

Student Number									
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2022

YEAR 11 YEARLY EXAMINATION

Biology

**General
Instructions**

- Reading time – 5 minutes
- Working time – 90 minutes
- Write using black pen
- Draw diagrams using pencil
- Calculators approved by NESA may be used

**Total Marks:
60**

Section I – 10 marks

- Attempt questions 1–10
- Allow about 15 minutes for this part

Section II – 60 marks

- Attempt questions 11–18
- Allow about 1 hour and 15 minutes for this part

Section I

10 marks

Attempt Questions 1–10

Allow about 15 minutes for this part

Use the multiple-choice answer sheet for Question 1–10.

Select the alternative A, B, C or D that best answers the question. Fill in the response circle completely.

Sample $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

A B C D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A B C D

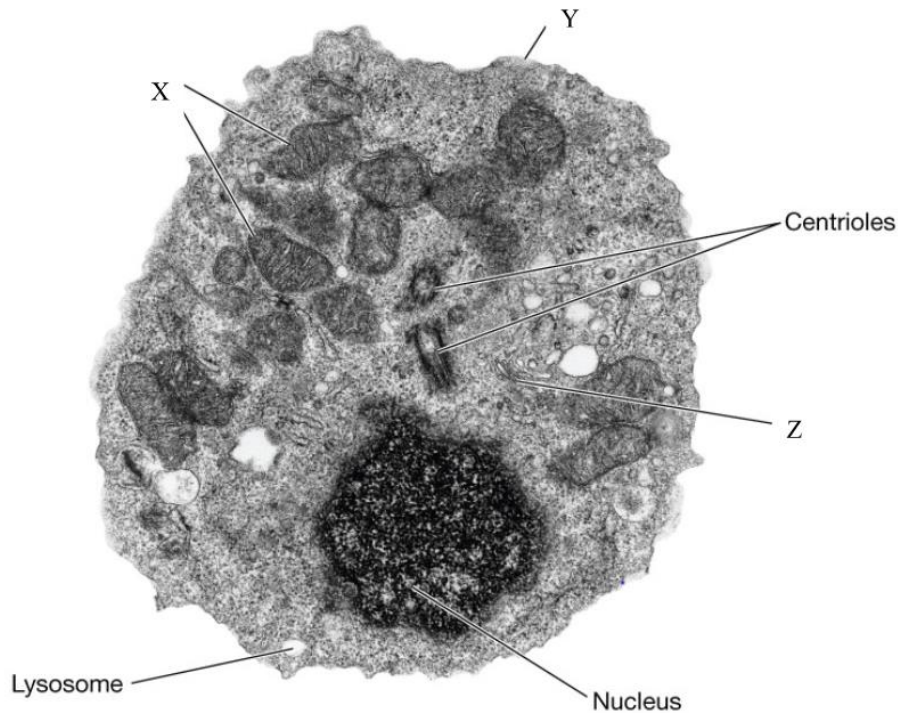
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correct
A B C D

-
- 1 Cells are composed of and require chemicals to function. Cells are mostly made up of water but also contain other inorganic and organic molecules. Which of the following only contains organic molecules?

- A. Lipids, proteins, phosphorus, iron
- B. Vitamin C, lipids, magnesium, oxygen
- C. Nucleic acids, proteins, lipids, magnesium
- D. Proteins, lipids, nucleic acids, vitamin C

2 The image below shows an electron micrograph of an animal cell.



The label X can best be described as which organelle?

- A. Mitochondria
- B. Plasma membrane
- C. Golgi apparatus
- D. Chloroplasts

3 Which of the following statements best describes facilitated diffusion?

- A. It is a type of active diffusion where particles move from an area of high concentration to an area of low concentration and occurs through a protein channel in the membrane.
- B. It is a type of active diffusion where particles move from an area of relatively low concentration to an area of high concentration and occurs against a concentration gradient.
- C. It is a type of passive diffusion where particles move from an area of low concentration to an area of high concentration and occurs through a protein channel in the membrane.
- D. It is a type of passive diffusion where the movement of particles is from an area of high concentration to an area of low concentration and occurs through a protein channel in the membrane.

- 4 Biologists Peter and Rosemary Grant conducted long term studies on the evolution of Darwin's finches on the Galapagos Islands. They measured the beak depth of birds over a 40-year period, during which time the island experienced severe drought which killed many of the finches.

The results of their studies for the years 1976 (before the drought) and 1978 (after the drought) are shown in the graphs below.

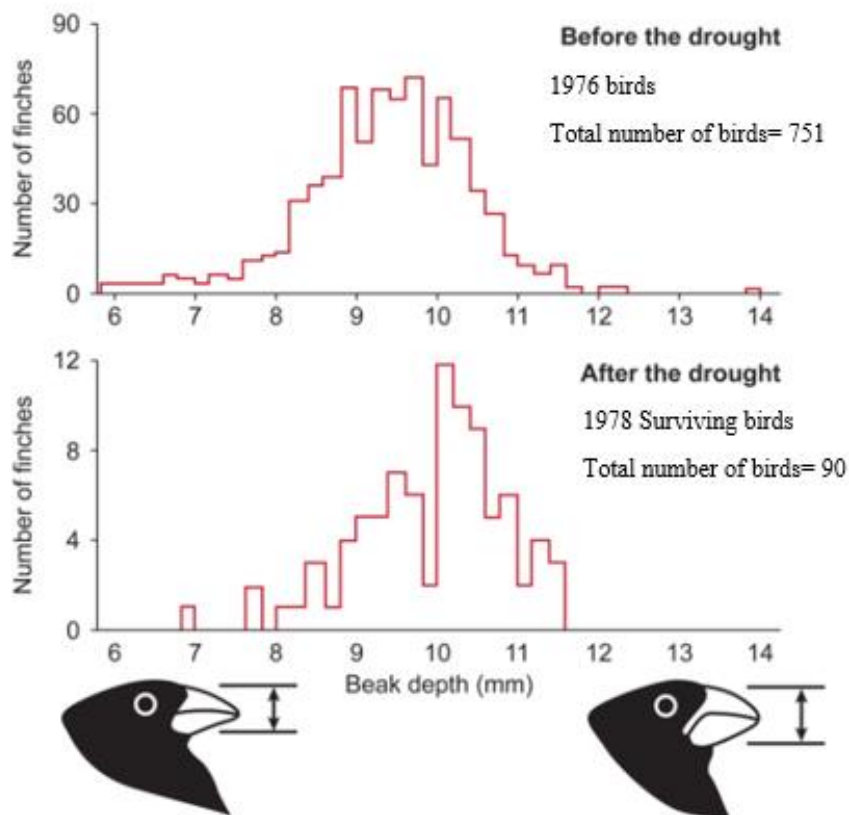
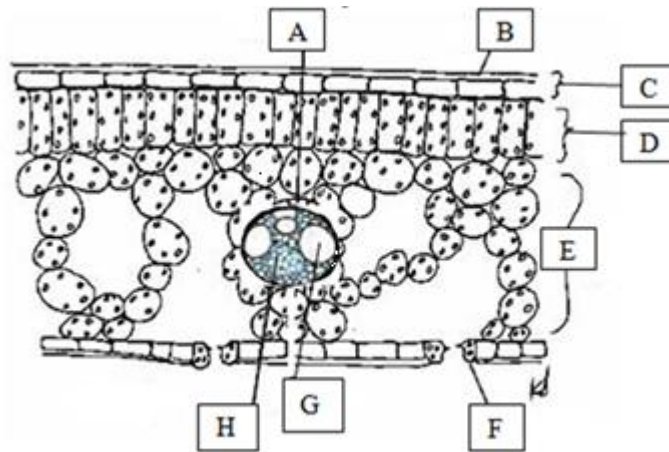


Image: UC Museum of Palaeontology Understanding Evolution, www.understandingevolution.org

What conclusion could be drawn from the data given above?

