
Student Number

2021
Year 11 Preliminary
High School Certificate
Examination

Biology

General Instructions

- Reading time – 5 minutes
- Working time – 1.5 hours
- Write using black pen
- Draw diagrams using pencil
- Write answers in examination book provided
- Write the question number at the start of each answer

Total Marks - 50

Section I - Pages 2 - 14

Marks (20)
Attempt Questions 1-20
Allow about 30 minutes for this section

Section II - Pages 14 - 22

Marks (30)
Attempt Questions 21-27
Allow about 1 hour for this section

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Section I

20 Marks
Attempt Questions 1-20
Allow about 30 minutes for this section

Use the multiple-choice answer sheet for Questions 1-20

A scientist developed four tests to detect the presence of features in living cells. The test and the features they can detect are outlined below:

Test 1	Test 2	Test 3	Test 4
DNA Ribosomes Cytoplasm	DNA Mitochondria Chlorophyll	DNA Ribosomes Capsule	DNA Ribosomes Golgi body

1. Which test would be the most appropriate to detect the presence of only bacteria cells?

A. 1
B. 2
C. 3
D. 4

2. What is the main site of protein production in eukaryotic cells?

A. Smooth ER
B. Rough ER
C. Golgi Body
D. Mitochondria

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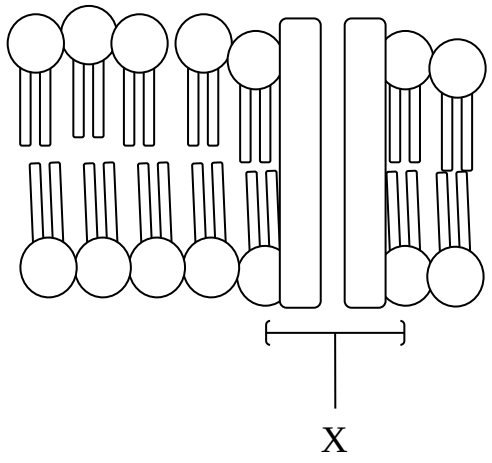
Below is a diagram of the phospholipid bilayer.



Source: Phospholipid bilayer, Roberts, 2021.

3. What process would structure X facilitate?

A. Active transport
B. Passive transport
C. Endocytosis
D. Exocytosis

Fungal cells have membrane bound organelles and they derive their nutrition from other living things.

4. They can be classified as:

A. heterotrophic prokaryotes
B. heterotrophic eukaryote
C. autotrophic prokaryotes
D. autotrophic eukaryotes

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5. Which one of the following best explains why there is an upper limit to cell size?

A. The larger the cell, the greater its surface area: volume ratio.
B. The smaller the cell, the greater its surface area: volume ratio.
C. The larger the cell, the greater its surface area.
D. The smaller the cell, the greater its surface area.

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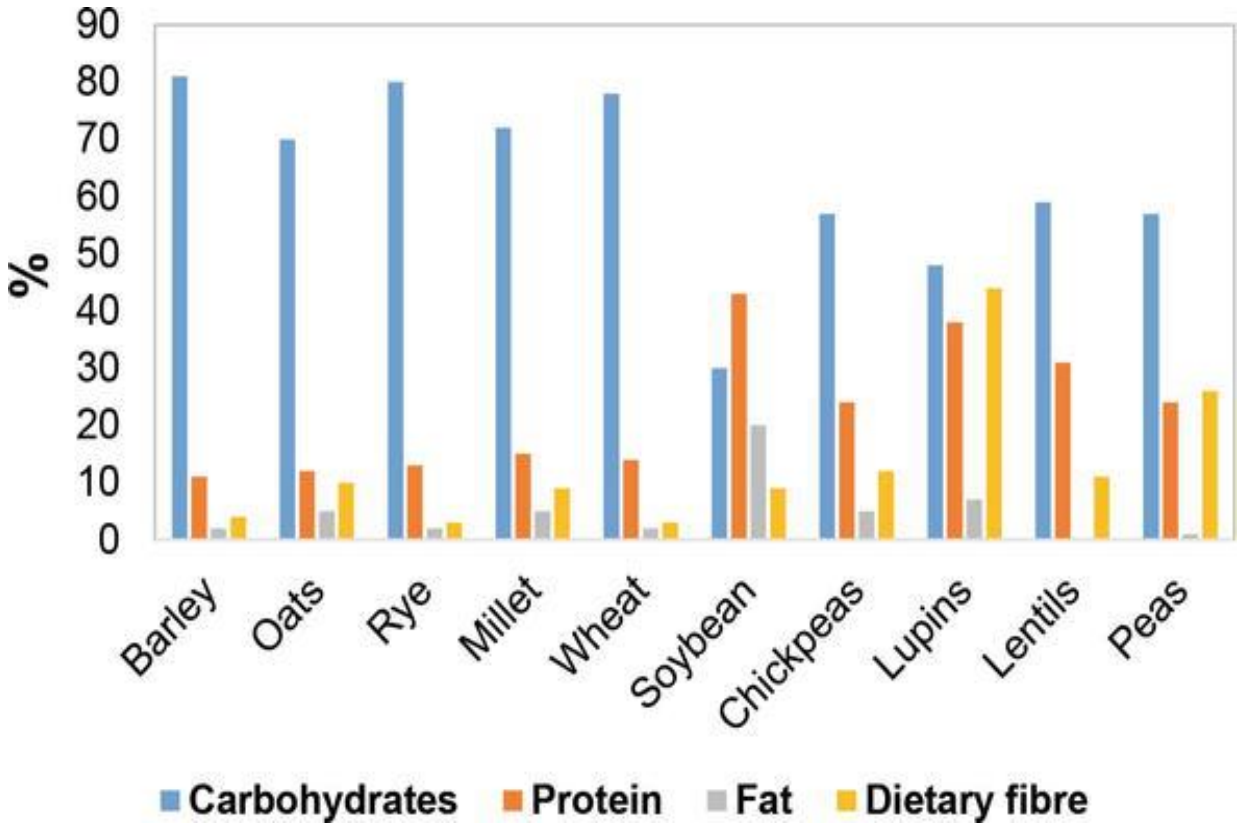
The graph below shows the nutrient content of different types of legumes.



