

**Answer ALL questions.**

**Write your answers in the spaces provided.**

**Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.**

**1** Many of the chemicals found in living organisms are polymers.

(a) (i) Which of the following molecules are all polymers?

(1)

- A** polypeptides, nucleotides, starch
- B** polypeptides, starch, lipids
- C** proteins, carbohydrates, lipids
- D** proteins, nucleic acids, starch

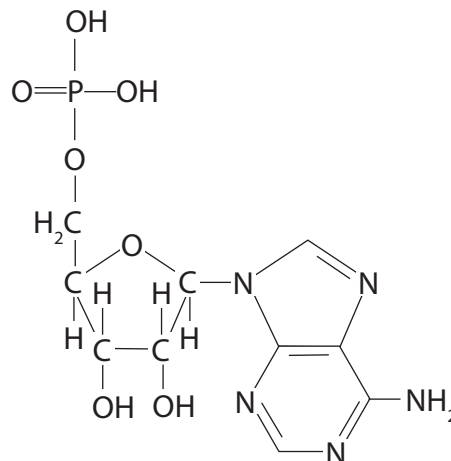
(ii) Which of the following molecules is made of different monosaccharides?

(1)

- A** amylose
- B** glycogen
- C** lactose
- D** maltose

(iii) The diagram shows the structure of a monomer.

(1)



This monomer is found in

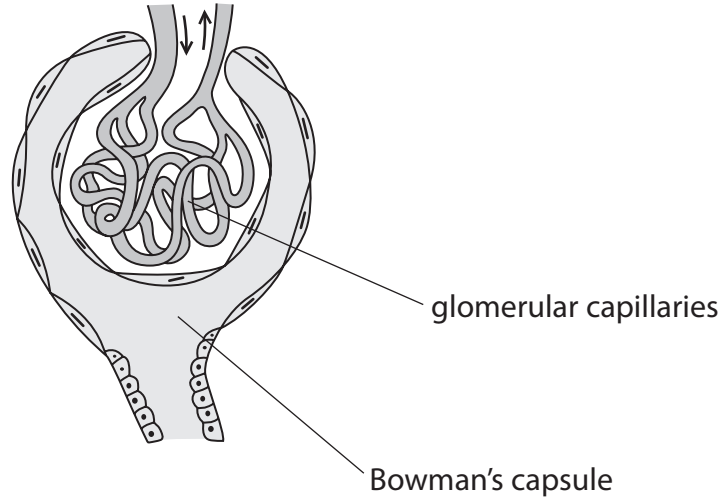
- A** DNA
- B** DNA polymerase
- C** haemoglobin
- D** mRNA





3 If untreated, high blood pressure can cause kidney damage.

The diagram shows a Bowman's capsule and the glomerular capillaries in a human's kidney.



The table shows the hydrostatic pressure in the glomerular capillaries and in the Bowman's capsule. It also shows the oncotic pressure of the blood in the glomerular capillaries.

Pressure and location in kidney	Pressure / kPa
hydrostatic pressure in glomerular capillaries	+9.2
hydrostatic pressure in Bowman's capsule	+2.0
oncotic pressure in glomerular capillaries	-4.0

(a) Use the data from the table to explain why glomerular filtrate is produced.

(2)

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- 4 The photograph shows a stonechat, *Saxicola dacotiae*.  
The species breeds only on the island of Fuerteventura.



- (a) Which of the following is the best definition of a species?

Individuals of the same species can interbreed to produce

(1)

- A fertile offspring
- B hybrid offspring
- C sterile offspring
- D viable offspring

- (b) Explain how this species of stonechat may have evolved on the island of Fuerteventura.

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(c) A survey has shown that there may be fewer than 1 000 pairs of *S. dacotiae* on Fuerteventura.

The number has declined over the last 20 years due to habitat loss.

Explain the role of zoos in the conservation of species such as *S. dacotiae*.

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**(Total for Question 4 = 9 marks)**



5 A person visited their doctor with symptoms of fatigue, dizziness and mental confusion.

The doctor suspected a heart condition and carried out an electrocardiogram (ECG).

The chart shows this ECG trace.



(a) (i) Which wave of a normal ECG trace is missing?

