
Student Number

2020
Year 11 BIOLOGY
Task 3 Sydney Girls High School

General Instructions

Reading time – 5 minutes

Working time - 60 minutes

Board-approved calculators may be used

Write using blue or black pen

Draw diagrams using pencil

Total marks: 37

Section 1: 10 multiple choice questions
Section 2: Questions 11 – 15

Component	Max mark	Mark achieved
P	**11**	
A	**13**	
K	**13**	
TOTAL	**37**	

1. **Use the Extra Writing Booklet if you require more space to answer a question.**
2. **If you do use the Extra Writing Booklet write "Continued" at the base of the answer you are writing. Then write the page number of the Extra Writing Booklet you are using e.g. "Continued on page 1"**

Section 1

10 marks

Attempt Questions 1 – 10

Use the multiple-choice answer sheet for Questions 1–10

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1. A population is correctly defined as having which of the following characteristics? 1K

1) Inhabiting the same general area.

2) Belonging to the same species.

3) Possessing a constant and uniform distribution and abundance.

A. 1 only

B. 2 only

C. 1 and 2 only

D. 1 and 3 only

2. Rapid rates of evolution would be most expected among species that: 1K

A. Mature in a few days or weeks and then reproduce
B. Mature very slowly only after they are 20 year's old
C. Have large bodies
D. Have small bodies

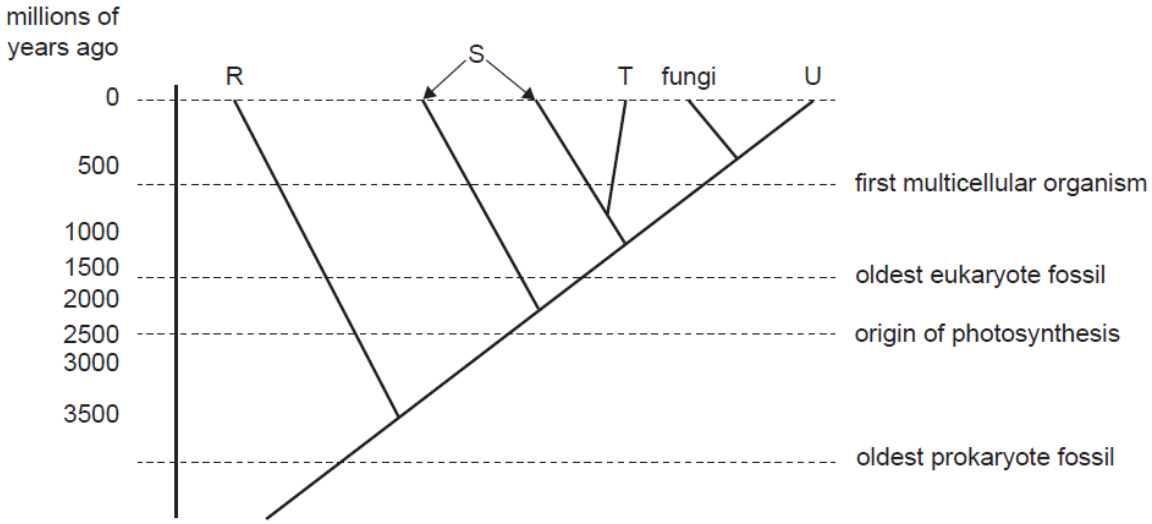
3. Two populations of platypuses (*Ornithorhynchus anatinus*) each live on a different island off the coast of Australia. Scientists believe that both of these island populations are at greater risk of dying out than populations of these platypuses on the mainland of Australia.

The table below shows combinations of size of the gene pool and genetic diversity for *Ornithorhynchus anatinus*. Which one of these combinations is most consistent with island populations of platypuses being at greater risk of dying out than are mainland populations? 1K

	Size of gene pool	*Genetic diversity*
J.	small	high
K.	large	high
L.	large	low
M.	small	low

A. J
B. K
C. L
D. M

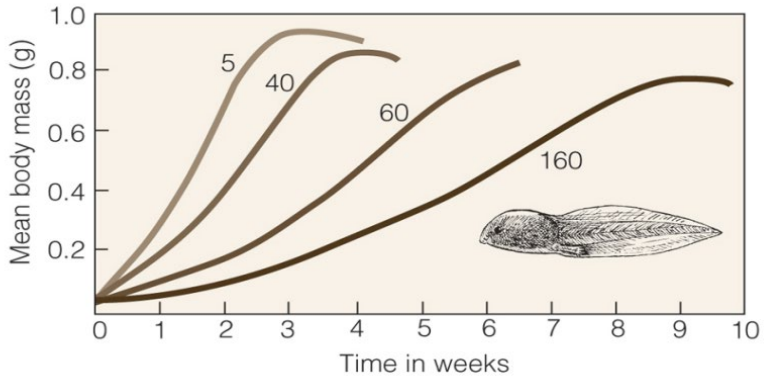
4. The phylogenetic tree below represents one model of the order and approximate time of appearance of the major groups of living organisms; and includes four groups represented by the letters R, S, T and U. 1K



Which of the following shows the correct placement of the organisms on the phylogenetic tree?

A. R – animals S – plants T – bacteria U – protists
B. R – bacteria S – protists T – plants U – animals
C. R – protists S – animals T – bacteria U – plants
D. R – plants S – animals T – bacteria U – protists

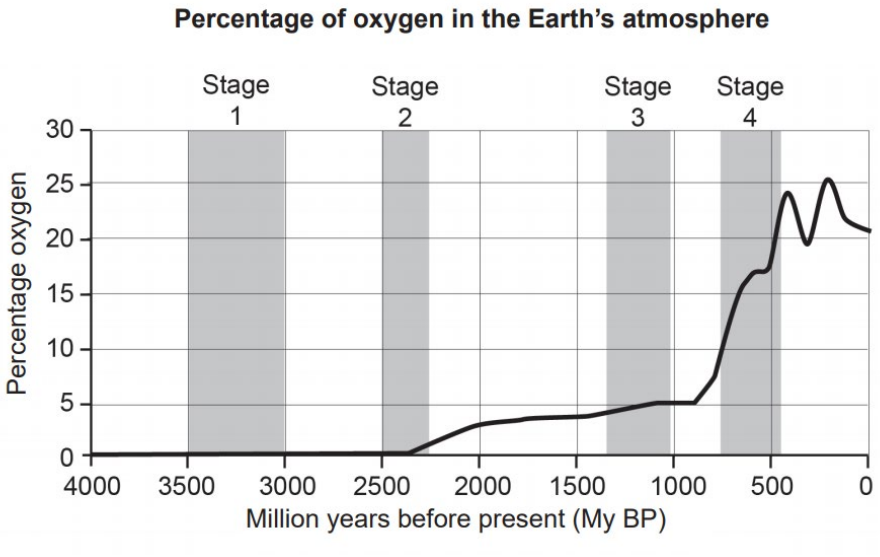
5. This following figure shows the results of an experiment where the number of tadpoles within a particular habitat was changed. This change was termed a "treatment". The numbers next to the lines on the graph are the numbers of individuals in each treatment. 1A



The results of this experiment indicate that:

A. access to resources decreases as population size decreases
B. access to resources increases as population size decreases
C. access to resources is not affected by population size
D. access to resources always affects population size

Questions 6 and 7 refer to the following graph. The graph shows an estimate of the percentage of oxygen in the Earth's atmosphere over time.