Source: Graph showing nutrient content of different legumes and cereal grains. Yvonne Maphosa 2017.

In order to maintain a healthy diet it is recommended that humans divide their diet as follows: **50% carbohydrates, 20% proteins and 30% lipids.**

6. According to the nutrient percentages, which of the legumes would be classified as the healthiest?

A. Barley
B. Soybean
C. Oats
D. Chickpeas

7. Identify the list that contains only monomers of macromolecules:

A. Amino acid, protein, fatty acid,
B. Monosaccharide, amino acid, nucleotide
C. Nucleotide, protein, lipid
D. Carbohydrate, protein, lipid.

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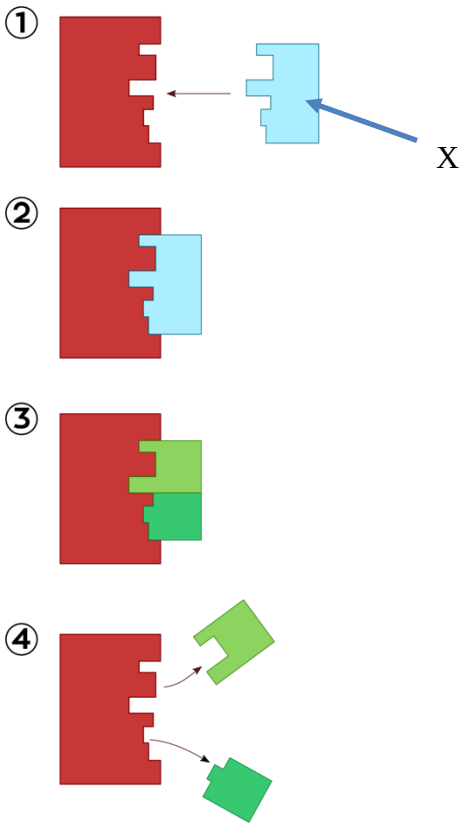
Use the image below to answer questions 8 and 9.



Source: Enzyme activity. Wikimedia Commons (Author Unknown)

8. What is the name of the model shown in the image above?

A. Enzyme activity
B. Lock and Key
C. Active site activation
D. Induced fit

9. What structure is labelled X in the image above?

A. Coenzyme
B. Protein
C. Substrate
D. Inhibitor

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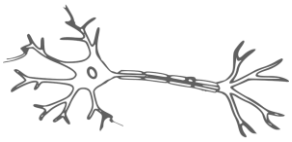
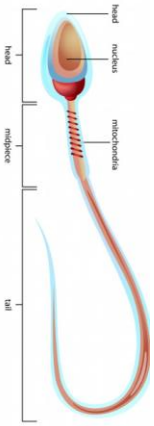
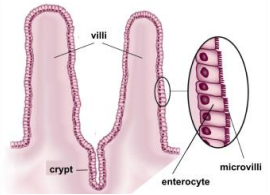
10. Which of the following factors can cause permanent damage to enzyme structure?

