native to South America which is farmed to produce wool.

The diagram shows part of the digestive system with stomach chambers (C1–C3) of an alpaca.



(i) Use the diagram and your knowledge of the ruminant digestive system, to suggest why the alpaca is not considered to be a 'true' ruminant.

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

(ii) Use your knowledge of the ruminant digestive system to explain the importance of stomach chamber C1 in obtaining nutrients.

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

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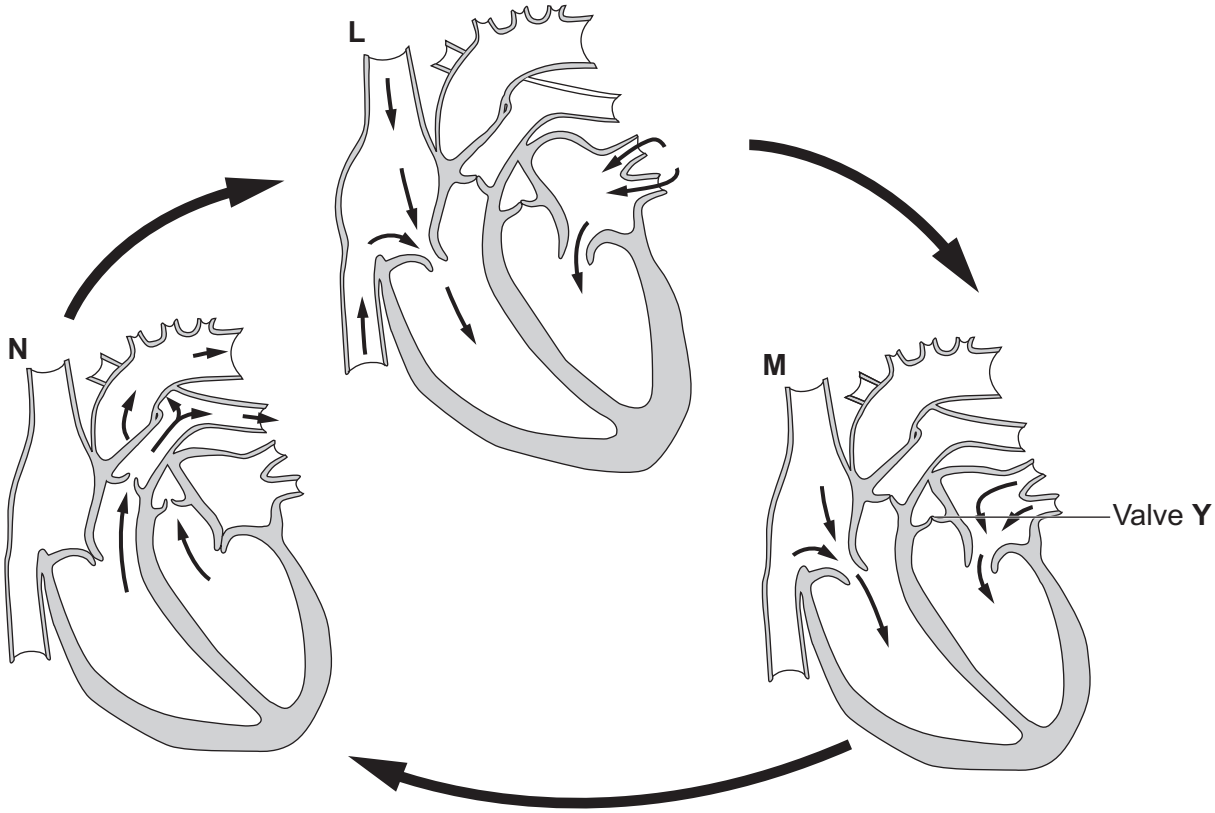
32 **(a)** The diagram shows a mammalian heart at different stages of the cardiac cycle.



(i) Identify the letter of the stage on the diagram that shows the heart in diastole **and** give a reason for your choice.

Stage .....

Reason .....

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

(ii) Describe the role of the valve, labelled **Y**.

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

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(b)* State the location of specialised heart tissues and explain their role in controlling the cardiac cycle.

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

Additional answer space if required.