- A. The most common beak depth of the population before the drought was 10.2mm.
- B. The average beak depth of the population after the drought is smaller than the original population.
- C. Finches with larger beak depth had an advantage in surviving the drought conditions.
- D. Finches with smaller beak depth had an advantage in surviving the drought conditions.

5 The diagram below shows a transverse section of a leaf.



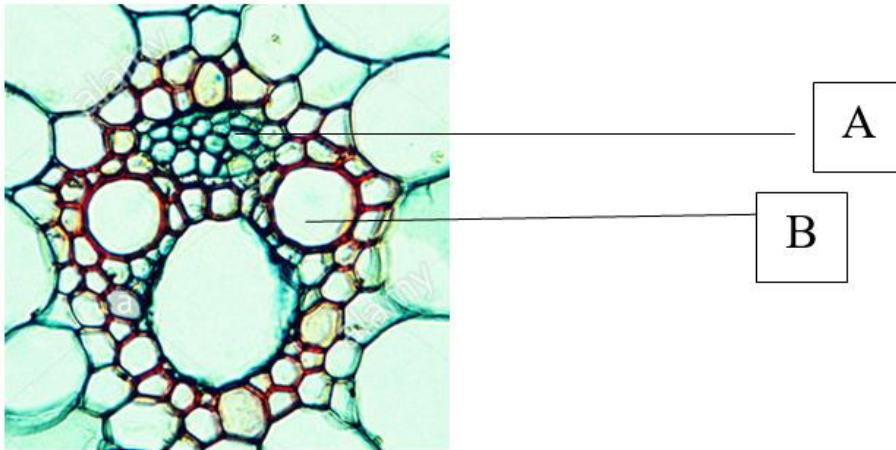
The spongy mesophyll tissue of the leaf is represented by which of the following letters?

- A. C
- B. D
- C. E
- D. F

6 What is the main function of the stomata?

- A. To control gas exchange and regulate the exchange of water between the plant's internal environment and surrounding environment.
- B. To transport water and inorganic nutrients around the plant.
- C. To transport organic nutrients such as sucrose around the plant.
- D. Stomata provide support for the leaf and are always located on the underside of the leaf.

7 The image below shows a cross section of a plant's vascular bundle.

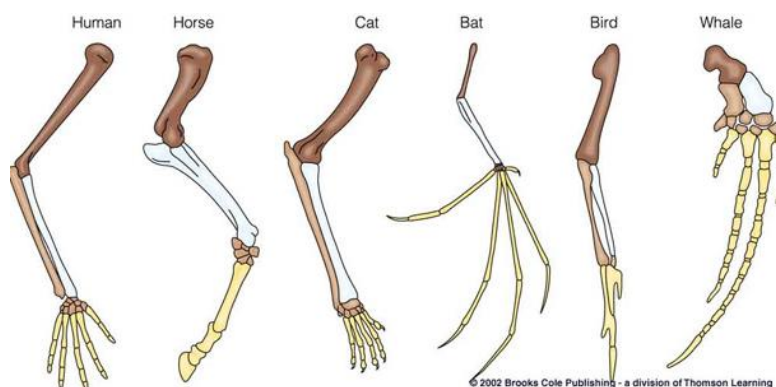


Source: <https://c8.alamy.com/comp/DE4N82/zea-stem-cross-section-vascular-bundle-vascular-tissue-xylem-phloem-DE4N82.jpg>

Which of the following best identifies structure A and its function?

- A. A is the phloem and its function is to carry water and mineral ions from the roots to the leaves
- B. A is the phloem and its function is to carry sugar and other organic molecules from the leaves to the roots
- C. A is the xylem and its function is to carry water and mineral ions from the roots to the leaves
- D. A is the xylem and its function is to carry sugar and other organic molecules from the leaves to the root

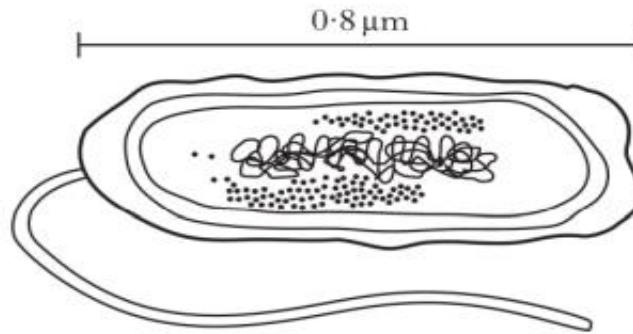
8 The picture shows the limbs of various animals.



Which evolutionary concept is supported by these structures?

- A. Convergent evolution
- B. Divergent evolution
- C. Coevolution
- D. Parallel evolution

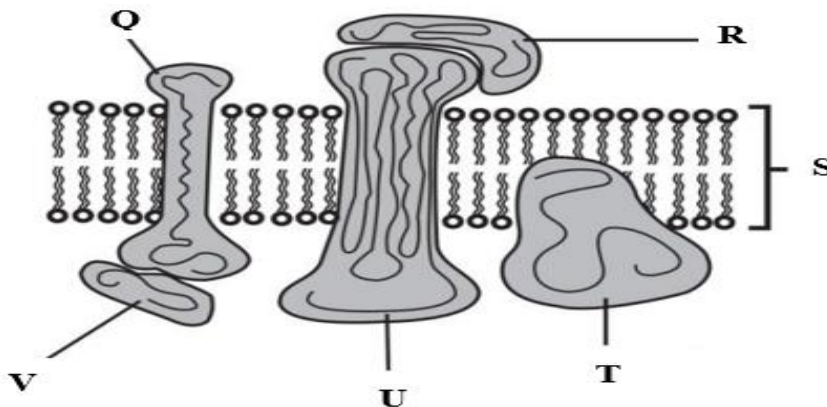
9 The following diagram shows a bacterial cell (drawing not to scale)



What is the length of this cell in millimetres (mm)?

- A. 0.0008
- B. 0.008
- C. 80
- D. 800

10 The diagram below shows the fluid mosaic model of a cell membrane.



Which line in the table identifies the correct name of the features Q and S?

	Q	S
A.	Peripheral membrane protein	Phospholipid bilayer
B.	Glycolipid	Carbohydrate chain
C.	Integral membrane protein	Phospholipid bilayer
D.	Glycoprotein	Cholesterol

End of Part A

Student Number								
Total /10								

Biology
Section I – Objective Response

10 marks
Attempt Questions 1 – 10
Allow about 15 minutes for this section

Write your student number at the top of this Section I Response Booklet

Select the alternative A, B, C or D that best answers the question and fill in the response circle completely.
Use ink for your answers.

- | | | | | |
|-----|-----|-----|-----|-----|
| 1. | A ○ | B ○ | C ○ | D ○ |
| 2. | A ○ | B ○ | C ○ | D ○ |
| 3. | A ○ | B ○ | C ○ | D ○ |
| 4. | A ○ | B ○ | C ○ | D ○ |
| 5. | A ○ | B ○ | C ○ | D ○ |
| 6. | A ○ | B ○ | C ○ | D ○ |
| 7. | A ○ | B ○ | C ○ | D ○ |
| 8. | A ○ | B ○ | C ○ | D ○ |
| 9. | A ○ | B ○ | C ○ | D ○ |
| 10. | A ○ | B ○ | C ○ | D ○ |

Student Number								
Section I /10								
Section II /50								
Total /60								

**Biology
Section II**

**50 marks
Attempt Questions 11 – 18
Allow about 1 hour 15 minutes for this section**

Instructions

- Write your student number at the top of this page.
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of the response.
- Extra writing paper is available on the last page.
- If you need more paper than provided, please raise your hand to request more paper.
- If you use extra paper, clearly indicate your student number and which question you are answering.