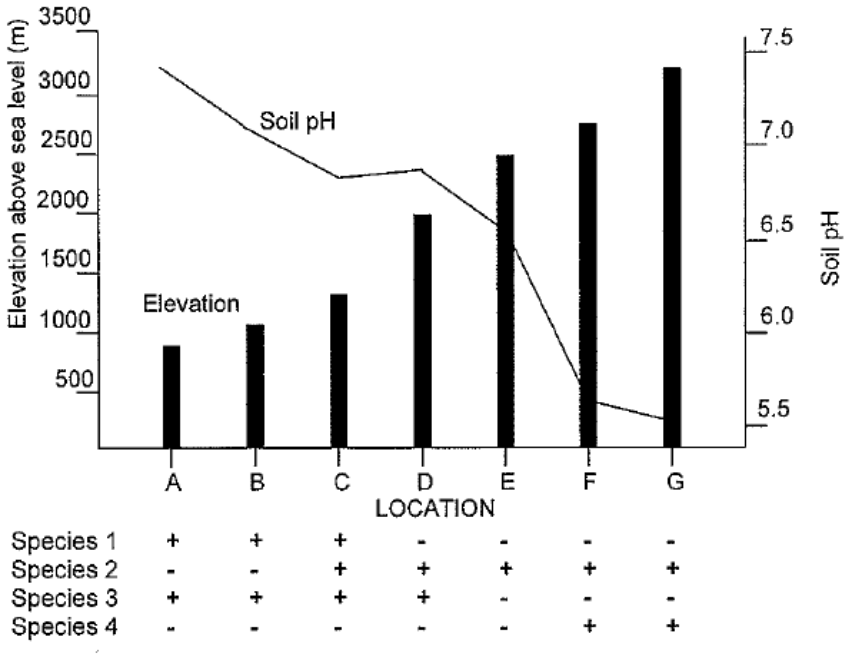
6. When iron combines with oxygen it forms iron oxide. Iron oxide deposits in rocks when they are being formed. These deposits create orange coloured "banded iron" formations. During which Stage would most of the iron formations be produced? 1A

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

7. Eukaryotes first evolved approximately 1500 million years before present. The evolution and diversification of eukaryotes required increasing amounts of oxygen in the atmosphere. During which Stage would the least diversification of eukaryotes have taken place? 1A

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

Questions 8 and 9 refer to the following diagram.



The diagram shows data from an ecological transect and indicates: which species (1 to 4) are present (+ = present, - = absent); the elevation above sea level; and the soil pH at each location on the transect locations A to G.

8. At which location is there the least, and the greatest, diversity of species? 1A

	Least	*Greatest*
A.	B	F
B.	E	C
C.	C	E
D.	A	G

9. Which species is found over the least, and the greatest, range in soil pH? 1A

	Least	*Greatest*
A.	Species 3	Species 1
B.	Species 4	Species 3
C.	Species 2	Species 4
D.	Species 4	Species 2

10. The following table shows ecological interactions. "+" indicates a benefit for the organism. "- "indicates a detrimental effect, and "0" indicates no effect. The first interaction has been identified for you as mutualism, an interaction which is beneficial to both organisms involved.

Ecological relationship	Species A	Species B
I (Mutualism)	+	+
II	+	-
III	+	0
IV	-	0
V	-	-

Which interaction would you expect to represent competition? 1K

A. II
B. III
C. IV
D. V

Section 2

Question 11 (3 marks)

The Cretaceous-Tertiary extinction event occurred 66 million years ago. The event resulted in the extinction of 75% of plant and animal species on Earth, including non-avian (non-flying) dinosaurs. However, many new species of animal and plants evolved after the event.

Figures 1 and 2 show two extinct species. The two species are of similar size.

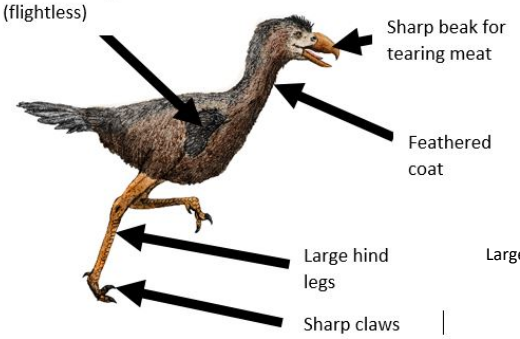


Figure 1 *Llallawavis scagliai (a species of Terror Bird) lived approximately 3 million years ago.*

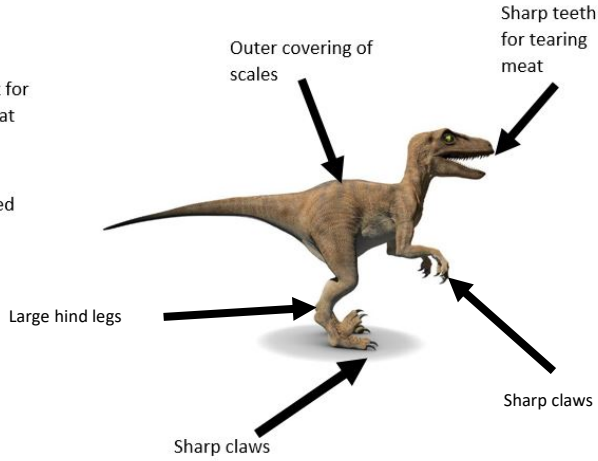


Figure 2 *A species of the genus Velociraptor which lived approximately 70 million years ago.*

How would Darwin and Wallace's theory of evolution by natural selection account for similarities OR differences in the adaptations shown in the two species? 3K

Question 12 (4 marks)

Figure 1 below shows an Aboriginal rock art painting which is believed to represent *Thylacinus cynocephalus* (Thylacine/ Tasmanian Tiger) in Wollemi National Park, North-West of Sydney. This area is thought to have been traditionally inhabited by both Wiradjuri and Darkinjung people.

An artist's sketch of the painting is shown in Figure 2.

Figure 1. Close-up of the Wollemi painting of a Thylacine.

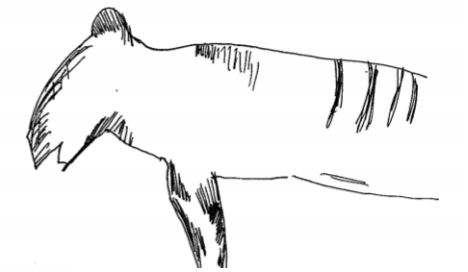


Figure 2. Artist's sketch of the Wollemi painting.

The art in the region has been classified into three phases, based on the methods used to produce the art. The Thylacine painting has been classified as 'Art Phase 3'.

Since the three phase classification system was introduced, the age of art across the region has been determined using radiometric dating of charcoal residues adjacent to the art. Charcoal is composed of almost pure carbon. The unstable isotope of carbon, Carbon 14, has a half - life of 5,730 years. Therefore, the percentage of Carbon 14 in the charcoal adjacent to the art indicates the age of the art.

The results of dating the three phases of Art across the region is in the following table.