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(c) Researchers were investigating whether the sex of human fetuses had an effect on heart rate.

The researchers obtained heart rate data for 60 fetuses recorded during pre-natal checks.

The fetuses were grouped according to sex and whether their heart rates were <140 bpm (low) or >140 bpm (high).

(i) The table shows the results of their investigation.

	Heart rate	**Observed frequency (f_o)**	**Expected frequency (f_e)**	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
Male	**<140 bpm**	24	19.7	18.5	
	>140 bpm	12	17.3	28.1	
Female	**<140 bpm**	6	12.3	39.7	
	>140 bpm	18	10.7	53.3	
				χ^2 =	

Complete the table **and** calculate the value of χ^2 for these results.

Use the equation: $\chi^2 = \Sigma\frac{(f_o - f_e)^2}{f_e}$

Give your answer to **2** decimal places.

Write your answer to **32(c)(i)** in the table. **[3]**

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(ii) The researchers hypothesised that the heart rates of female fetuses were higher than males.

Use your calculated value for χ^2 in **(c)(i)** and the probability table below to conclude whether this hypothesis is supported at 5% significance level.

	χ^2				χ^2				
p%	99	97.5	95	90	10	5.0	2.5	1.0	0.5
v = 1	.0001	.0010	.0039	.0158	2.706	3.841	5.024	6.635	7.879
2	.0201	.0506	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860

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

(iii) The researchers used probability calculations to determine the expected values for each group.

Suggest why the researchers could not assume an expected value of 15 for each group.

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

(iv) Suggest **one** modification to the investigation that could improve the validity of their results.

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

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33 **(a)** Daylength is an environmental factor that affects flowering in plants.

Hyoscyamus niger and *Euphorbia pulcherrima* are species of plant that show different flowering patterns when exposed to periods of light and dark over a 24-hour period.

The plants were exposed to three different variations of light and dark periods:

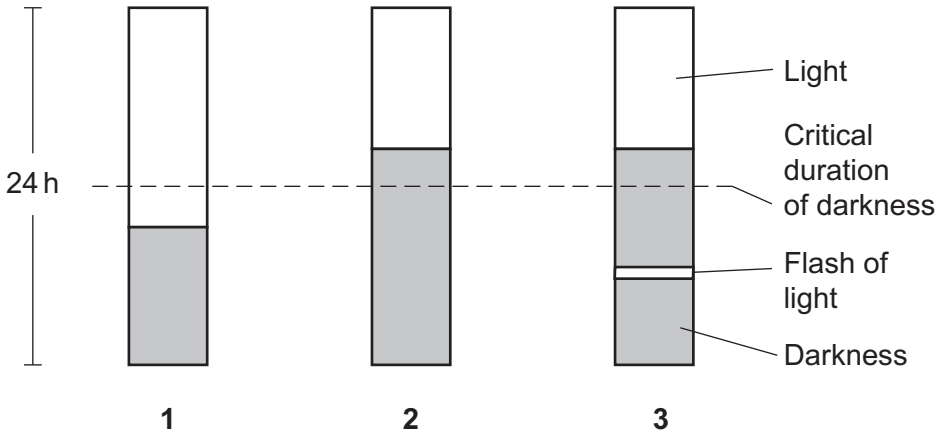
1 10 hours of darkness followed by 14 hours of light.

2 14 hours of darkness followed by 10 hours of light.

3 6 hours of darkness then a flash of light followed by a further 8 hours of darkness and then 10 hours of light.

Fig. 33.1 shows these variations of light and dark periods to which the plants were exposed to over a 24-hour period during an investigation.

Fig. 33.1



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(i)* It was concluded that *H. niger* is a short-day plant and *E. pulcherrima* is a long-day plant.

Compare the flowering patterns of these two species when exposed to each of the different periods of light and dark shown in **Fig. 33.1**.

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

Additional space if required.

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(ii) Explain how flowering plants monitor periods of light and dark.

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

(iii) Some plants are known as day-neutral because flowering is not affected by daylength.

Suggest **one** environmental factor that could trigger flowering in day-neutral plants.