Please turn over

Question 11 (5 marks)

a) Complete the table by inserting the correct type of adaptation for each plant feature.

3

Plant feature	Type of adaptation
Sunken stomata	
Touch-me-not plant curling its leaves upon touch	
Salt secreted through glands on the leaf surface	

b) Many species of Acacia, grow throughout Australia. One of the species of Acacia shown below is found in the Blue Mountains in New South Wales and one grows in the desert of Central Australia.

2



Identify whether Species A or Species B is the species that grows in the desert and provide one reason for your answer.

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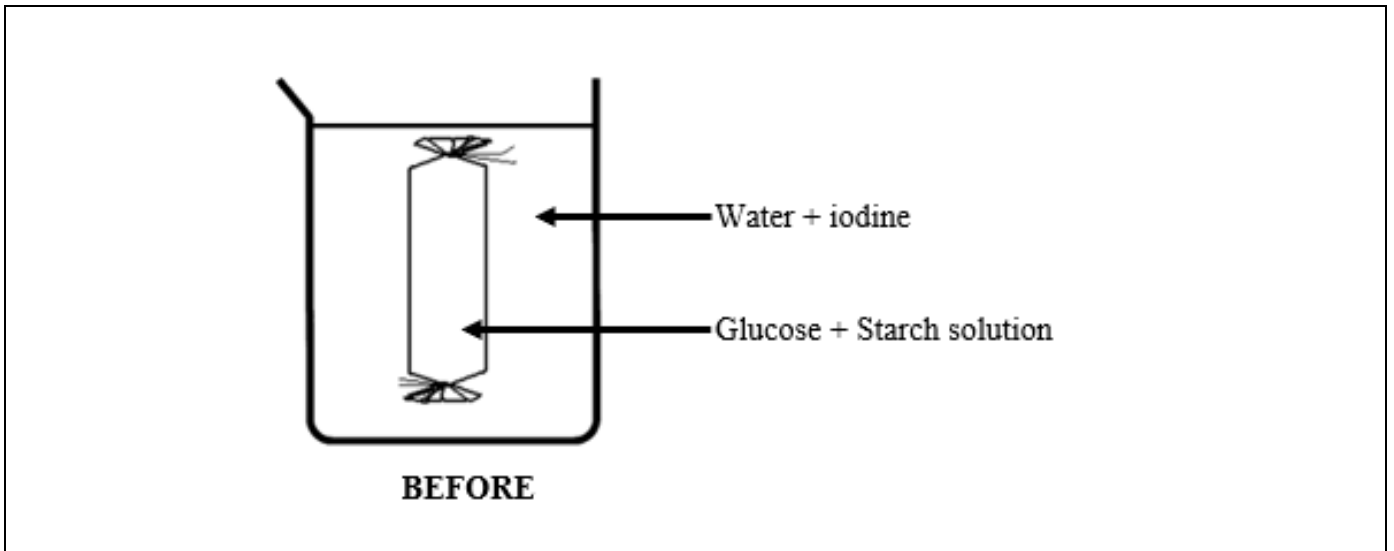
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Question 12 (4 marks)

A student set up the following experiment to model the movement of materials into and out of cells. When iodine comes into contact with starch, it turns a blue-black colour.



She left the experiment for 30 minutes, then recorded her results in the table below.

Initial Contents	Solution Colour		Presence of Glucose	
	Initial	Final	Initial	Final
Dialysis Tubing (15% Glucose + 1% Starch)	Clear	Blue-black	+	+
Beaker (Water + iodine)	Straw yellow	Straw yellow	-	+

Explain how the results of this investigation model the movement of materials into and out of cells.

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Question 13 (8 marks)

- a) Outline how comparative embryology and biochemical evidence support the theory of evolution by natural selection.

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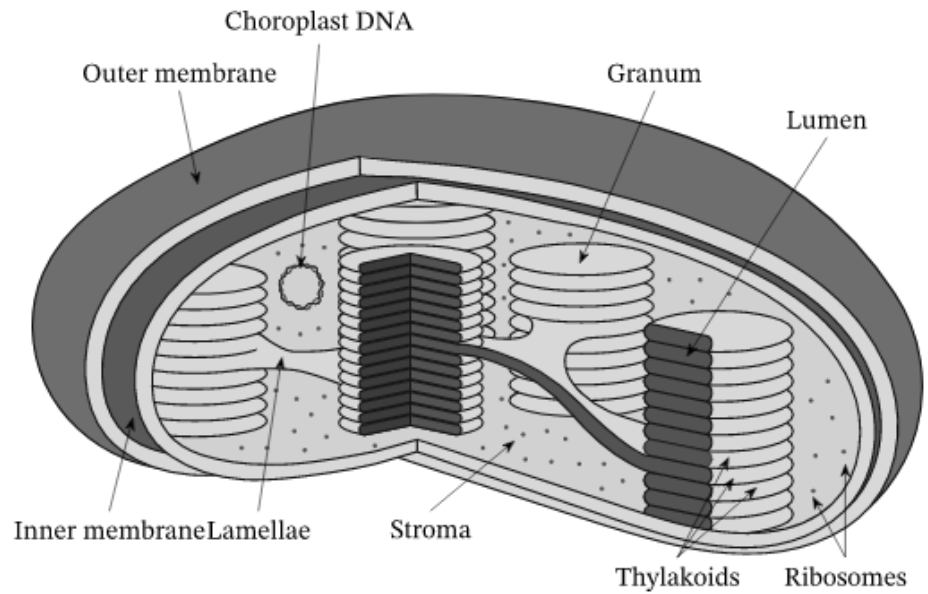
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Question 13 continues on the following page.

Question 14 (4 marks)

Light independent

Light dependent



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a) Draw arrows on the diagram of the chloroplast to identify the sites of the light independent and the light dependent reactions during photosynthesis.

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b) Describe the importance of the role played by photosynthesis in an ecosystem.

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Question 15 (7 marks)

a) Draw a series of labelled diagrams to show the lock and key model of enzyme function.

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b) State an advantage and a limitation of using models in Biology.

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c) In the space below, sketch a graph that shows the effect of temperature on enzyme activity.

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Question 16 (12 marks)

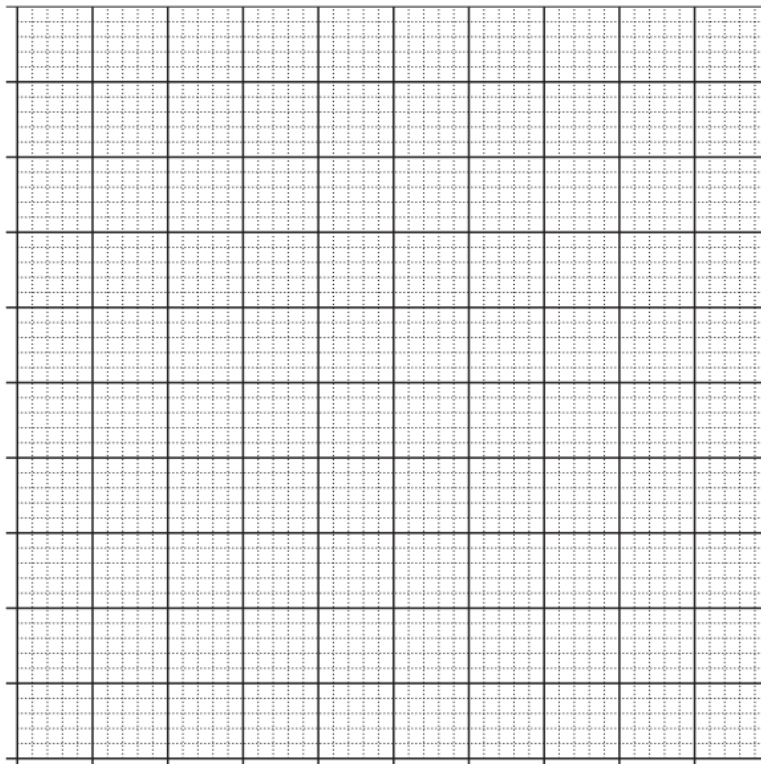
A student wanted to investigate the effect of different light intensities on the rate of photosynthesis in plants. The student set up an experiment where aquatic plants were placed in solution containing carbon dioxide and then exposed to different intensities of light. The number of oxygen bubbles produced by the plants over time were counted and recorded.