A. Substrate concentration
B. Enzyme concentration
C. Low temperature
D. High temperature

Below is a description of four cells, their functions and images of their structure.

1- Send signals long distances through the body and join with other similar cells
2- Move rapidly through liquid to transport genetic material
3- Hold large amounts of oxygen, fit in small spaces.
4- Have a high surface area to absorb nutrients

W  Source: Red blood cells. Wikimedia Commons, Anatomy and physiology connexions.	X  Source: Neuron diagram. Wikimedia Commons (Author Unknown)	Y  Source: Sperm cell diagram. Wikimedia Commons (Author Unknown)	Z  Source: Intestinal endothelium. Wikimedia Commons (Author Unknown)

11. Match the number and letter of the function and structure of each specialised cell above

A. 1X, 2Y, 3W, 4Z
B. 1Y, 2X, 3W, 4Z
C. 1W, 2X, 3Y, 4Z
D. 1Z, 2W, 3X, 4Y

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Use the stimulus below to answer questions 12, 13 and 14.

Large beetles can contract muscles in their bodies to move air through their tracheoles to increase gas exchange. Scientists placed these beetles in sealed environments containing different concentrations of carbon dioxide and oxygen and measured the rate of contractions

The results of the experiment are shown in the table below

	Air mixture % and body contractions per minute			
Beetle number	Air: Oxygen 20 CO_2 0.1	Oxygen 100	Oxygen 80 CO_2 20	Mixture X
1	40	10	62	91
2	45	12	70	95
3	43	9	68	102
4	47	11	72	87

12. What is the most likely mixture of oxygen and carbon dioxide in mixture X?

A. 10% oxygen 90% carbon dioxide
B. 70% oxygen 30% carbon dioxide
C. 90% oxygen 10% carbon dioxide
D. 95% oxygen 5% carbon dioxide

13. What is the dependent variable for this experiment?

A. The temperature
B. The body contractions per minute
C. The oxygen concentration
D. The carbon dioxide concentration

14. Which of the following statements best describes the results for this experiment?

A. Beetles breathe more when more oxygen is present.
B. Beetle body contractions decrease as oxygen level decreases.
C. Beetle body contractions increase as oxygen levels decrease.
D. Beetles breathe less when there is more carbon dioxide present.

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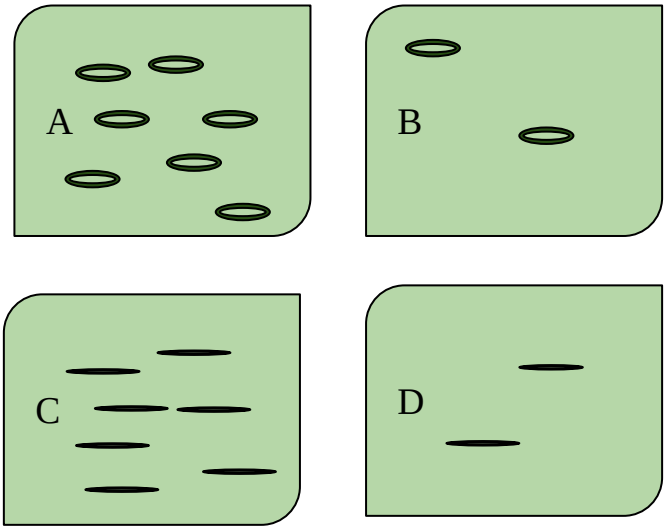
Below are diagrams representing the underside of different leaves showing stomata. Plants found in dry regions have less stomata.



Source: Stomata diagram, Roberts, 2021.

15. Identify the leaf that would likely be found in a dry region on a humid day.

A. A
B. B
C. C
D. D

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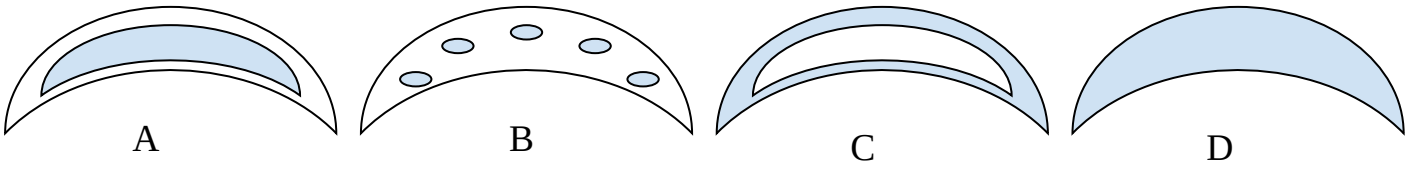
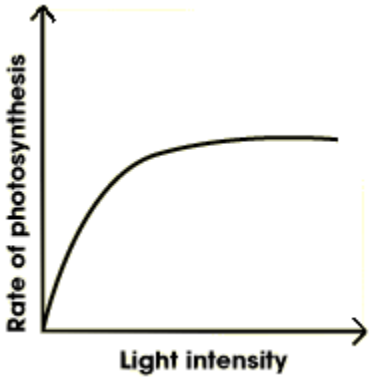
A celery stalk is placed in a beaker of water containing a blue dye that can stain xylem vessels. The stalk is removed from the water after a day and cut in two.