Table: Age of Art in the Wollemi Region

Art Phase	Range of Carbon 14 (%)	Age Before Present (years)
1	23 - 48	12000- 6000
2	48 - 81	6000 - 1700
3	82 - 96	1600 - 300

a) It was previously thought that *Thylacinus cynocephalus* went extinct on the mainland of Australia between 2 and 3 thousand years ago. Does the Wollemi painting of a Thylacine challenge this assumption? Explain your answer. 2P

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b) Propose further research which could be undertaken to increase understanding of the evolutionary history of *Thylacinus cynocephalus* in the Wollemi region. 2P

Question 13 (5 marks)

bHLH proteins are found in all plants.

bHLH proteins are important in cell division, growth and development of plants.

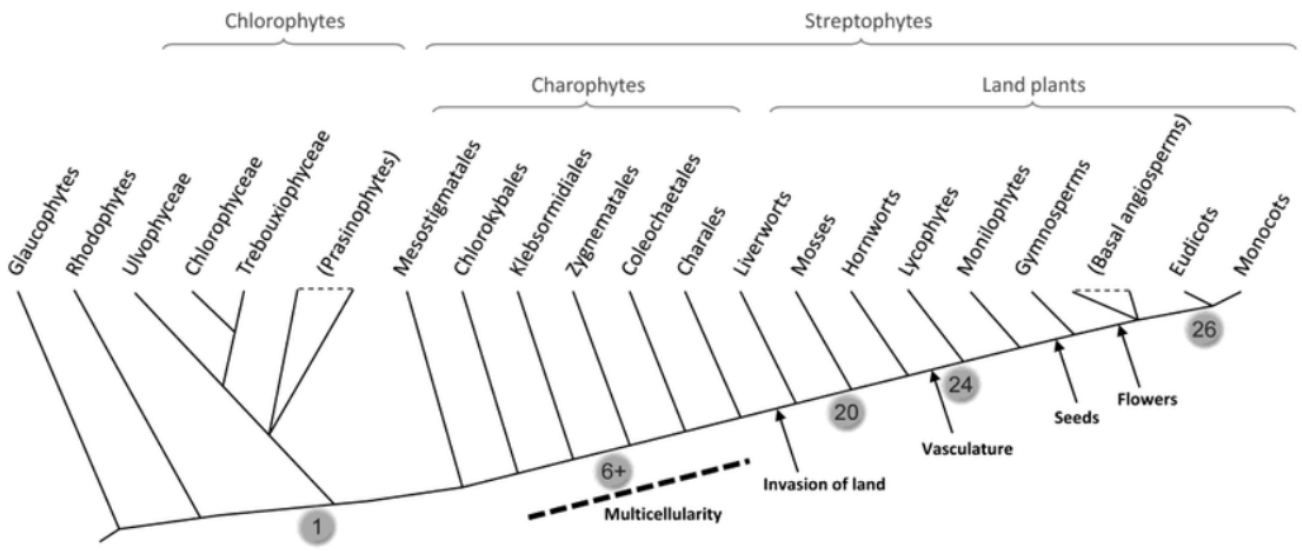
A protein "family" is a set of proteins with similar structures or functions. A protein family can be further classified into "subfamilies".

Many bHLH protein families and subfamilies have been identified in plants.

The cladogram diagram below shows the evolution of bHLH proteins in plants. The grey balloons show the number of newly evolved bHLH subfamilies at different times in the evolution of plants.

Some of the most important events in land plant evolution are indicated in the cladogram e.g. when plants became multicellular; when plants began producing seeds.

Cladogram – evolution of bHLH proteins in plants



a) Propose a hypothesis for the relationship between the number of bHLH subfamilies and the evolution of multicellularity in plants. 2P

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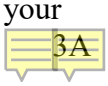
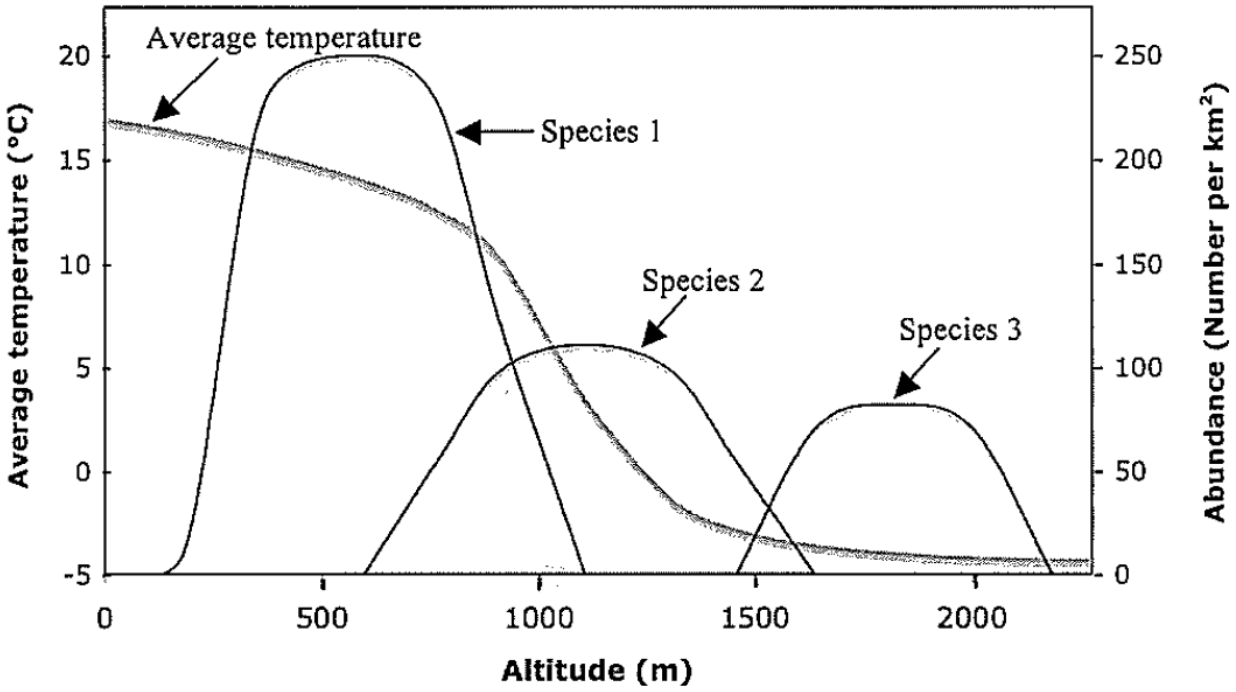
b) Did the evolution of multicellularity occur in aquatic or terrestrial (land) plants? Explain your answer.



Question 14 (7 marks)

The graph below shows the abundance of three eucalypt species and the average winter temperature at different altitudes in the Kosciuszko region of NSW. The highest mountain in this region is Mount Kosciuszko which reaches an altitude of 2228 metres.

Graph: The abundance of three eucalypt species and the average winter temperature at different altitudes in the Kosciuszko region of NSW



A study in the United States of 975 plant and animal species which live in mountain regions has shown that, for every one degree Celsius (1^0 C) increase in temperature, species move 100 m upslope, to higher altitudes. For every species studied, this movement upslope reduced both the area that the species could inhabit and its population size.

a) There are three axes on the graph: X axis; Y axis – left; and Y axis – right.

i) Which axis/axes on the graph shows the abundance of the different species of eucalypt at different altitudes? 1P

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ii) Which axis/axes on the graph shows the average temperature at different altitudes?

--- 1P

b) Currently, Species 3 has an altitudinal range of approximately 1460 metres to 2170 metres and a maximum abundance of 80 within this altitudinal range. The corresponding range in average winter temperatures over this altitudinal range is approximately - 4.2 degrees Celcius to - 3.1 degrees Celcius.