(1)

- A P
- B QRS
- C ST
- D T

(ii) The doctor diagnosed a heart condition called 'Sick Sinus Syndrome' (SSS).

Use the information in the trace to explain the electrical activity in this person's heart.

(3)

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(iii) The diagram shows a normal ECG trace.



Calculate the difference between the heart rates of this normal ECG trace and that of the person with Sick Sinus Syndrome.

(2)

Answer ..... beats  $\text{min}^{-1}$

(iv) Analyse the data to explain the symptoms of Sick Sinus Syndrome.

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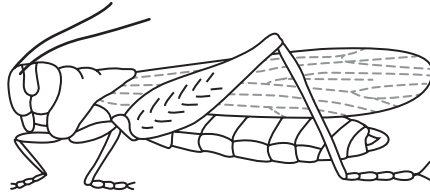
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**(Total for Question 5 = 8 marks)**



- (b) (i) Many living organisms need a gas exchange system.

The drawing shows a locust.



Magnification  $\times 1$

Explain why a locust has a gas exchange system whereas a *Paramecium* does not.

(2)

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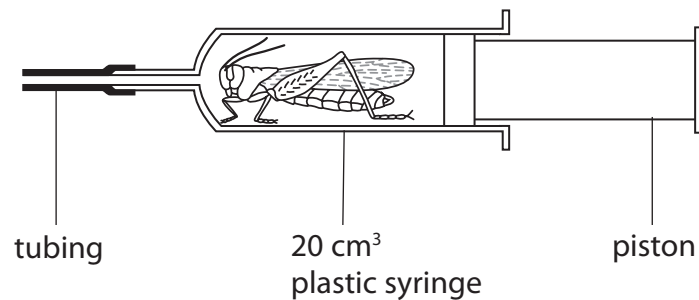
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- (ii) A student placed a locust inside a transparent syringe and observed the movement of the abdomen.



The student recorded the number of times the abdomen pumped in 30 seconds. This was carried out three times.

The syringe was then flushed with atmospheric air and the procedure repeated first with air exhaled by a human, then pure oxygen and then a mixture of 5% carbon dioxide and 95% oxygen.

The syringe was flushed with atmospheric air in between each treatment.

The results are shown in the graph on page 14.



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**(Total for Question 6 = 12 marks)**



7 The island of Lanzarote is near the African coast and has a desert climate.

The photograph shows the edge of a lava flow from a volcano that erupted on this island about 200 hundred years ago.

In the foreground is an area that was not covered by the lava flow.

Over a long period of time, the lava will change to look like the climax community seen in the foreground.



lava flow

climax community  
in foreground

(a) Explain how the edge of the lava flow will change over time to look like the foreground.

(4)

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(b) (i) King Juba's spurge, *Euphorbia regis-jubae*, is a plant that occupies a niche in the climax community.

Explain the niche occupied by King Juba's spurge.

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(ii) King Juba's spurge grows very slowly on the island of Lanzarote.

Explain how climate affects the growth of King Juba's spurge on this island.

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**(Total for Question 7 = 11 marks)**



- 8 The stems of tomato plants can be green or purple, hairy or smooth.

The allele for purple stems (P) is dominant to the allele for green stems (p). The allele for hairy stems (H) is dominant to the allele for smooth stems (h).

- (a) Two tomato plants, heterozygous for both stem characteristics, were crossed.

Draw a genetic diagram to show the expected ratio of phenotypes of the plants obtained from this cross.

(4)