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

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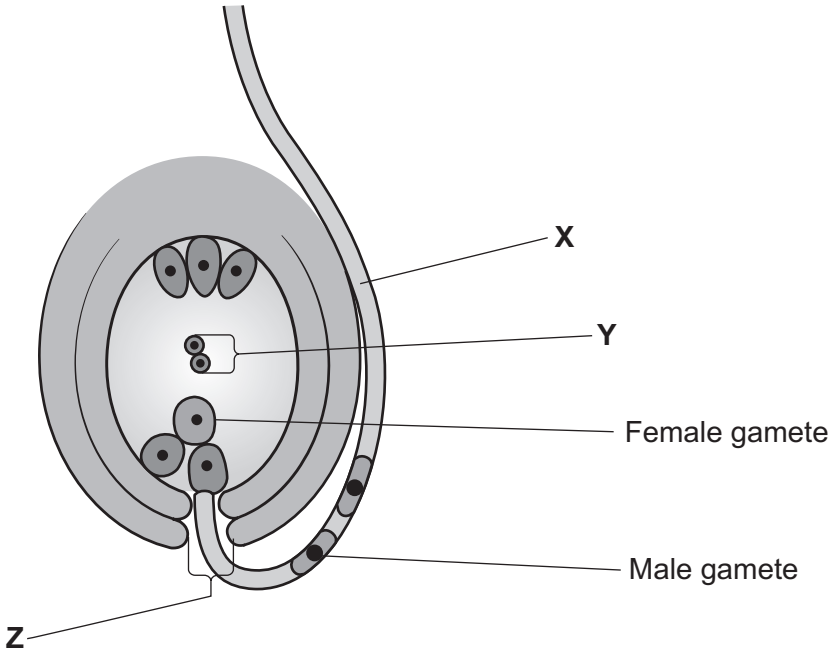
(b) **Fig. 33.2** shows the process of fertilisation in a flowering plant.

Fig. 33.2



(i) Identify the structures labelled **X** and **Z**.

Structure **X** .....

Structure **Z** .....

[2]

(ii) Describe what happens to structure **Y** during **and** after fertilisation.

During fertilisation .....

.....

After fertilisation .....

.....

[2]

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(iii) Explain how the production of the male and female gametes in **Fig. 33.2** ensures they are genetically different to the parent plants.

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

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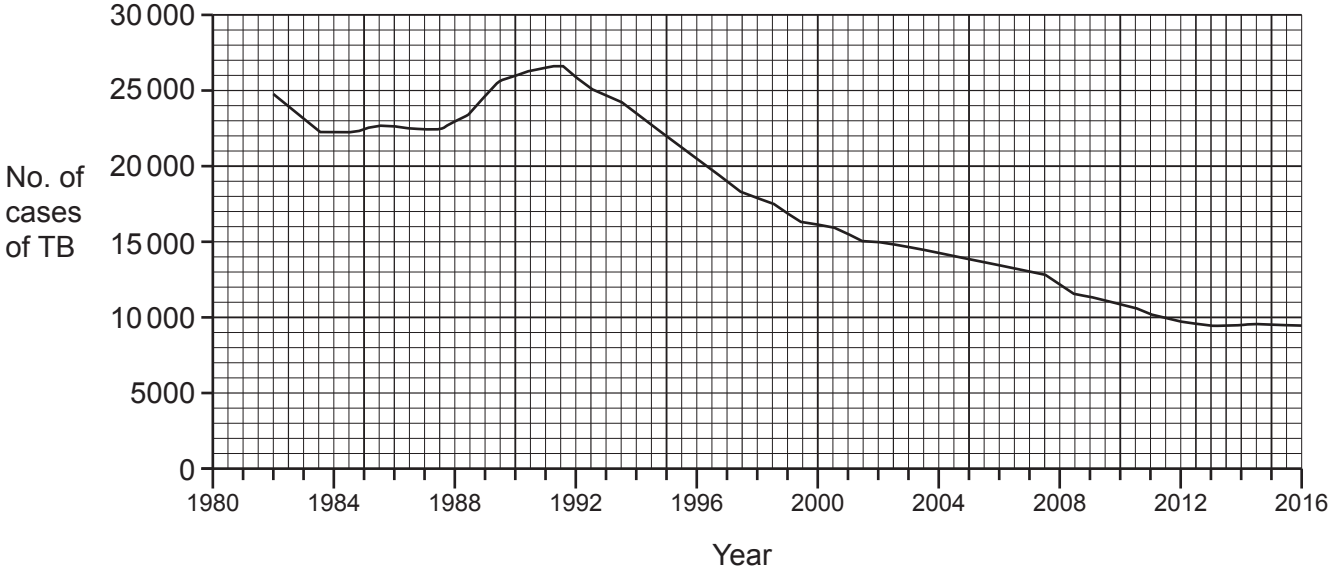
34 Tuberculosis (TB) is a disease caused by a pathogen.