The experiment was repeated ten times for each light intensity and the average results are recorded in the table below.

Light Intensity (Lux)	Average number of bubbles produced in 30 seconds
0	0.00
2	7.00
4	11.0
6	14.0
8	14.5
10	15.0

a) Graph the data on the grid.

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b) Identify the independent and the dependent variables for this investigation. 2

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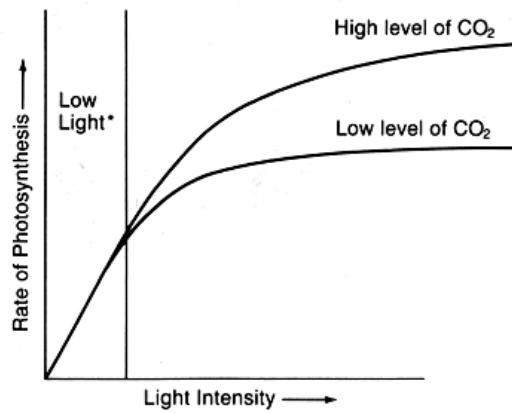
c) Identify a relevant controlled variable and justify why it should be controlled in this investigation. 2

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d) The student decided to extend their investigation by repeating the same experiment but with different concentrations of dissolved carbon dioxide (CO₂). The predicted results are shown in the graph below.



Explain the predicted results of this investigation. 4

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Question 17 (4 marks)

Table 1 shows the estimated population of southern brown bandicoots (*Isodon obesulus*) during a monthly live-trapping program in the Harry Waring Marsupial Reserve in Western Australia. In July, tracks and sightings indicated that a single fox entered the reserve. About six months later, its carcass was found.

Table 1: Estimated population of southern brown bandicoots (Isodon obesulus)

<i>Month</i>	<i>Estimated population of southern brown bandicoot</i>
September	80
October	78
November	60
December	100
January	96
February	125
March	131
April	120
May	116
June	120
July	118
August	60
September	20
October	18
November	13
December	14
January	16
February	14
March	30
April	35

Question 17 continues on the following page.

Question 18 (6 marks)

- a) Outline TWO similarities and TWO differences between the transport systems of animals and plants.

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- b) Identify and describe one theory that accounts for the movement of water in the xylem tissue of plants.

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End of Examination

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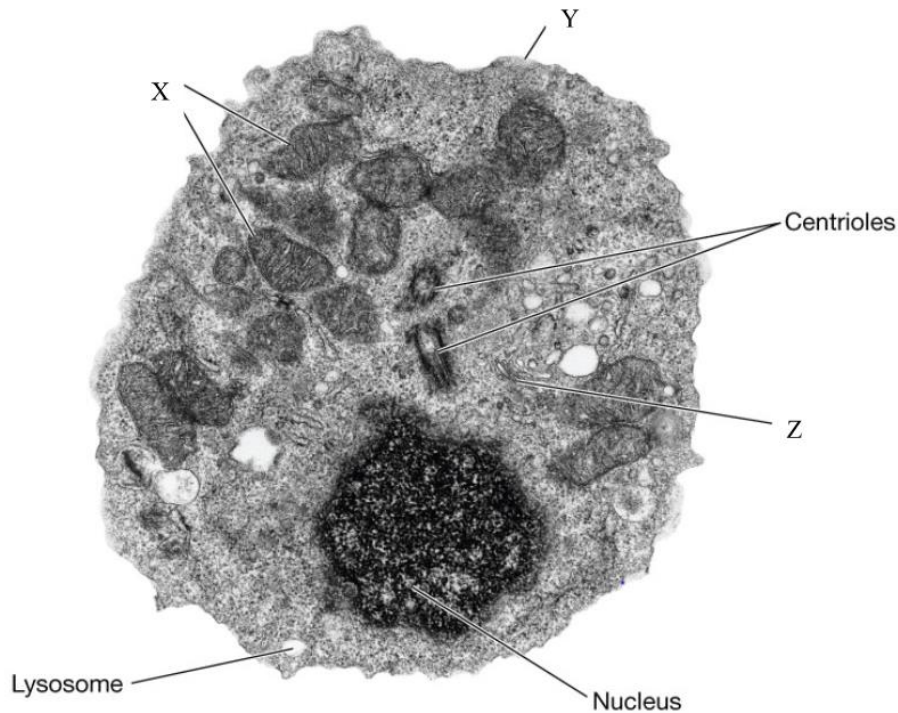
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- B. Vitamin C, lipids, magnesium, oxygen
- C. Nucleic acids, proteins, lipids, magnesium
- D. **Proteins, lipids, nucleic acids, vitamin C**

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The label X can best be described as which organelle?

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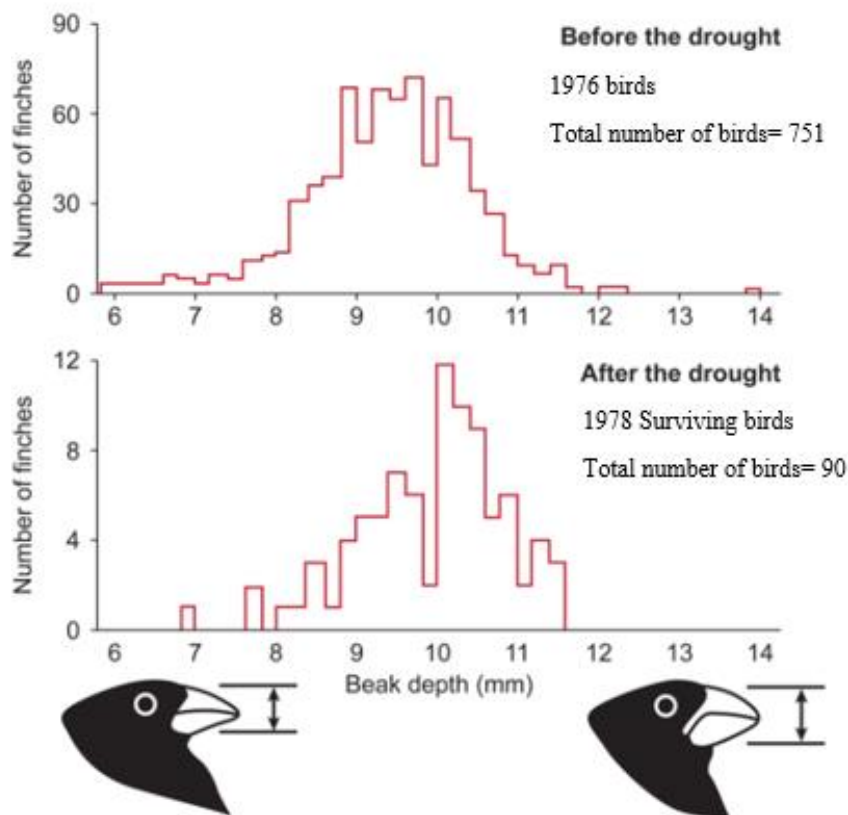
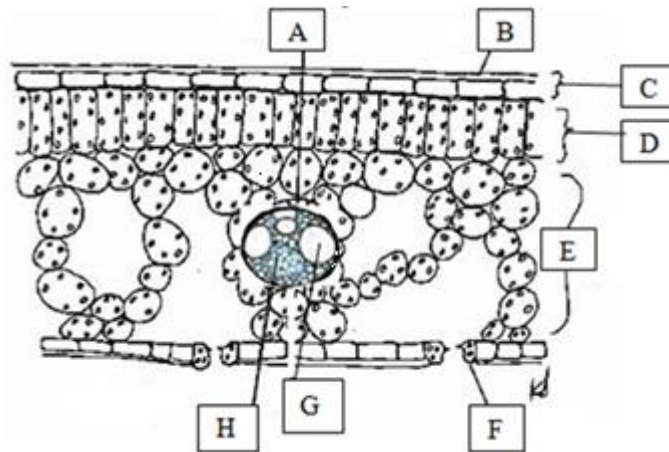