Predict changes from the present range and abundance of Species 3 over different altitudes if the average winter temperature in the region increases by 3 degrees Celcius. Explain your predicted changes. 5A

Question 15 (9 marks)

Scientists studied the evolution of the radiolarian *Pseudocubus vema*, a species of protist which lives in the world's oceans. In order to study its evolution, scientists collected fossils of the species and studied the structure and age of the fossils. The structural feature they studied was the "thoracic width" of the species. This is the width of the body region called the thorax. The age of the fossils was determined using radiometric dating. The oldest fossil was allocated the time "0.0 million years" and the youngest fossil allocated the time "2.5 million years". The age of a fossil was therefore measured as "millions of years since the oldest known fossil".

Figure 1 shows the structure of *Pseudocubus vema* and how the thoracic width was measured

Figure 2 is a graph of how the average/mean thoracic width of the species has changed over time. A broken line across the data points indicates a period of minimal change in the mean thoracic width of the species. "Shift" refers to the onset of a change in the width of the thorax of the species.

Figure 1: Pseudocubus vema – the thoracic width is shown by ⟷ *on the diagram.*

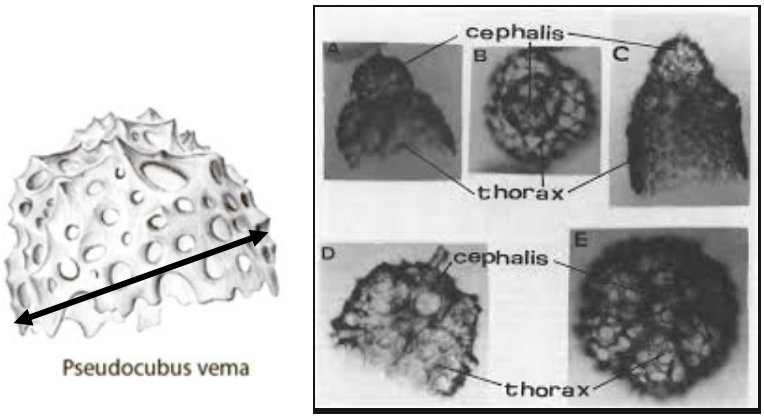
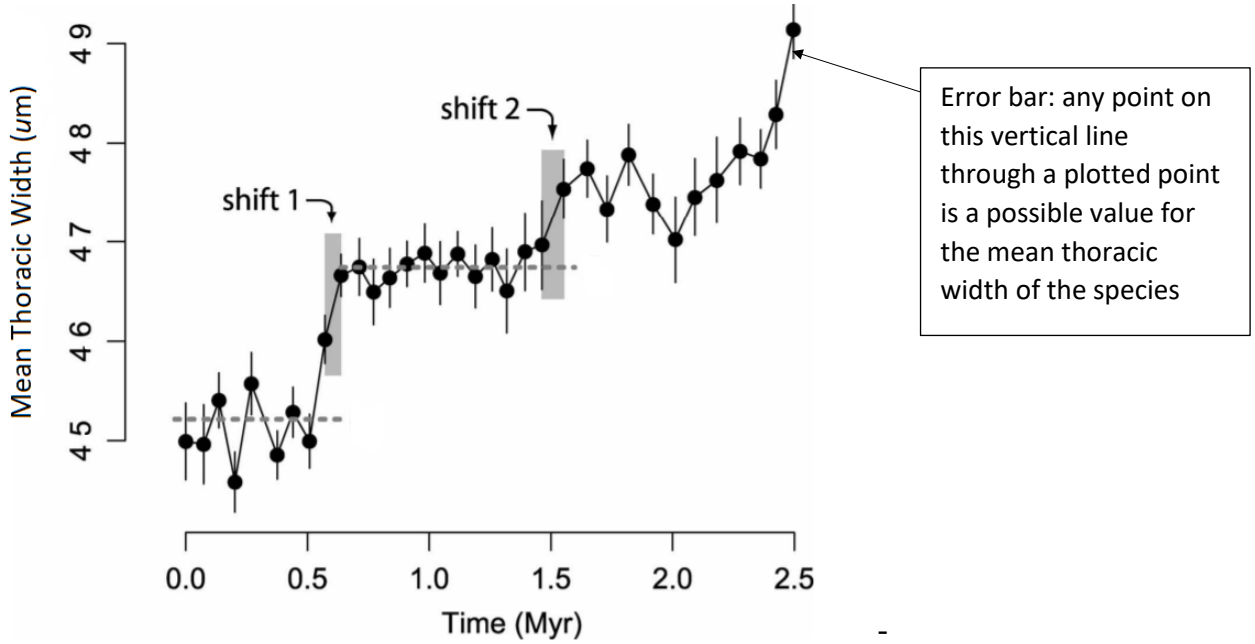


Figure 2. Mean Thoracic Width of Pseudocobus vema since oldest known fossil of the species



a) During which period(s) of time was the species *Pseudocubus vema* showing the least change in thoracic width? 1P

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b) During which period(s) of time was the species *Pseudocubus vema* experiencing the greatest change in thoracic width? 1P

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c) The scientists claimed that their work showed evidence for "punctuated equilibrium". Do you support their hypothesis? Give reasons for your answer. 5K

CONTINUED ON NEXT PAGE

d) The scientists dated the fossils by obtaining ice core samples; using the isotopic composition of hydrogen and oxygen in water molecules released by melting the ice cores. This technology was also able to determine the air temperatures at the time the radiolarian samples were fossilised.

How are ice core samples obtained? 2P

END OF PAPER

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Section 1: 10 multiple choice questions
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Section 1

10 marks

Attempt Questions 1 – 10

Use the multiple-choice answer sheet for Questions 1–10

---

1. A population is correctly defined as having which of the following characteristics? 1K

1) Inhabiting the same general area.

2) Belonging to the same species.

3) Possessing a constant and uniform distribution and abundance.

A. 1 only

B. 2 only

C. 1 and 2 only

D. 1 and 3 only

2. Rapid rates of evolution would be most expected among species that: 1K

A. Mature in a few days or weeks and then reproduce
B. Mature very slowly only after they are 20 year's old
C. Have large bodies
D. Have small bodies

3. Two populations of platypuses (*Ornithorhynchus anatinus*) each live on a different island off the coast of Australia. Scientists believe that both of these island populations are at greater risk of dying out than populations of these platypuses on the mainland of Australia.