(a) State the name of the pathogen that causes TB.

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

(b) In many countries TB is a notifiable disease and the number of cases in the population are recorded each year.

The graph shows the number of cases of TB recorded in the United States of America (USA) between 1982 and 2016.



(i) Suggest **one** advantage of recording data on notifiable diseases such as TB.

.....

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

(ii) In 2015 the population of the USA was estimated at 320 million people.

Calculate the prevalence rate of TB in the USA in 2015.

Give your answer to **3** significant figures.

Rate = ... per 100 000 **[2]**

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(iii) The overall trend in the data shows a decrease in the prevalence rate of TB.

Suggest why there was an increase in prevalence rate that occurred between 1985 and 1991.

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.....

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

(c) The table shows some of the data recorded for TB in the USA in 2016.

Age group (years)	Sex	Number of cases per 100 000
0–5	male	1.3
	female	1.0
5–14	male	0.3
	female	0.4
15–24	male	2.5
	female	1.9
25–44	male	3.8
	female	2.8
45–64	male	4.6
	female	2.1
65 and over	male	6.5
	female	3.2

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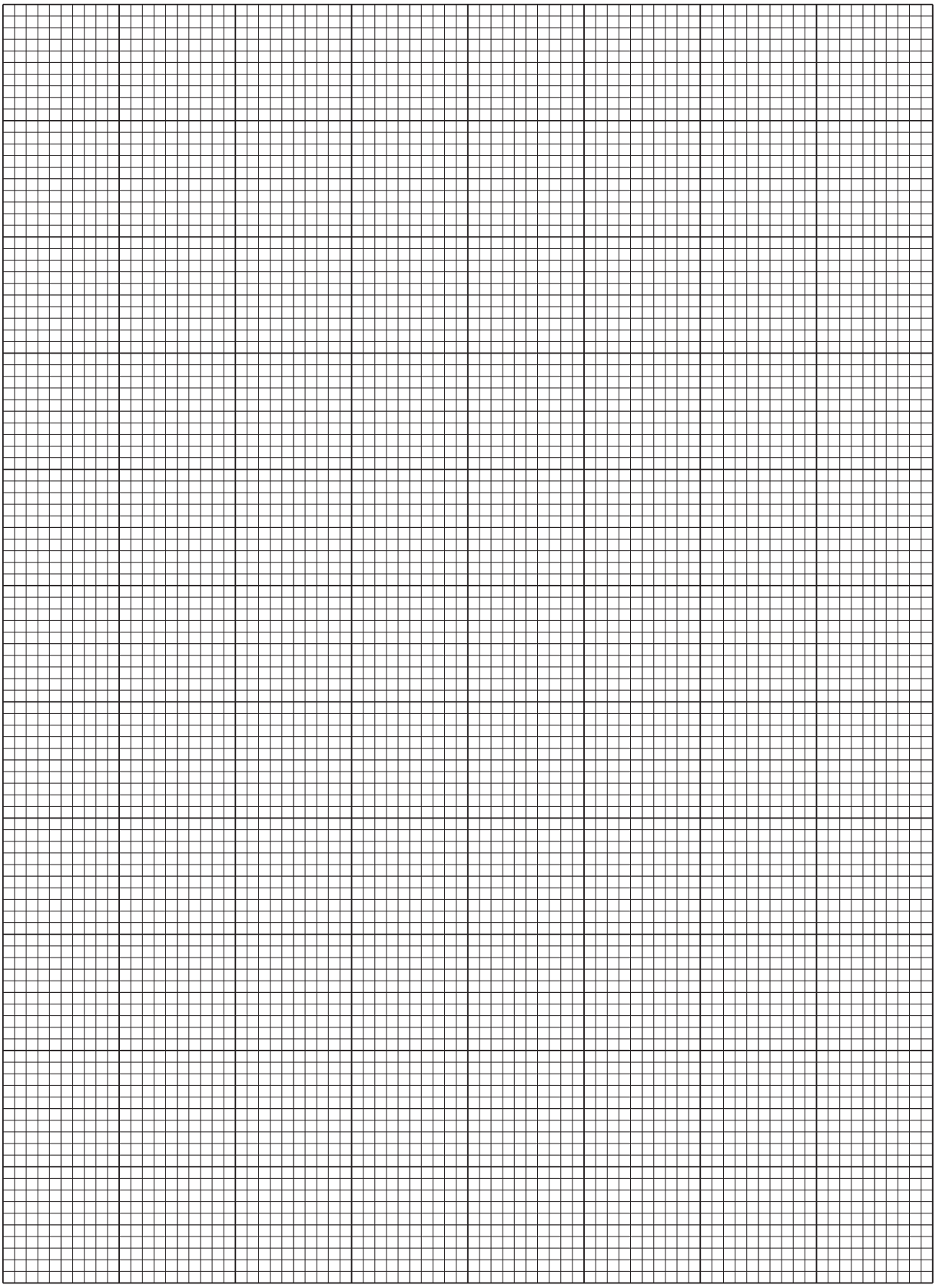
(i) Plot the results from the table on the grid.