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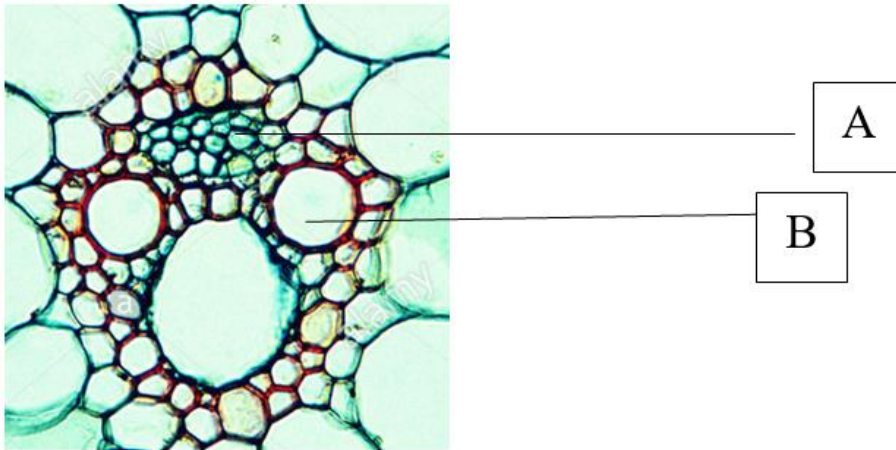
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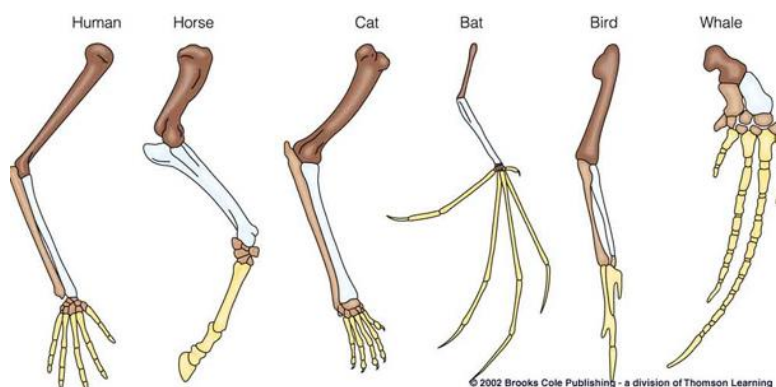


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Which of the following best identifies structure A and its function?

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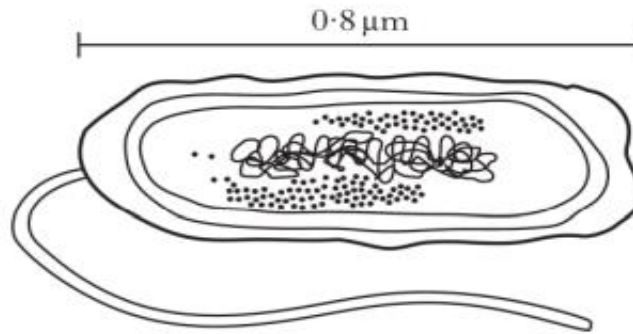
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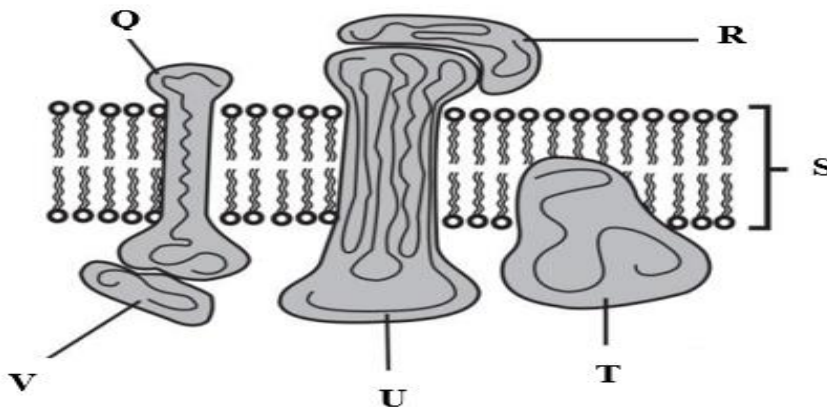
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Which line in the table identifies the correct name of the features Q and S?

	Q	S
A.	Peripheral membrane protein	Phospholipid bilayer
B.	Glycolipid	Carbohydrate chain
C.	Integral membrane protein	Phospholipid bilayer
D.	Glycoprotein	Cholesterol

End of Part A

Student Number								
Total /10								

Biology
Section I – Objective Response

10 marks
Attempt Questions 1 – 10
Allow about 15 minutes for this section

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- | | | | | |
|-----|-----|-----|-----|-----|
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| 2. | A ○ | B ○ | C ○ | D ○ |
| 3. | A ○ | B ○ | C ○ | D ○ |
| 4. | A ○ | B ○ | C ○ | D ○ |
| 5. | A ○ | B ○ | C ○ | D ○ |
| 6. | A ○ | B ○ | C ○ | D ○ |
| 7. | A ○ | B ○ | C ○ | D ○ |
| 8. | A ○ | B ○ | C ○ | D ○ |
| 9. | A ○ | B ○ | C ○ | D ○ |
| 10. | A ○ | B ○ | C ○ | D ○ |

Student Number								
Section I /10								
Section II /50								
Total /60								

**Biology
Section II**

50 marks

Attempt Questions 11 – 18

Allow about 1 hour 15 minutes for this section

Instructions

- Write your student number at the top of this page.
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Please turn over

Question 11 (5 marks)

a) Complete the table by inserting the correct type of adaptation for each plant feature.

3

Plant feature	Type of adaptation
Sunken stomata	Structural
Touch-me-not plant curling its leaves upon touch	Behavioural
Salt secreted through glands on the leaf surface	Physiological

1 mark 1 Correct answer

b) Many species of Acacia, grow throughout Australia. One of the species of Acacia shown below is found in the Blue Mountains in New South Wales and one grows in the desert of Central Australia.

2



Identify whether Species A or Species B is the species that grows in the desert and provide one **reason** for your answer.

Reason = to justify or explain.

Species A must be the species that grows in the desert. This is because Species A has very fine and pointy leaves. This must mean that Species A had adapted to an environment that is arid and dry with minimal water availability. The fine and thin leaf structure reduces the surface area on the leaves and thus reduces the number of stomata present in the leaves which reduces the rate of transpiration in the organism for evaporative cooling, minimising the rate of water loss in the organism to ensure its survival.