The table below shows combinations of size of the gene pool and genetic diversity for *Ornithorhynchus anatinus*. Which one of these combinations is most consistent with island populations of platypuses being at greater risk of dying out than are mainland populations? 1K

	Size of gene pool	*Genetic diversity*
J.	small	high
K.	large	high
L.	large	low
M.	small	low

A. J
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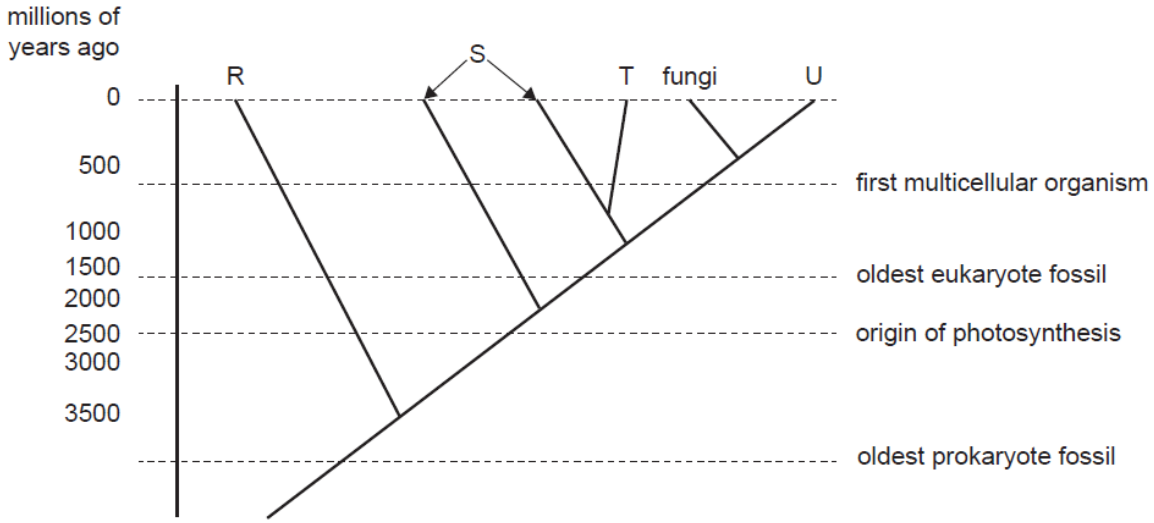
D. M

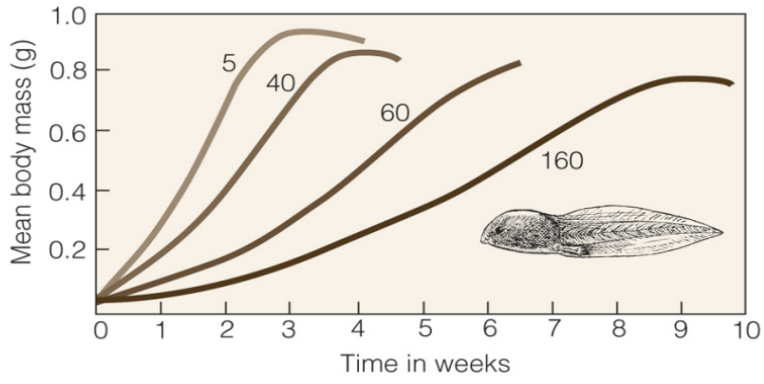
4. The phylogenetic tree below represents one model of the order and approximate time of appearance of the major groups of living organisms; and includes four groups represented by the letters R, S, T and U. 1K



Which of the following shows the correct placement of the organisms on the phylogenetic tree?

A. R – animals S – plants T – bacteria U – protists
B. R – bacteria S – protists T – plants U – animals
C. R – protists S – animals T – bacteria U – plants
D. R – plants S – animals T – bacteria U – protists

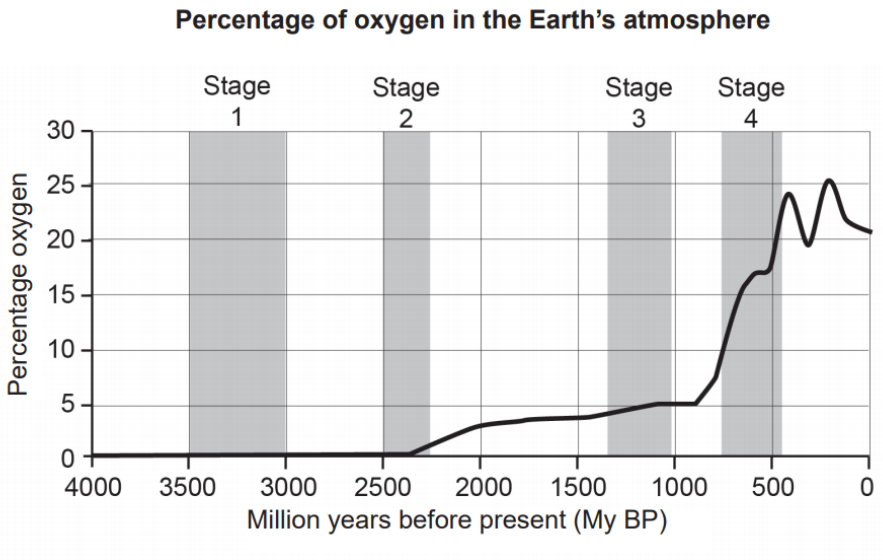
5. This following figure shows the results of an experiment where the number of tadpoles within a particular habitat was changed. This change was termed a "treatment". The numbers next to the lines on the graph are the numbers of individuals in each treatment. 1A



The results of this experiment indicate that:

A. access to resources decreases as population size decreases
B. access to resources increases as population size decreases
C. access to resources is not affected by population size
D. access to resources always affects population size

Questions 6 and 7 refer to the following graph. The graph shows an estimate of the percentage of oxygen in the Earth's atmosphere over time.



6. When iron combines with oxygen it forms iron oxide. Iron oxide deposits in rocks when they are being formed. These deposits create orange coloured "banded iron" formations. During which Stage would most of the iron formations be produced? 1A

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

7. Eukaryotes first evolved approximately 1500 million years before present. The evolution and diversification of eukaryotes required increasing amounts of oxygen in the atmosphere. During which Stage would the least diversification of eukaryotes have taken place? 1A

A. Stage 1
B. Stage 2
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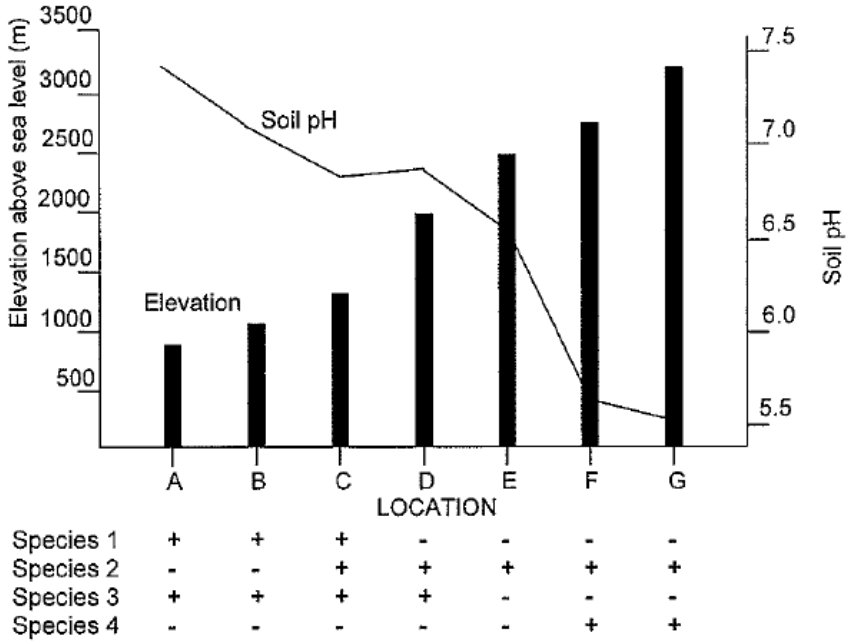
D. Stage 4

Questions 8 and 9 refer to the following diagram.



The diagram shows data from an ecological transect and indicates: which species (1 to 4) are present (+ = present, - = absent); the elevation above sea level; and the soil pH at each location on the transect locations A to G.