Source: Xylem vessels, Roberts, 2021.

16. Which image best represents what you expect to see?
    A. A
    B. B
    C. C
    D. D

Below is a graph indicating the rate of photosynthesis with increased light.



Source: Limiting factor of photosynthesis graph, Roberts, 2021.

17. What is the limiting factor for photosynthesis in the graph above?
    A. Oxygen
    B. Light
    C. Glucose
    D. Carbon dioxide

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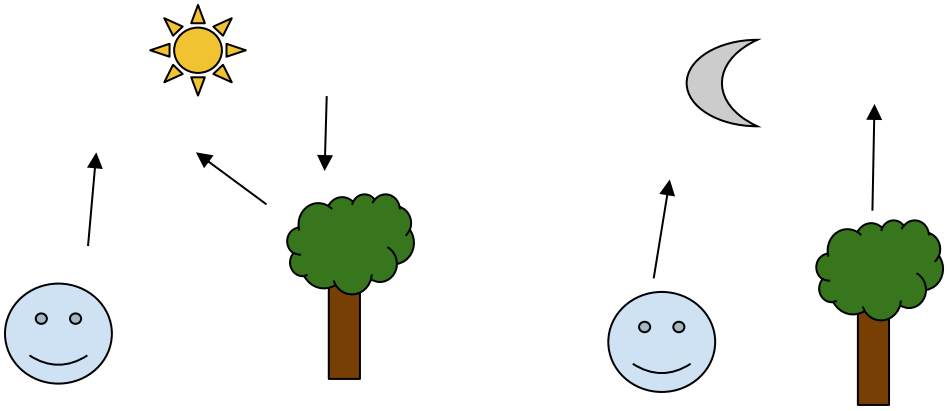
Below is a diagram representing plants and animals during day and night.



Source: Gas exchange in plants and animals, Roberts 2021.

18) What do the arrows represent?

A. Water
B. Carbon dioxide
C. Heat
D. Oxygen

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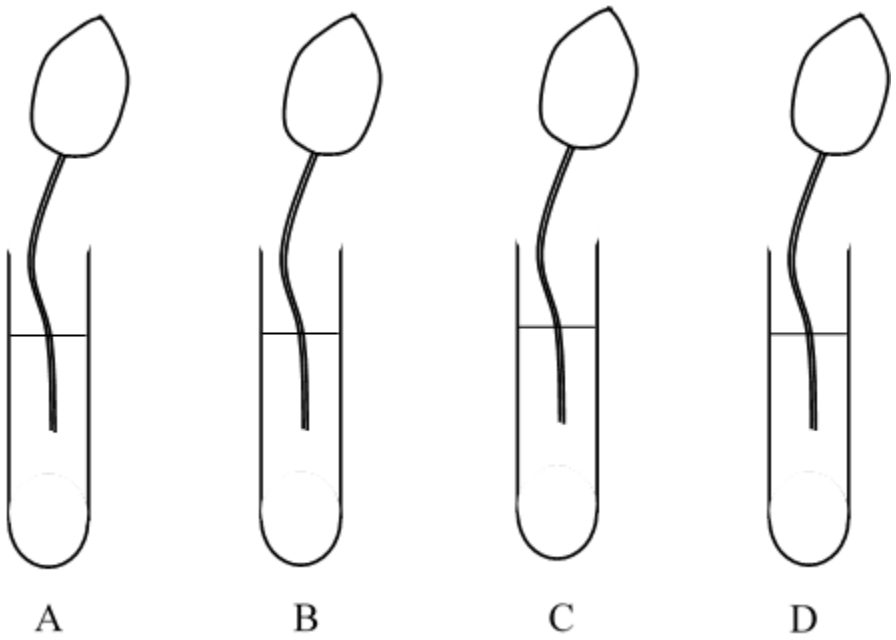
A student wanted to test the effect of temperature on transpiration. Four identical leaves have been placed in tubes of water, and the decrease in water level measured over a one hour period.



Test tube	Wind speed (km/hr)	Humidity (%)	Temperature (°C)
A	5	20	25
B	5	60	35
C	5	50	25
D	10	20	35

19) Which two test tubes would you use to investigate the effect of humidity on water loss from a leaf?