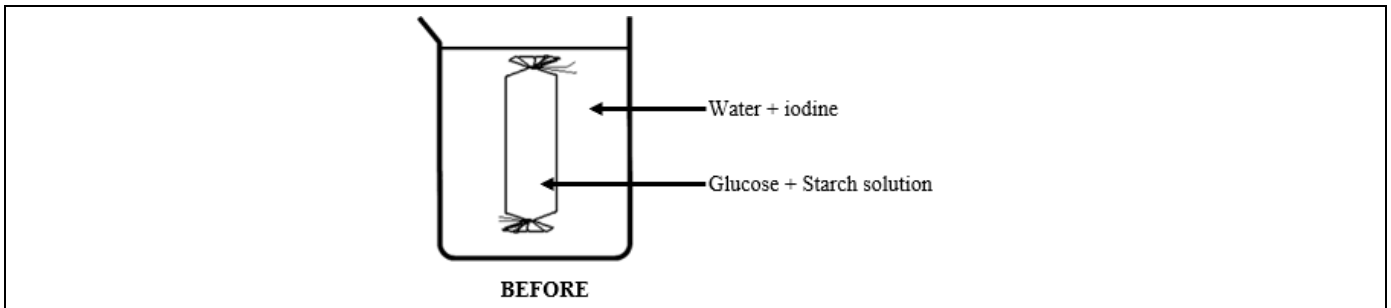
Marking criteria	Marks
<ul style="list-style-type: none"> Species A is identified as the plant species that grows in the desert. Explains how the thin needle-like leaf in plant A as the adaptation that assist the plant to reduce water loss. Less stomates to reduced transpiration, less SA for reduced rate of photosynthesis. 	2
<ul style="list-style-type: none"> One of the above 	1

Marker's feedback:

- Transpiration occurs primarily through the stomates. Hence, your answer should make a reference to a reduced number of stomates to sufficiently explain. However, if students only mention reduced SA, mark awarded (just).

Question 12 (4 marks)

A student set up the following experiment to model the movement of materials into and out of cells. When iodine comes into contact with starch, it turns a blue-black colour.



She left the experiment for 30 minutes, then recorded her results in the table below.

Initial Contents	Solution Colour		Presence of Glucose	
	Initial	Final	Initial	Final
Dialysis Tubing (15% Glucose + 1% Starch)	Clear	Blue-black	+	+
Beaker (Water + iodine)	Straw yellow	Straw yellow	-	+

Explain how the results of this investigation model the movement of materials into and out of cells.

4

This experiment demonstrates diffusion of substances through a semi-permeable membrane. The dialysis tubing represents the cell membrane, and the contents of the tubing and beaker represent materials inside/outside the cell.

The results show that smaller molecules, like iodine and glucose, were able to pass through the dialysis tubing, whereas the larger starch molecules could not diffuse through the membrane. This is shown in the results as glucose is present in the beaker after 30 minutes, and the iodine has diffused into the dialysis tubing and reacted with starch changing the colour of the solution to blue-black. The starch did not diffuse through the dialysis tubing, as the colour outside remains straw yellow.

A similar phenomenon is seen in cells, where the semi-permeable membrane allows only certain molecules into/out of the cell.

Marking criteria	Marks
<p>Answer achieves all 5 of the below:</p> <ul style="list-style-type: none"> ▪ links the nature of the dialysis tubing to model the selective permeability of the cell membrane, i.e., allowing certain substances to pass through and not others – P ▪ outline the movement of substances move from an area of ↑ concentration to ↓ – D ▪ demonstrates knowledge that the iodine diffuses into the tube from the beaker and reacted with the starch, causing the solution inside to be blue-black – I ▪ demonstrates knowledge that the starch is unable to diffuse out of the dialysis tubing, hence the beaker remained straw yellow – S ▪ demonstrates knowledge that the glucose can also diffuse out of the tubing – G 	4
<ul style="list-style-type: none"> ▪ Answer achieves 4 of the above 	3
<ul style="list-style-type: none"> ▪ Answer achieves 2-3 of the above 	2
<ul style="list-style-type: none"> ▪ Answer achieves 1 of the above 	1

Marker's feedback:

- Those who only mentioned the word 'semipermeable membrane' without saying what it means did not get the P criteria.

Marking criteria	Marks
Answer achieves 7 of the below: <ul style="list-style-type: none"> ▪ provides a specific observation made by Darwin – O ▪ demonstrates the knowledge that natural variation exists in populations – V ▪ demonstrates the knowledge of selection pressure & adaptation – A ▪ understands the role of natural selection in the evolutionary process – N ▪ specifies that the species will evolve when its favourable traits are passed on over many generations and accumulate – H ▪ recognises the correct type of evolution, divergent or convergent from the observation provided above – E ▪ makes the above points using the details observed in Darwin’s observations – D 	4
<ul style="list-style-type: none"> ▪ Answer achieves 5-6 of the above 	3
<ul style="list-style-type: none"> ▪ Answer achieves 3-4 of the above 	2
<ul style="list-style-type: none"> ▪ Answer achieves 1-2 of the above 	1

Sample answer

The many animal species that Charles Darwin collected in the Galapagos Islands were significant in supporting the Theory of Evolution. One of the most famous was the various species of finches. Darwin with the help of ornithologist John Gould demonstrated that the different varieties of finches collected in the Galapagos Island were actually variations of the same species. Using data and observations about beak length and size as well as detailed observations regarding the environments and food sources available to the finches Darwin was able to show how the beaks changed overtime due to changes in enviromental pressures and food types. Each island had different selection pressures and as a result around 15 species of finch now exist. Naturally occuring changes in beak size and shape has allowed these birds to utilise the different food sources on the various islands and for the best suited to survive, breed and pass on these variations. If finches lived in environments where the habitats were mainly forests and the birds fed in trees on grubs and insects a beak that was able to grasp objects such as twigs was favoured. Birds that had beaks with these variations were likely to survive and became the dominant beak type.

If the finches were on an island whose main food source was seeds or cactus a beak that is larger and longer and more pointed would be advantageous. Finches that had exhibited this variation would be most likely to surive, breed and pass on this trait to future generations.

The Galapagos finches were significant in supporting the Theory of Evolution through natural selection as they demonstrated the variations that can naturally occur in a species and how these traits can be selected and enhanced due to changes and differences in environment. The Galapagos finches are a prime example of adaptive radiation.

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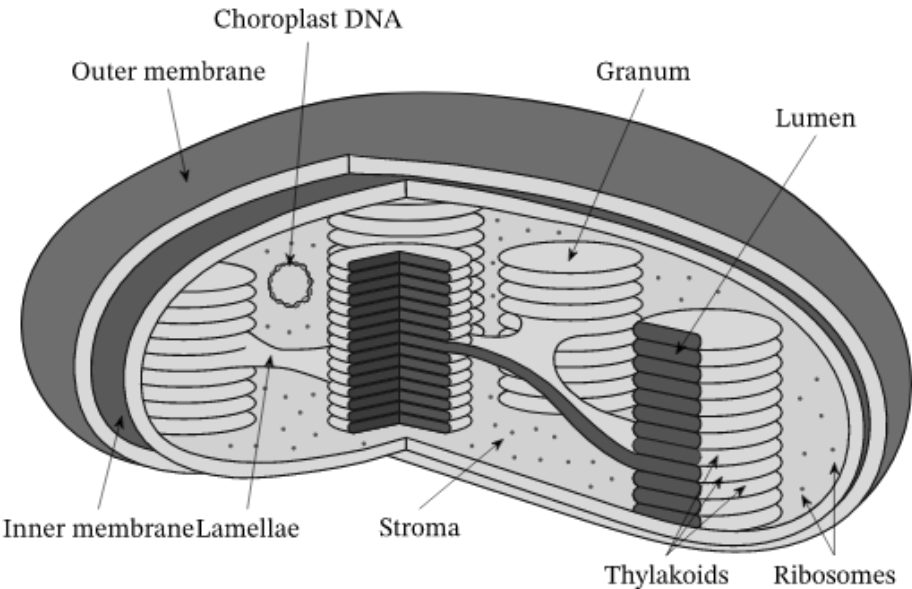
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End of Question 13
Question 14 is on the following page

Question 14 (4 marks)

Light independent

Light dependent



5

- a) Draw arrows on the diagram of the chloroplast to identify the sites of the light independent and the light dependent reactions during photosynthesis. 1