8. At which location is there the least, and the greatest, diversity of species? 1A

	Least	*Greatest*
A.	B	F
B.	E	C
C.	C	E
D.	A	G

9. Which species is found over the least, and the greatest, range in soil pH? 1A

	Least	*Greatest*
A.	Species 3	Species 1
B.	Species 4	Species 3
C.	Species 2	Species 4
D.	Species 4	Species 2

10. The following table shows ecological interactions. "+" indicates a benefit for the organism. "- "indicates a detrimental effect, and "0" indicates no effect. The first interaction has been identified for you as mutualism, an interaction which is beneficial to both organisms involved.

Ecological relationship	Species A	Species B
I (Mutualism)	+	+
II	+	-
III	+	0
IV	-	0
V	-	-

Which interaction would you expect to represent competition? 1K

A. II
B. III
C. IV
D. V

Section 2

Question 11 (3 marks)

The Cretaceous-Tertiary extinction event occurred 66 million years ago. The event resulted in the extinction of 75% of plant and animal species on Earth, including non-avian (non-flying) dinosaurs. However, many new species of animal and plants evolved after the event.

Figures 1 and 2 show two extinct species. The two species are of similar size.

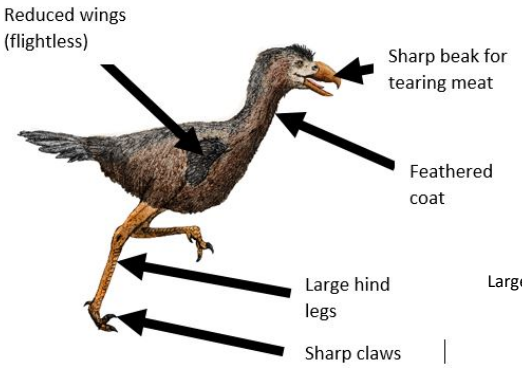


Figure 1 *Llallawavis scagliai (a species of Terror Bird) lived approximately 3 million years ago.*

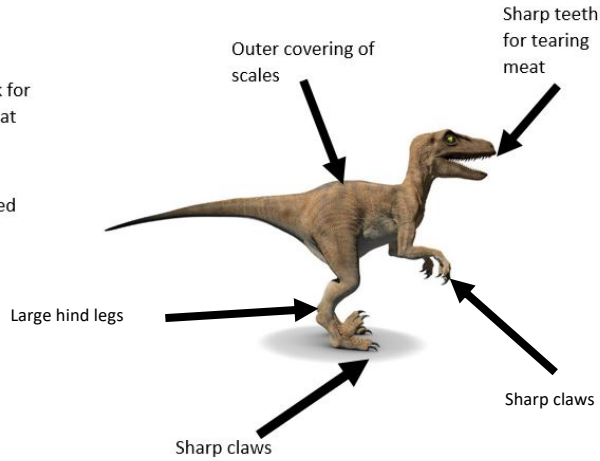


Figure 2 *A species of the genus Velociraptor which lived approximately 70 million years ago.*

How would Darwin and Wallace's theory of evolution by natural selection account for similarities OR differences in the adaptations shown in the two species? 3K

3 marks:

Relates two similarities/differences in adaptations to the theory of evolution by natural selection in relation to plausible evolutionary processes, using specific examples (linked to specific similarities/differences). Evolutionary processes need to account for favourable traits providing ability to survive and/or reproduce.

2 marks:

Relates one similarities/difference to the theory of evolution by natural selection in relation to one evolutionary process.

1 mark:

Cite one similarity /m difference between the two species OR Describes the theory of evolution by natural selection.

Many students focused the question on describing Natural selection, and not on similarities and/or differences between the two species.

Overall students needed to be more specific when describing similarities/differences and teo specific evolutionary processed would account for these similarities/differences.

There was a common misconception that *L.scagliai* was a direct descendent of the Velociraptor.

Sample:

Both *L.scagliai* and the *Velociraptor* have adapted the ability to tear meat with a sharp beak and sharp teeth respectively. After the extinction of the non-avian dinosaurs *L.scagliai* adapted this advantageous trait through convergent evolution, as this bird filled an ecological niche that had been left empty, allowing the bird to survive and reproduce.

L.scagliai has a feathered coat while the Velociraptor is covered in scales. Prior to the extinction, avian dinosaurs developed feathers due to divergent evolution, filling a new avian niche. *L.scagliai* still has this adaptation even though it most likely does not fly.

Question 12 (4 marks)

Figure 1 below shows an Aboriginal rock art painting which is believed to represent *Thylacinus cynocephalus* (Thylacine/ Tasmanian Tiger) in Wollemi National Park, North-West of Sydney. This area is thought to have been traditionally inhabited by both Wiradjuri and Darkinjung people.

An artist's sketch of the painting is shown in Figure 2.

Figure 1. Close-up of the Wollemi painting of a Thylacine.

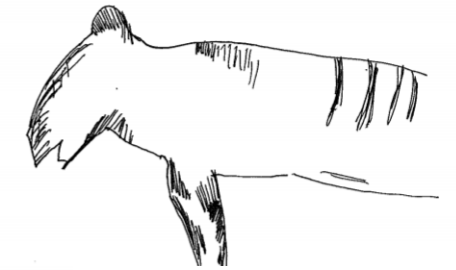


Figure 2. Artist's sketch of the Wollemi painting.

The art in the region has been classified into three phases, based on the methods used to produce the art. The Thylacine painting has been classified as 'Art Phase 3'.

Since the three phase classification system was introduced, the age of art across the region has been determined using radiometric dating of charcoal residues adjacent to the art. Charcoal is composed of almost pure carbon. The unstable isotope of carbon, Carbon 14, has a half - life of 5,730 years. Therefore, the percentage of Carbon 14 in the charcoal adjacent to the art indicates the age of the art.

The results of dating the three phases of Art across the region is in the following table.

Table: Age of Art in the Wollemi Region

Art Phase	Range of Carbon 14 (%)	Age Before Present (years)
1	23 - 48	12000- 6000
2	48 - 81	6000 - 1700
3	82 - 96	1600 - 300

It was previously thought that Thylacinus cynocephalus went extinct on the mainland of Australia between 2 and 3 thousand years ago. Does the Wollemi painting of a Thylacine challenge this assumption? Explain your answer.

2 marks:

Explains how the research challenges the previous assumption, referring to specific data in the table.

1 mark:

Links data to challenging previous assumption OR Cites one relevant piece of information

Generally, this question was answered very well.

The most common mistake was not citing specific data from the table to answer the question. Some students made the question too complicated, attempting to explain radioactive decay to answer the question.

a) Propose further research which could be undertaken to increase understanding of the evolutionary history of *Thylacinus cynocephalus* in the Wollemi region. 2P

2 marks:

Proposes reasonable, described method in which more research could be undertaken to increase understanding.

1 mark:

Proposes method in which more research could be undertaken to increase understanding.

Generally, this question was answered very well. Most techniques described were plausible.

Most common error was only listing a technique with no description of how this technique may function to increase understanding.

Question 13 (5 marks)

bHLH proteins are found in all plants.

bHLH proteins are important in cell division, growth and development of plants.