A. A & C
B. B & D
C. A & B
D. C & D

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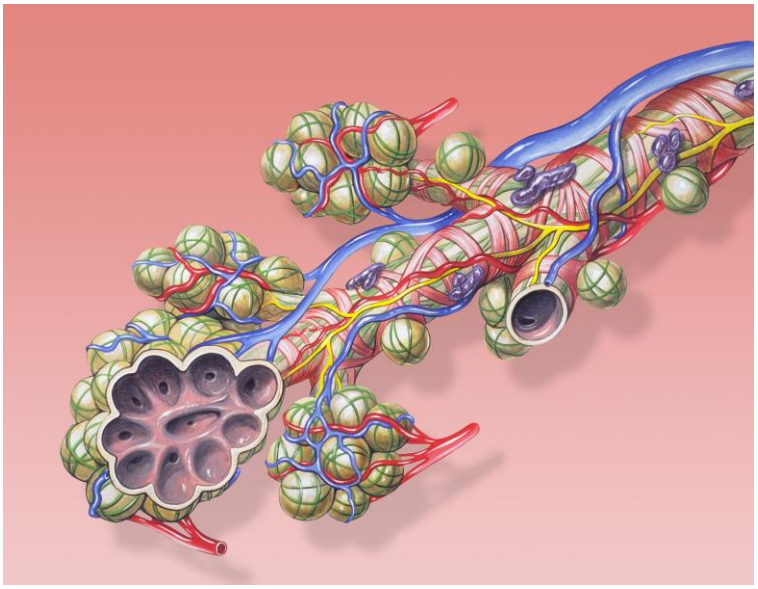
Below is a diagram of an alveoli.



Source: alveoli, Wikimedia commons, (author unknown)

20) Which of the following is not a feature of this gas exchange surface?

A) Counter current exchange
B) Short diffusion distance
C) High concentration gradient
D) High surface area

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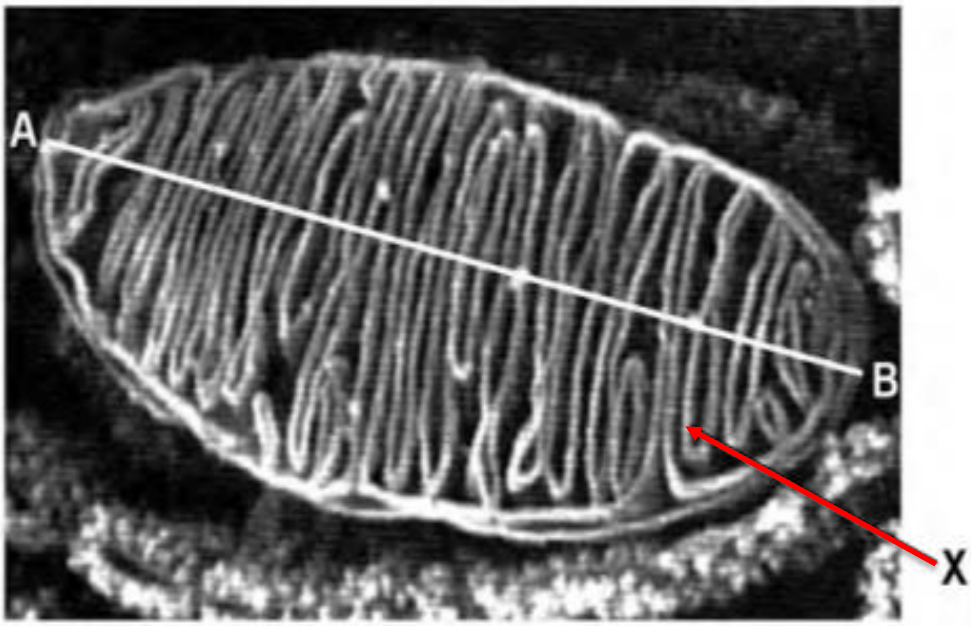
Section II

30 Marks
Attempt Questions 21 - 27
Allow about 1 hour for this section

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Question 21 (4 marks)

The image below shows a mitochondria



a) Identify the technology that was used to create this image. **1**

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Student Number

b) Explain the function of the part of the mitochondria labelled X in the image **3**

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Student Number

Question 22 (4 marks)

Below is a representation of the fluid mosaic model of the cell membrane

a) Assess the validity of this model **4**

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Question 23 (3 marks)

A student places a hypotonic solution of starch into a semipermeable membrane tube. This tube is then sealed and placed into a hypertonic solution. The starch is too large to exit the membrane but water can enter and leave.