- b) Describe the importance of the role played by photosynthesis in an ecosystem. 3

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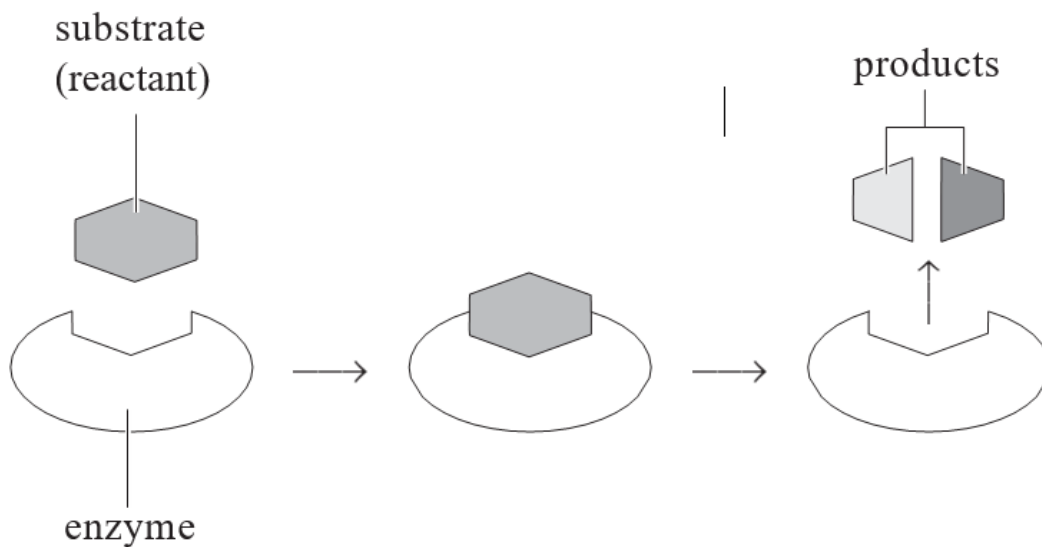
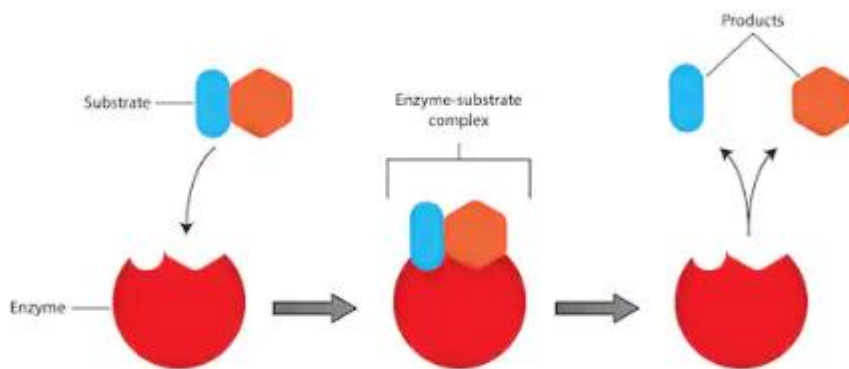
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Question 15 (7 marks)

a) Draw a series of labelled diagrams to show the lock and key model of enzyme function.

3



The substrate comes together with the enzyme.

The substrate forms a complex binding with the active site of the enzyme.

New products leave the active site of the enzyme. The enzyme remains unchanged.

Note: Responses may include a catabolic or anabolic reaction.

b) State an advantage and a limitation of using models in Biology.

2

(c) For example:

One benefit of using models is that they can simplify an abstract concept or allow us to visualise something that is too small to see with the unaided human eye. For example, using a model of a cell membrane allows us to understand how the membrane performs its function.

One limitation of using models is that they cannot incorporate the exact details of the real object or concept. For example, real chemical bonds and proteins are very different from the solid structures from which we make the models (for example, using materials found in a school laboratory).

Note: A range of responses are acceptable.

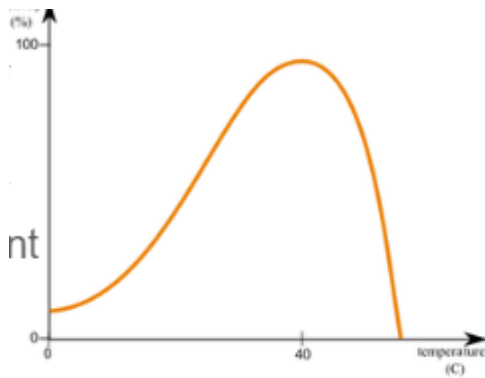
- Outlines ONE benefit of using models.

AND

- Outlines ONE limitation of using models2

c) In the space below, sketch a graph that shows the effect of temperature on enzyme activity.

2



Question 16 (12 marks)

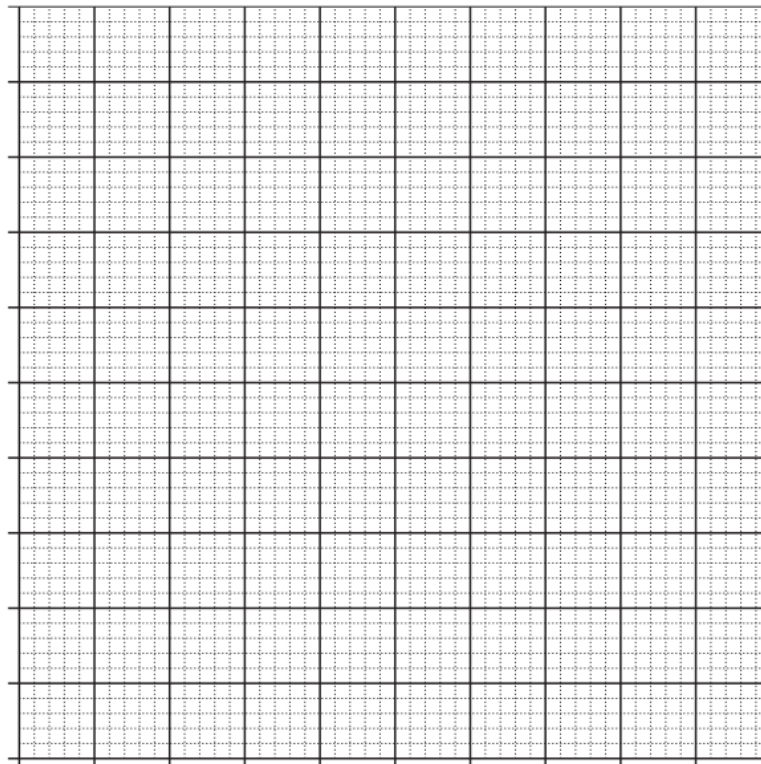
A student wanted to investigate the effect of different light intensities on the rate of photosynthesis in plants. The student set up an experiment where aquatic plants were placed in solution containing carbon dioxide and then exposed to different intensities of light. The number of oxygen bubbles produced by the plants over time were counted and recorded.

The experiment was repeated ten times for each light intensity and the average results are recorded in the table below.

Light Intensity (Lux)	Average number of bubbles produced in 30 seconds
0	0.00
2	7.00
4	11.0
6	14.0
8	14.5
10	15.0

a) Graph the data on the grid.

4



Criteria	Marks
<ul style="list-style-type: none">• All data plotted correctly• Axes labels provided• Correct scale• Units (Lux) included	4
<ul style="list-style-type: none">• Three of the above	3
<ul style="list-style-type: none">• Two of the above	2

• One of the above	1
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b) Identify the independent and the dependent variables for this investigation. 2

Criteria	Marks
• Identifies the independent variable AND identifies the dependent variable	2
• Identifies the independent variable OR identifies the dependent variable	1

Independent variable: Light intensity

Dependent variable: Average number of bubbles in 30s for the rate of photosynthesis

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c) Identify a relevant controlled variable and justify why it should be controlled in this investigation. 2

Eg.,

Controlled variable: Size of plant

Justification:

The size of the plant should be kept the same as if different sized plants were used, this may affect the results as a larger plant may have a higher rate of photosynthesis than a smaller plant, thus the results could not be contributed to the change in light intensity only.