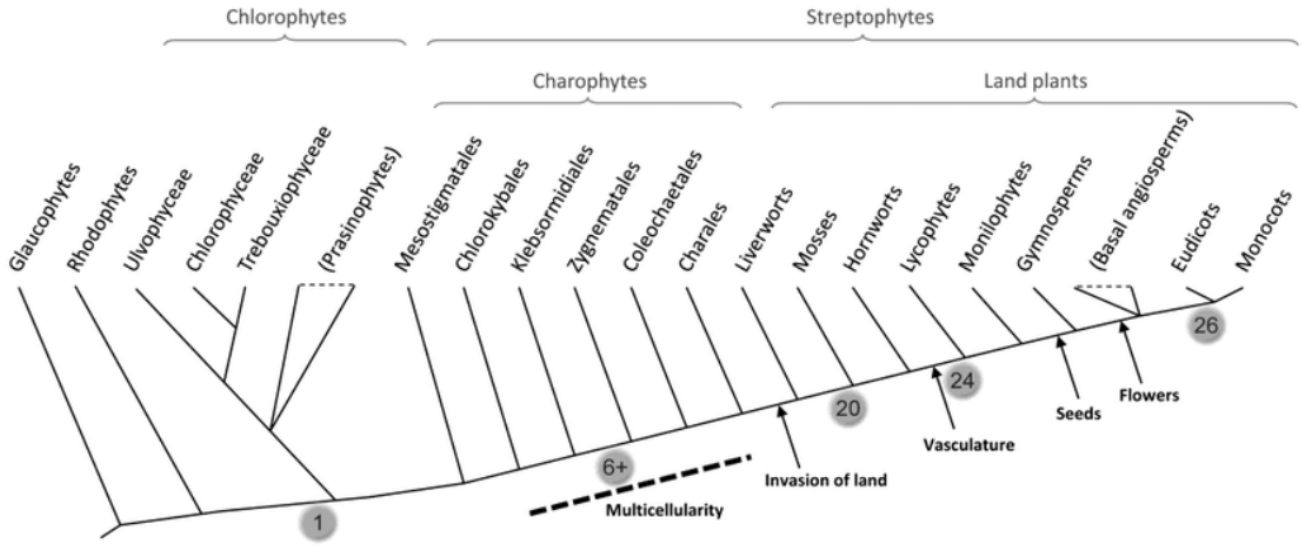
A protein "family" is a set of proteins with similar structures or functions. A protein family can be further classified into "subfamilies".

Many bHLH protein families and subfamilies have been identified in plants.

The cladogram diagram below shows the evolution of bHLH proteins in plants. The grey balloons show the number of newly evolved bHLH subfamilies at different times in the evolution of plants.

Some of the most important events in land plant evolution are indicated in the cladogram e.g. when plants became multicellular; when plants began producing seeds.

Cladogram – evolution of bHLH proteins in plants



a) Propose a hypothesis for the relationship between the number of bHLH subfamilies and the evolution of multicellularity in plants. 2P

2 marks

Must be a statement with an independent variable and a dependent variable (s)

1 mark

One independent variable and a dependent variable (s)

An increase in bHLH subfamilies led to multicellularity in plants.

b) Did the evolution of multicellularity occur in aquatic or terrestrial (land) plants? Explain your answer. 3A

Supports using data from the cladogram – 1 mark for each datum cited; maximum of 2 marks

Done quite well

Many students didn't provide TWO pieces of data from cladogram as evidence

Some did not refer to cladogram AT ALL to answer the question

Aquatic plants.

Explanation (at least two citing specific data from the cladogram)

e.g. The cladogram shows "Invasion of land" evolved after "multicellularity".

e.g. The cladogram shows the earliest terrestrial plants as Liverworts. This plant group evolved after "invasion of land"

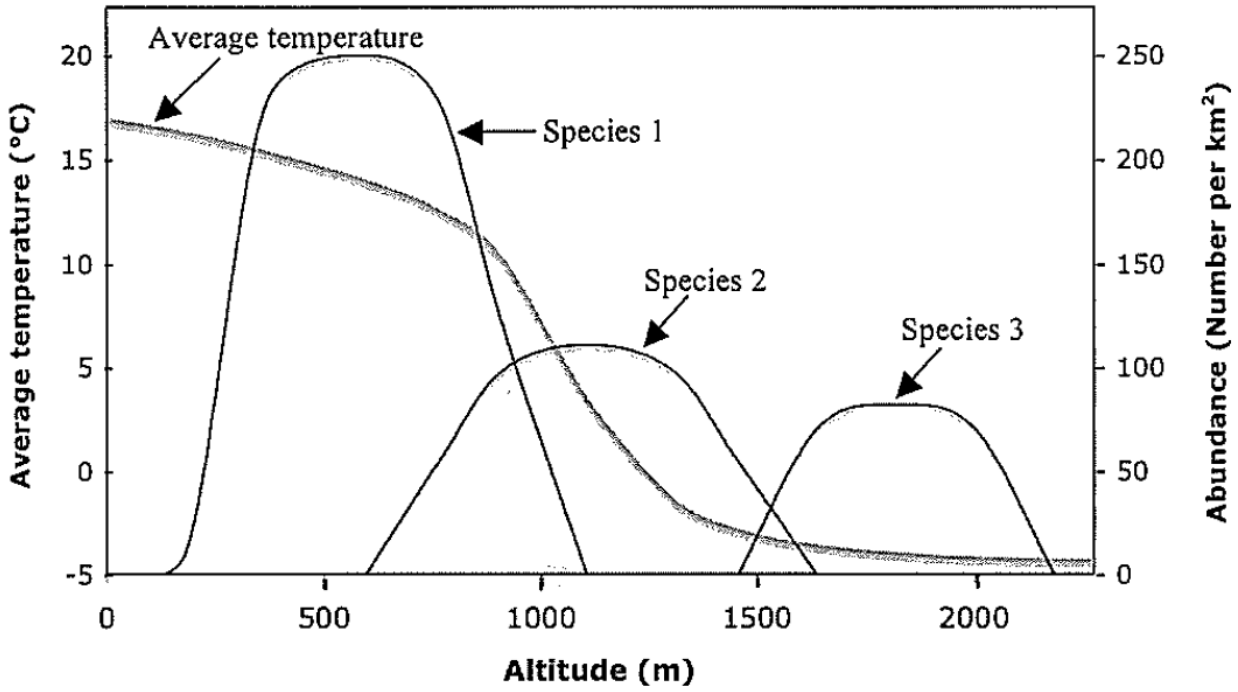
e.g. All plants between the Glaucophytes and the Mesostigmitales were unicellular and aquatic.

e.g. Multicellularity arose in the aquatic Chlorokybales.

Question 14 (7 marks)

The graph below shows the abundance of three eucalypt species and the average winter temperature at different altitudes in the Kosciuszko region of NSW. The highest mountain in this region is Mount Kosciuszko which reaches an altitude of 2228 metres.

Graph: The abundance of three eucalypt species and the average winter temperature at different altitudes in the Kosciuszko region of NSW



A study in the United States of 975 plant and animal species which live in mountain regions has shown that, for every one degree Celsius (1^0 C) increase in temperature, species move 100 m upslope, to higher altitudes. For every species studied, this movement upslope reduced both the area that the species could inhabit and its population size.

a) There are three axes on the graph: X axis; Y axis – left; and Y axis – right.

i) Which axis/axes on the graph shows the abundance of the different species of eucalypt at different altitudes? 1P

Y-axis right

ii) Which axis/axes on the graph shows the average temperature at different altitudes? 1P

Y-axis left

Some students included x and y axis

b) Currently, Species 3 has an altitudinal range of approximately 1460 metres to 2170 metres and a maximum abundance of 80 within this altitudinal range. The corresponding range in average winter temperatures over this altitudinal range is approximately - 4.2 degrees Celsius to - 3.1 degrees Celsius.