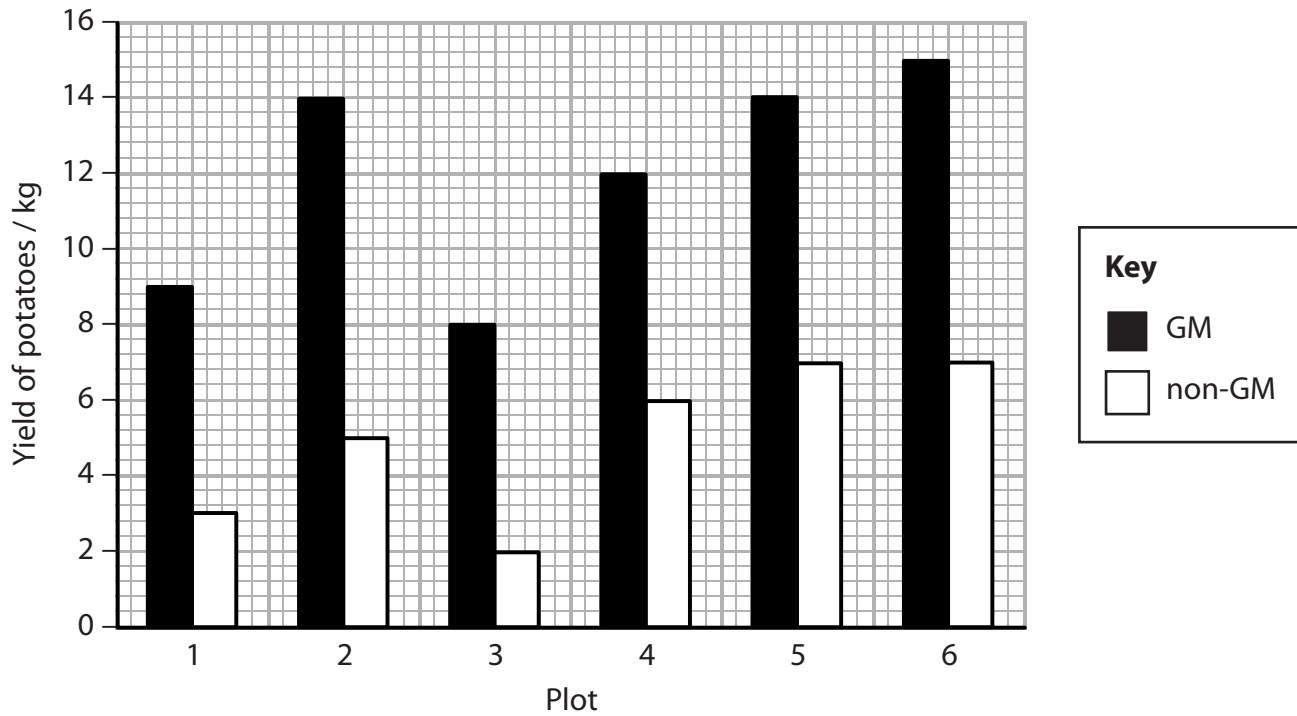


(b) Tomato plants and potato plants are both affected by a fungal disease called blight.

In 2014, a study was carried out to compare the yield of potatoes genetically modified (GM) for blight resistance with the yield of non-modified (non-GM) potatoes.

The study was carried out using 96 plants of each variety, equally divided between six different plots.

The graph shows the results of this study.



(i) Calculate the percentage change in yield due to blight resistance in plot 2.

(2)

Answer .....%



(ii) The raw data for potato yield in this study are shown in the table.

Plot number	Potato yield / kg	
	GM	non-GM
1	9.0	3.0
2	14.0	5.0
3	8.0	2.0
4	12.0	6.0
5	14.0	7.0
6	15.0	7.0
Mean	12.0	5.0
Standard Deviation	2.9	2.1

A Student's *t*-test was used to compare the potato yields.

State a suitable null hypothesis for this test.

(1)

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(iii) Calculate the *t* value for the data to compare GM with non-GM potato yields, using the formula:

(3)

$$t = \frac{x_1 - x_2}{\sqrt{\left(\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}\right)}}$$

Answer .....







- 9 The ability to taste phenylthiocarbamide (PTC) depends on a single gene.

This gene has two alleles. One is a dominant, tasting allele (T), and the other is a recessive, non-tasting allele (t).

In a survey, it was found that 64% of people could taste PTC.

- (a) The Hardy-Weinberg equation is

$$(p + q)^2 = 1$$

Use this equation to calculate the proportion of the population who would be TT, Tt and tt.

(4)

- (b) There is no known selective advantage for being able to taste PTC.

- (i) Describe two conditions under which these proportions remain the same over many generations.

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(ii) In native American populations 98% of individuals can taste PTC.

In native Australian population 58% of individuals can taste PTC.

State why these two populations have different frequencies of the T allele.