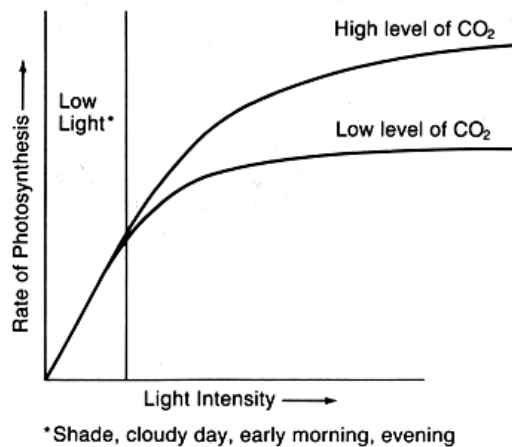
Criteria	Marks
• Identifies one correct controlled variable • Provides thorough justification for this variable	2
• Identifies one correct controlled variable • Attempt to provide justification for this variable	1

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d) The student decided to extend their investigation by repeating the same experiment but with different concentrations of dissolved carbon dioxide (CO₂). The predicted results are shown in the graph below.



Explain the predicted results of this investigation.

4

Carbon dioxide is a reactant in the process of photosynthesis, thus it would be expected that the higher level of carbon dioxide should produce a higher rate of photosynthesis.

Criteria	Marks
<ul style="list-style-type: none"> • Provides an explanation for the expected results: <ul style="list-style-type: none"> • Explains low light section for both graphs • Explains what happens after low light as the graph increases • Explains the difference between the low co2 and high co2 graphs • Explains the plateau of the graph 	4

Suggested answer: Light is a requirement for photosynthesis. In the low light portion of the graph, the rate of photosynthesis is limited by the amount of light available. As the light increases, the rate of photosynthesis also increases. This trend continues until eventually the rate of photosynthesis is limited by the amount of carbon dioxide that is available, which is when the two graphs separate. Therefore, the high level of CO₂ has a higher rate of photosynthesis than the low level of CO₂. At the end of the graph, both plateau. After the plateaus, the rate of photosynthesis can no longer increase with increasing light as some factor (enzyme saturation, CO₂ amount) is now limiting the rate of photosynthesis.

Question 17 (4 marks)

Table 1 shows the estimated population of southern brown bandicoots (*Isodon obesulus*) during a monthly live-trapping program in the Harry Waring Marsupial Reserve in Western Australia. In July, tracks and sightings indicated that a single fox entered the reserve. About six months later, its carcass was found.

Table 1: Estimated population of southern brown bandicoots (Isodon obesulus)

<i>Month</i>	<i>Estimated population of southern brown bandicoot</i>
September	80
October	78
November	60
December	100
January	96
February	125
March	131
April	120
May	116
June	120
July	118
August	60
September	20
October	18
November	13
December	14
January	16
February	14
March	30
April	35

Question 17 continues on the following page.

Table 2 shows the impact of the cane toad (*Rhinella marina*) on Mertens' water monitor (*Varanus mertensi*), a type of lizard, as shown by a study conducted in the Kimberly region in Western Australia. Population counts during 2001–2009 were in 'pre-toad arrival' years, while population counts during 2011–2013 were in 'post-toad arrival' years.

Table 2: Impact of the cane toad (*Rhinella marina*) on Mertens' water monitor (*Varanus mertensi*)

Year	Estimated population of Mertens' water monitor
2000	6
2001	8
2002	9
2003	6
2009	8
2010	6
2011	3
2012	1
2013	6

Source: Data sourced with permission from Doody J S, Mayes P, Clulow S, et al. (7 March 2014).

Using the trends shown in the tables, and your knowledge from the Biology course, outline and explain the effects that introduced species can have on other species in communities. **4**

Sample answer:

Table 1 shows a decrease in the southern brown bandicoot population after the introduction of a fox to the reserve. Foxes prey on bandicoots; thus, the introduction of the fox resulted in it killing many of the bandicoots. This can be seen in the bandicoot population plummet from approximately 100 animals to less than 20 animals in a 12-month period. After the fox was found dead, the bandicoot population began to increase. Native animals such as bandicoots fall easy prey to an introduced predator such as a fox. The fox acted as a selection pressure in the community and the bandicoots were unable to adapt, only recovering their population once the fox died.

Table 2 shows that, after the introduction of the cane toad in 2010, the Mertens' water monitor population decreased (decreasing from eight animals in 2009 to one animal three years later). This is because the cane toad is poisonous; when the Mertens' water monitors eat the cane toads, they die. Cane toads have a devastating impact on the Mertens' water monitor population as their reproductive rate is high, they eat a wide variety and they are poisonous. The water monitor population began to increase as they began to adapt to the selection pressure imposed by the cane toad, perhaps by taste aversion. Hence, this population is showing signs of microevolution.

Criteria	Marks
<ul style="list-style-type: none"> • Outlines the trends in both tables • Suggests reasons for the trends in both tables • Relates the introduced species to a selection pressure • Explains the increase in population as evidence of adaptation 	4

Question 18 (6 marks)**4**

- a) Outline TWO similarities and TWO differences between the transport systems of animals and plants.

Transport systems (vascular tissue) in plants and animals have a similar structure and function in many ways.

Similarities:

- Vascular tissue transports nutrients, such as glucose, water and inorganic nutrients, around the plant or animal so that all cells receive the nutrients they need.
- Both plants and animals have specific tube-like tissues that carry materials around the organism.

Differences:

- Animals have a network of veins, arteries and capillaries, which contain blood. Plant vascular tissue includes xylem cells, such as tracheids, and vessel elements and phloem (sieve plates and tubes, and companion cells) which contain sap.
- In animals, blood flows in one direction from the heart to the lungs, back to the heart, and then to the body tissues. Plants do not have a closed system such as this. Flow in xylem tissue is one-way from the roots to the leaves, but flow in phloem tissue is bi-directional.

Criteria	Marks
• Outlines TWO similarities and TWO differences between the transport systems of plants and animals.	4
• Outlines at least ONE similarity and ONE difference between the transport systems of plants and animals.	2-3
• Provides some relevant information	1

- b) Identify and describe one theory that accounts for the movement of water in the xylem tissue of plants. **2**

Criteria	Marks
• Identifies the transpiration cohesion tension theory and describes the mechanism	2
• Identifies the transpiration cohesion tension theory or describes the mechanism	1

Sample answer:

The cohesion-tension theory (C-T theory) by Boehm (1893) and Dixon and Joly (1894) postulates that the water ascent in trees is exclusively due to the transpirational pull from continuous water columns in the xylem conduit running from the roots to the leaves. This pull is argued to create tension gradients of several MPa in order to overcome the gravitational force and frictional resistances. Water under tension (negative pressure) is in a metastable state. By means of his ingenious vacuum line-based experiment on leafy twigs, Otto Renner (1911) demonstrated that the xylem water indeed may exist under tension. Therefore, he favored the C-T theory, but nevertheless argued "that the turgor of the xylem parenchyma cells attains equilibrium with the pressure of the adjacent vessels." Clearly, hydraulic coupling of these tissues would preclude xylem tensions of several MPa inferred by the C-T theory. In fact, Renner (1925) found moderate tensions yielding a mean value of 0.32 ± 0.2 MPa ($n = 43$). Textbooks did not present these data, rather

introduced the pressure bomb technique of Scholander et al. (1965) to support the C-T theory. The output of this tool, the *balancing pressure*, is measured on excised leafy twigs, and is considered to reflect 1:1 the xylem tension in the intact plant.

End of Examination