Predict changes from the present range and abundance of Species 3 over different altitudes if the average winter temperature in the region increases by 3 degrees Celsius. Explain your predicted changes. 5A

1 Cur- current/present day data (need to cite ONE present ALITITUDE or ABUNDANCE information from graph) Many students did not do this

2P – TWO prediction for ALTITUDE AND/OR ABUNDANCE

2C – TWO CAUSES linked to PREDICTIONS Many students did not do this OR only stated ONE

cause/explanation of predicted changes.

One sample answer

The present altitudinal range of Species 3 is approx. 1460 m to 2170 m, with a maximum abundance of 80-85 at approx. 1815m. This is over a temperature range of -4.2 to -3.1 degrees C; with the maximum abundance of 85 at a temperature of approx. - 3.7 degrees C. The current minimum average temp in the region is approx. – 5 degrees C.

If the average winter temperature in the region increases by 3 degrees, temperatures at all altitudes will increase. The minimum average temperature in the region will be – 2 degrees C.

The species' ability to survive temperatures outside its present temperature range is unlikely to change.

This will mean that the species will move upslope to areas within its present temperature range. The maximum altitude it can access is 2228 m, the height of Mount Kosciuszko. The minimum temperature it will be able to access is -2 degrees Celcius.

The abundance of the species will change across all altitudes e.g. it will decrease at altitudes which exceed the maximum temperature at which the species currently exists.

Question 15 (9 marks)

Scientists studied the evolution of the radiolarian *Pseudocubus vema*, a species of protist which lives in the world's oceans. In order to study its evolution, scientists collected fossils of the species and studied the structure and age of the fossils. The structural feature they studied was the "thoracic width" of the species. This is the width of the body region called the thorax. The age of the fossils was determined using radiometric dating. The oldest fossil was allocated the time "0.0 million years" and the youngest fossil allocated the time "2.5 million years". The age of a fossil was therefore measured as "millions of years since the oldest known fossil".

Figure 1 shows the structure of *Pseudocubus vema* and how the thoracic width was measured

Figure 2 is a graph of how the average/mean thoracic width of the species has changed over time. A broken line across the data points indicates a period of minimal change in the mean thoracic width of the species. "Shift" refers to the onset of a change in the width of the thorax of the species.

Figure 1: Pseudocubus vema – the thoracic width is shown by ⟷ *on the diagram.*

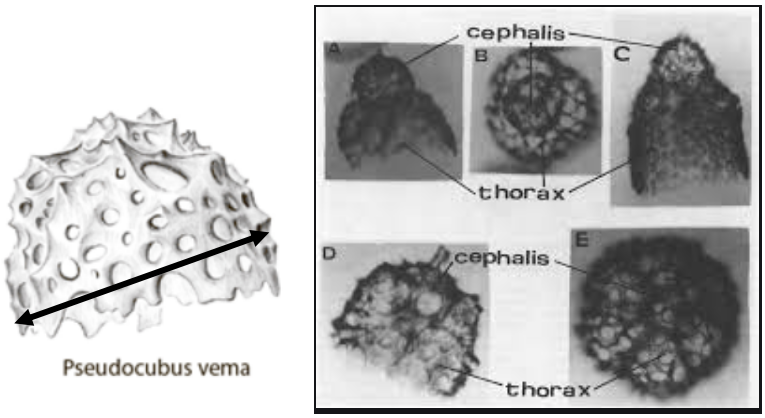
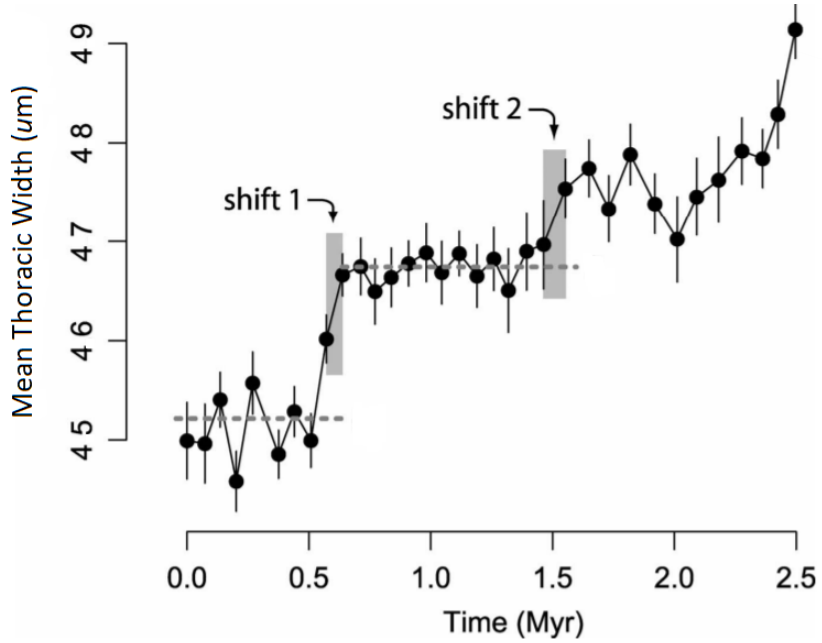


Figure 2. Mean Thoracic Width of Pseudocobus vema since oldest known fossil of the species



Error bar: any point on this vertical line through a plotted point is a possible value for the mean thoracic width of the species

-

a) During which period(s) of time was the species *Pseudocubus vema* showing the least change in thoracic width? 1P

Between Shift 1 and Shift 2 / specific time period cited from graph

b) During which period(s) of time was the species *Pseudocubus vema* experiencing the greatest change in thoracic width? 1P

Time periods defined as Shift 1, Shift 2 / time period/periods cited from graph

c) The scientists claimed that their work showed evidence for "punctuated equilibrium". Do you support their hypothesis? Give reasons for your answer. 5K

Statement of support or rejection = 1K

Defines punctuated equilibrium in terms of stasis and rapid change = 2 K

Cites at least 2 features of the graph that support the hypothesis = 1 mark/ feature

Yes. I support this hypothesis.

Punctuated equilibrium predicts that evolutionary change takes place in short periods of time within long periods of limited change (stasis/ equilibrium).

The graph provides evidence for this because it shows periods of rapid change in e.g. Shift 1 and Shift 2 taking place within long periods of stasis e.g. 0.0 – 0.5 Myr)

Definition of punctuated equilibrium Not done by most

Most did not cite data from graph to support their reason

Be careful when reading off graph, many stated 0.5 Myr as beginning of stability rather than 0.7

d) The scientists dated the fossils by obtaining ice core samples; using the isotopic composition of hydrogen and oxygen in water molecules released by melting the ice cores. This technology was also able to determine the air temperatures at the time the radiolarian samples were fossilised.

How are ice core samples obtained? 2P

Includes any two of the following

Areas were sampled are obtained in areas that contain ancient ice

Areas include e.g. Antarctica

Cores are drilled with hand augers (for shallow holes)

Cores are drilled with power drill/s

Cores drilled to depths of over 3.2 km

Many students addressed WHY and not the HOW