Draw an annotated flow diagram below to show the process that is occurring. **3**

Image	Image	Image
Description	Description	Description

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Question 24 (4 marks)

Carbon 14 is a radioactive version of regular carbon. It can be used to trace the products of photosynthesis throughout plants.

Scientists exposed a growing plant to high amounts of carbon dioxide consisting of carbon 14 for 48 hours.

They then proceeded to test a sample of a root tip, new leaf, old leaf, xylem vessel and a phloem vessel.

a) Describe how carbon 14 moves from the air and is stored in the tissues around the plant. **4**

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Question 25 (4 marks)

Below is an image of a kangaroo rat with information regarding it's adaptations

- Lives in a burrow
- Mainly nocturnal
- Extended nasal cavity
- Obtain all water from seeds and grasses
- Produces highly concentrated urine
- Sandy fur colour
- Large feet allow them to jump high and move fast

Source: Kangaroo rat, Wikimedia commons, Rex 2005.

The kangaroo rat is an Australian native animal that lives in an extremely arid environment.

Complete the following table describing the kangaroo rats adaptations and how they allow it to overcome a named selection pressure . **4**

Adaptation type	Adaptation	How is aids in survival
Structural		
Physiological		

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Question 26 (3 marks)

Below is an image of a dolphin and a shark.

Source: Dolphin, Wikimedia commons, Juvenile Atlantic spotted dolphin, Sheilapic76.
Source: Great White shark, Wikimedia commons, Terry Goss.

Explain the type of evolution that is occurring in the images shown above. **3**

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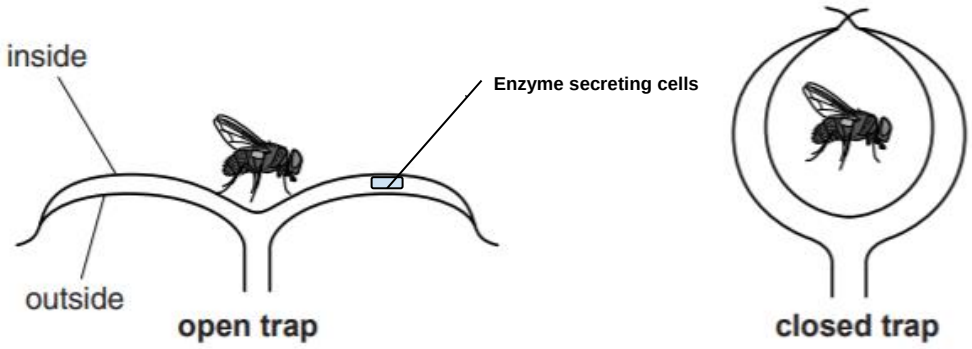
Question 27 (8 marks)

Venus fly traps are a carnivorous plant that live in nutrient-poor soils. They trap insects and digest them in order to gain nutrients.

When a trap closes the cells on the outside of the trap flood with water causing them to swell and trap the insect as shown in the diagram below.



Source: Venus fly trap diagram, Roberts 2021.

Using your knowledge of evolution by natural selection, active and passive transport and digestion explain how Venus fly traps have evolved to survive in nutrient poor environments. **8**

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Multiple choice

Question	Answer
1	C
2	B
3	B
4	B
5	B
6	D
7	B
8	B
9	C
10	D
11	A
12	B
13	B
14	C
15	B
16	B
17	D
18	B
19	A
20	A

Question 21

a) Identify the technology used to create the image

	Marks
Correctly identifies an electron microscope	1

b) Explain the function of the part of the mitochondrion labelled in the image

Criteria	Marks
Cause and effect statement referring to the cristea or folded internal membrane, high surface area and increased respiratory efficiency.	3
Sketches the link between high surface are and respiratory efficiency in general terms	2
Makes a relevant statement	1

The image labelled is the cristae.
Cause: This folded internal membrane increases the surface area of the mitochondria which is the site for chemical reactions such as aerobic respiration.
Effect: A high surface area and therefore sites for chemical reactions increases the efficiency of respiration within the mitochondria.