[3]

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(ii) The following conclusions were drawn from these data:

- The risk of TB increases with age.
- Males have a greater risk of contracting TB than females.

Evaluate these conclusions.

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.....

.....

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

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35 In the UK, pregnant women receive dietary advice as part of an antenatal care programme.

(a) The table shows the roles of some of the nutrients required by pregnant women as part of a balanced diet.

Complete the table by stating the name of a nutrient that matches the role.

Role in the growing fetus	**Nutrient**
DNA synthesis, production of erythrocytes and cell division	.....
Synthesis of haemoglobin	.....
Synthesis of the pigment, rhodopsin	.....

[3]

(b) In addition to dietary advice, pregnant women are offered tests to monitor their health and the health of the fetus.

The tests offered includes testing urine for the presence of glucose which could indicate gestational diabetes.

State **one** other test offered to pregnant women and give a reason why it is offered.

Test .....

.....

Reason .....

.....

[2]

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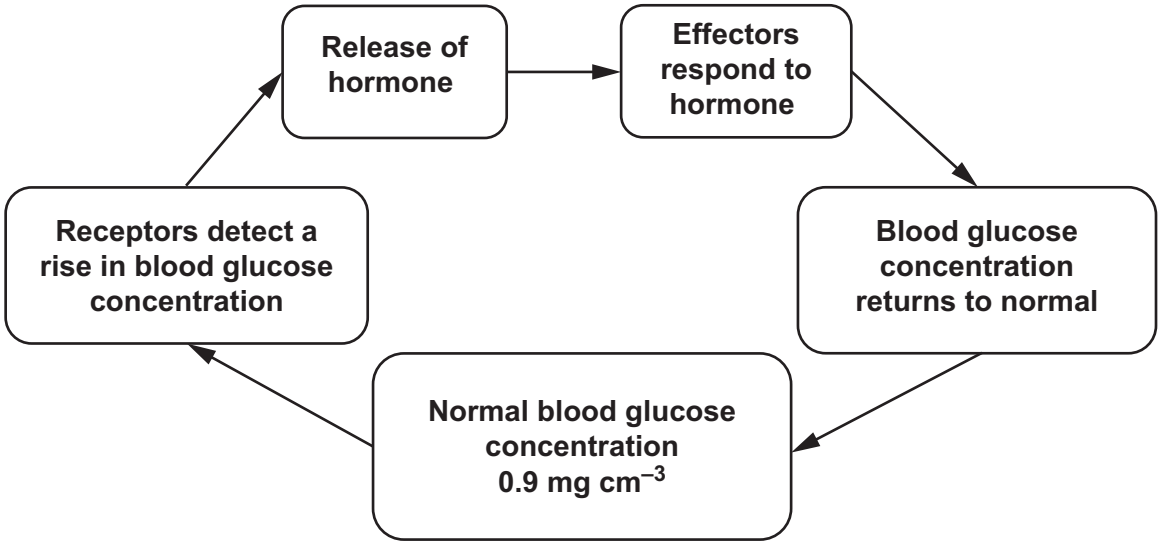
(c) Gestational diabetes is a type of diabetes that only occurs in pregnancy.