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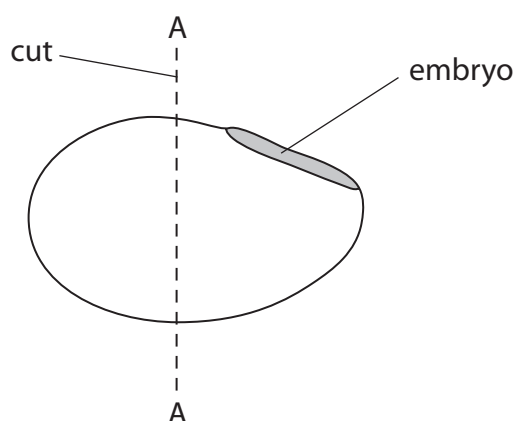
**(Total for Question 9 = 9 marks)**

**10** Gibberellin stimulates amylase activity. Amylase converts insoluble starch into maltose.

A student suggested that developing embryos in seeds produce gibberellin.

To test this idea, the student carried out two experiments.

In each experiment barley seeds were cut as shown in the diagram.



The seed halves were sterilised by washing in bleach.

In the first experiment, seed halves that contained an embryo were placed on sterile starch agar.

Seed halves without an embryo were placed on sterile starch agar and on sterile starch agar containing gibberellin.

The seed halves were incubated for 48 hours at 25°C. Iodine solution was then poured over the agar.

The table shows the results of the student's first experiment.

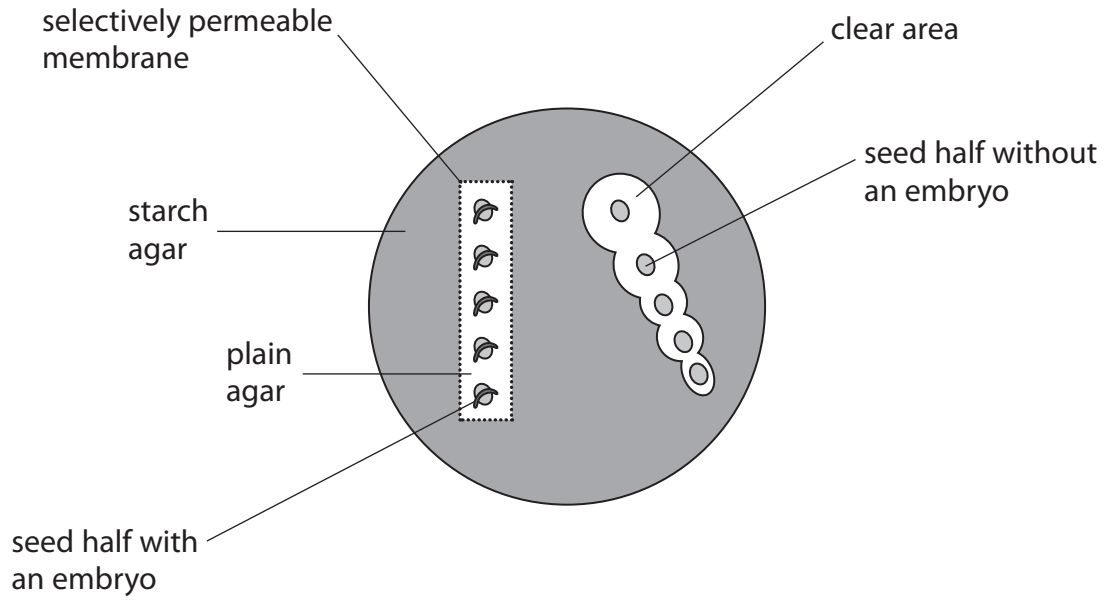
Agar	Seed halves	Result
starch	with an embryo	clear area around seed halves
starch	without an embryo	no clear area around seed halves
starch + gibberellin	without an embryo	clear area around seed halves

In the second experiment, seed halves containing an embryo were placed onto plain agar in a "boat" made from a selectively permeable membrane.

This boat was embedded in starch agar.

These seed halves were also incubated for 48 hours at 25°C. Iodine solution was then poured over the agar.

The diagram shows the results from the second experiment.



(a) Explain why sterile conditions were maintained.

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\***(b)** Analyse the data from these two experiments to explain the results obtained by the student.

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**(Total for Question 10 = 8 marks)**

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**TOTAL FOR PAPER = 90 MARKS**