Question 22

Assess the validity of the model

Criteria	Marks
• Makes at least 3 points for and or against the model (at least one opposing view) • Makes a clear judgement of the validity based on the points argued	4
• Makes 2 points for and or against the model (at least one opposing view) • Makes a clear judgement of the validity based on the points argued	3
• Makes at least 2 points for and or against the model (at least one opposing view) OR • Makes a clear judgement of the validity based on a point argued	2
• Makes a relevant comment	1

23
Draw an annotated flow diagram below to show the process that is occurring. (3 marks)

Band Range 4

Criteria	Marks
• Draws a flow diagram with at least three steps outlining the process of osmosis described in the stimulus. • Clear labels • Uses expert terms	3
• Draws a flow diagram with at least three steps outlining the process of osmosis described in the stimulus • Clear labels • Uses general terms	2
• Draws a flow diagram outlining the process of osmosis described in the stimulus • Uses general terms	1
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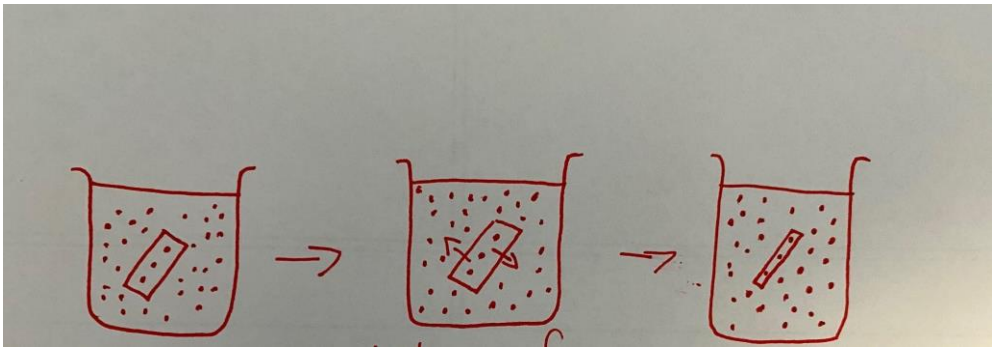
Sample answer



annotations for diagram:

1) hypotonic tube placed into hypertonic solution.
2) Water moves from high concentration to low concentration via osmosis, diluting the hypertonic solution.
3) Starch remains in the tube but water is lost. Tube shrinks due to movement of water into hypertonic solution.

Question 24

Describe how carbon 14 moves from the air and is stored in the tissues around the plant. (4 marks)

Describe: provide characteristics and features
Band range: 5

Criteria	Marks
Describes the pathway of carbon through the plant in great detail using expert terms including: ● Carbon 14 enters the plant as CO2. ● transforming to glucose during photosynthesis. ● Converting to sucrose for transport. ● Being stored as starch in cells or being used for other organic processes.	4
Describes the pathway of carbon through the plant in general terms including: ● Carbon 14 enters the plant as CO2. ● transforming to glucose during photosynthesis. ● Converting to sucrose for transport. ● Being stored as starch in cells or being used for other organic processes.	3
Describes the pathway of carbon through the plant in general terms including TWO of the following points: ● Carbon 14 enters he plant as CO2. ● transforming to glucose during photosynthesis. ● Converting to sucrose for transport. ● Being stored as starch in cells or being used for other organic processes.	2
Describes the pathway of carbon through the plant in general terms including ONE of the following points: ● Carbon 14 enters he plant as CO2. ● transforming to glucose during photosynthesis. ● Converting to sucrose for transport. ● Being stored as starch in cells or being used for other organic processes.	1

Sample answer
Carbon 14 in the form of carbon dioxide enters the leaf of the plant through the stomata.

Carbon dioxide is a reactant in photosynthesis producing glucose.

This glucose now contains the carbon 14

Glucose is converted into sucrose and transported around the plant in a source to sink motion via the phloem vessels.

Once it enters the cells where it is required it is either converted into energy through aerobic respiration, used for other organic processes or stored as starch in the vacuole. The organic matter of the plant now contains the carbon 14.

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Question 25
Complete the following table describing the kangaroo rats adaptations and how they allow it to overcome a named selection pressure . (6 marks)

Band Range: 3

Criteria	marks
• Correctly matches all **two** adaptations the adaptation type. • Explains how all **two** of the adaptations allow the organism to overcome a named selection pressure.	4
• Completes the above with one error	3
• Completes the above with two errors	2
• Completes the above with three errors	1

Sample answer

Adaptation type	Adaptation	How is aids in survival
Structural	Sandy fur	Camouflages the kangaroo rat from predators.
Physiological	Produces concentrated urine	Producing concentrated urine saves water in an arid environment.