In women with gestational diabetes, the homeostatic control of glucose concentration in the blood does not function correctly during their pregnancy.

The diagram below shows part of the negative feedback mechanism for the homeostatic control of glucose.



(i) State the name of the receptors that detect a rise in blood glucose concentration **and** their location in the body.

Name .....

Location in the body .....
[1]

(ii) Explain how the effectors respond to the hormone to return blood glucose concentration to normal.

.....

.....

.....

.....

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

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(iii) Gestational diabetes is similar to type 2 diabetes.

Explain why blood glucose concentration is **not** controlled in women with gestational diabetes.

.....

.....

.....

.....

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

(d) Women with gestational diabetes during pregnancy have an increased risk of developing type 2 diabetes in later life.

(i) Suggest why these women have an increased risk of developing type 2 diabetes.

.....

.....

.....

.....

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

(ii) Suggest **one** way that women with gestational diabetes could reduce the risk of developing type 2 diabetes in later life.

.....

.....

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

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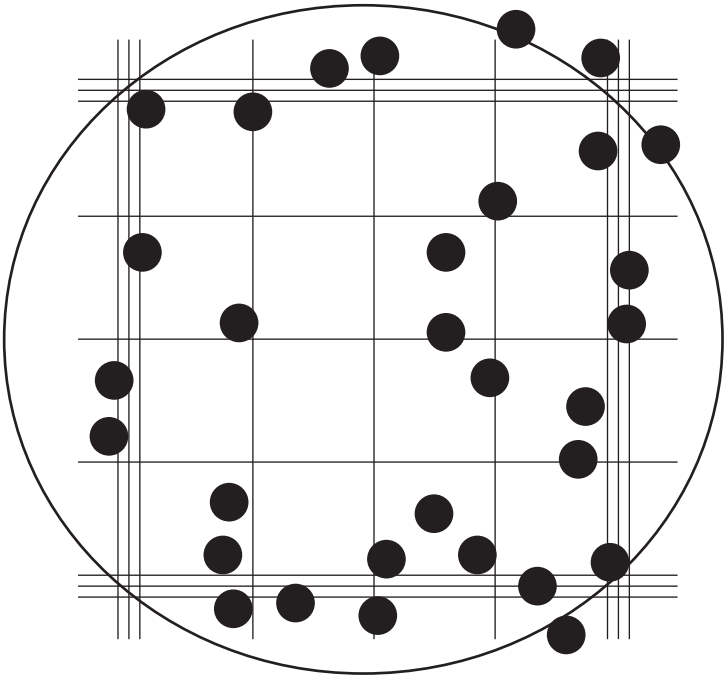
36 A group of students were using a haemocytometer to count the number of algal cells in a population.

Each student used the same method to prepare their cell samples for viewing under a microscope.

The drawing shows the field of view seen by one of the students.



(a) The student counted all the cells in their field of view.

The other students stated that this method of counting cells was not correct and would affect their class results.

(i) Outline a correct method for counting cells using a haemocytometer.

.....

.....

.....

.....

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

(ii) Explain how the class results would be affected by including the results obtained by the student who counted all the cells in their field of view.

.....

.....

.....

.....

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

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(b) Other methods can be used to count cells.

Complete the sentences about a method to count cells using the most appropriate word(s).

..... is an electronic method of counting cells that uses laser beams. The cells can be tagged to make them ..... when they pass through the laser beam. The specific scattering of light as each cell passes through the beam allows them to be counted and also for their ..... and physical characteristics to be analysed.

[3]

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

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

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