Note – if students contradicted/classified adaptations incorrectly e.g.noctural/live in burrow as physiological or structural, one mark was deducted

Question 26
Explain the type of evolution that is occurring in the images shown above. (4 marks)

Explain: Relate cause and effect; make the relationship between things evident.
Band Range: 4-5

Criteria	Marks
• Identifies the example is convergent evolution • Describe how dolphins and sharks are different • Identifies similar selection pressures and adaptations • Communicates using expert terms demonstrating a thorough understanding	3
• Identifies the example is convergent evolution • Describe how dolphins and sharks are different • Identifies similar selection pressures and adaptations • Sketches in general terms demonstrating a basic understanding	2
• Identifies the example is convergent evolution or • Describe how dolphins and sharks are different OR • Identifies similar selection pressures and/ or adaptations	1
•	

Sample answer
The image above is an example of convergent evolution between a shark and dolphin. Sharks are fish, have gills and are exothermic, whereas dolphins are mammals, have lungs and are endothermic. Their body structures are similar as they fill similar niches and are exposed to similar selection pressures. Both animals are hunters and so their eyes face forward, both live in water and so a sleek streamlined bilateral shape with fins for directional movement are preferable adaptations.

27
Extended answer question (8 marks)
Venus fly traps are a carnivorous plant that live in nutrient-poor soils. They trap insects and digest them in order to gain nutrients.

When a trap closes the cells on the outside of the trap flood with water causing them to swell and trap the insect as shown in the diagram below.

Source: Venus fly trap diagram, Roberts 2021.

Using your knowledge of evolution by natural selection, active and passive transport and digestion explain how venus fly traps have evolved to survive in nutrient poor environments.

Criteria	Marks
• Describes autotroph nutritional requirements • Explain how active transport can be used to move water to change the osmotic pressure within plant cells. • Describes the function of enzymes in digestion • Explains the process of evolution by natural selection using the example of the venus fly trap • Uses expert terms to convey a thorough understanding of all topics.	8
• Describes autotroph nutritional requirements • Explain how active transport can be used to move water to change the osmotic pressure within plant cells. • Describes the function of enzymes in digestion • Explains the process of evolution by natural selection using the example of the venus fly trap • Uses general terms to convey a sound understanding of all topics.	7
• Describes autotroph nutritional requirements • Explain how active transport can be used to move water to change the osmotic pressure within plant cells. • Describes the function of enzymes in digestion • Explains the process of evolution by natural selection using the example of the venus fly trap • Uses general terms to convey a basic understanding of all topics	6
• Describes autotroph nutritional requirements. • Describes the process of osmosis. • Describes the process of active transport • Describes the function of enzymes • Explains the process of evolution by natural selection • Links most of the above points back to the question	5
Describes 4 of the following: • Describes autotroph nutritional requirements. • Describes the process of osmosis. • Describes the process of active transport • Describes the function of enzymes • Explains the process of evolution by natural selection	3/4

Describes 3 of the following: • Describes autotroph nutritional requirements. • Describes the process of osmosis. • Describes the process of active transport • Describes the function of enzymes • Explains the process of evolution by natural selection	3
Describes 2 of the following: • Describes autotroph nutritional requirements. • Describes the process of osmosis. • Describes the process of active transport • Describes the function of enzymes • Explains the process of evolution by natural selection	2
• Makes a relevant comment	1

The venus fly trap is an autotroph and so it gains the majority of its nutritional requirements through the process of photosynthesis where water and carbon dioxide are used along with sunlight to form glucose and oxygen.

Plants also require other nutrients such as nitrogen, phosphorus and potassium which they usually gain from soil. As venus fly traps grow in nutrient poor soil they have evolved to survive by trapping and digesting insects.

Insects are trapped by the "trap" closing, this is done by altering the water content of the cells found on the outside of the trap. Water is a small molecule and can freely move across the surface of a cell membrane. However the osmotic pressure of a cell can be changed by varying the amounts of solutes the cell contains. Cells can use active transport to pull solutes inside the cell against a concentration gradient using specialised proteins in the membrane structure and ATP. This increases the concentration inside the cell and causes water to move via osmosis from an area of high water concentration to low water concentration. This movement fills the cells on the outside of the venus fly trap and causes the trap to close.

The diagram indicates that enzyme secreting cells line the inside of the trap. Enzymes are specialised proteins that catalyse reactions and can be used to break down molecules into their simplest forms. In this case these digestive enzymes function outside of the plant and break down the trapped insects into components that can then be absorbed into the plant.

These traits would have evolved via natural selection over many thousands of years, where one plant was able to lure or trap insects, therefore increasing it's access to nutrients and so increasing its likelihood of survival and reproduction below is a summary of the process:

Variation in population: closing leaves
Selection pressure: nutrient poor soil

Adaptive advantage: closing leaves trap insects which die and decompose, leaving behind nutrients for the plant to absorb.
Survive and reproduce: Plants that could trap insects had more access to nutrients, were healthier and more likely to survive and reproduce, passing the adaptation onto the next generation.
Change in population over time: The population of the species would begin a higher frequency of the favourable characteristics. Some of these characteristics may have become more pronounced in later generations and been selected for. Over many years the entire population would change.