

Variation and Evolution

Mark Scheme



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1. Variation and evolution are fundamental concepts in biology; the following questions examine different facets of these interconnected processes. Circle the letter of the correct answer for each.

a) Which of the following is **not** a feature of natural selection?

D – is the only correct answer.

1 mark

Total: 1 mark

b) The bar chart shows the heights of wheat plants grown from 1000 wheat seeds.



What form of variation do the wheat seeds show when they grow?

C – is the only correct answer.

1 mark

Total: 1 mark

c) Discontinuous variation results in individuals fitting into clear, distinct categories for a particular characteristic. Which human trait listed below is best described this way?

D – is the only correct answer.

1 mark

Total: 1 mark

d) The theory of evolution by natural selection, which explains how species adapt and change over generations, was independently proposed by which pair of scientists?

B – is the only correct answer.

1 mark

Total: 1 mark

(Total for Question 1 is 4 marks)

2. Soay sheep live on St. Kilda, a group of small, remote islands near Scotland that have very cold, windy, and rainy weather.
- a) Suggest **one** observable physical trait that likely shows variation within the Soay sheep population on St. Kilda?

Any one of the following:	
- Coat / fleece / wool colour. - Horn size / shape / curl. - Body size / mass / weight. - Wool / fleece length / thickness.	
	Total: 1 mark

- b) The figure above contains information about lambs when the St. Kilda sheep population is large versus small. How does this information show that population size strongly influences lamb survival?

Any two from:	
In high population years, overall lamb survival is lower / in low population years, overall lamb survival is higher.	1 mark
In high population years, only lambs with a high(er) body mass are likely to survive.	1 mark
Low population years, lambs with a lower body mass / a wider range of body masses can survive.	1 mark
	Total: 2 marks

- c) Suggest an explanation for the effect that you have described.

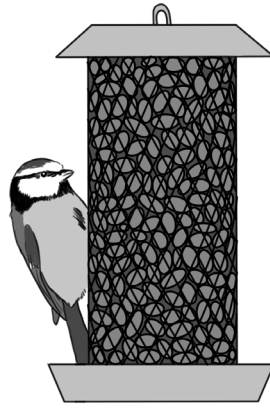
Any three from:	
In high population years there is increased competition for a named limited resource, e.g., food / grass / territory / shelter.	1 mark
Lambs with a higher body mass are stronger / have more fat/energy reserves. So they are more likely to outcompete other lambs / survive starvation / survive the cold conditions.	1 mark
In high population years there is a greater chance of disease spreading due to the sheep being in closer contact.	1 mark
Lambs with a lower body mass may have a weaker immune system / be more susceptible to disease.	1 mark
	Total: 3 marks

- d) How can the theory of natural selection explain the evolution of the adaptive traits observed in Soay sheep living under the extreme conditions of St. Kilda?

An answer that contains any four from the following points:	
There is variation within the sheep population (caused by mutation).	1 mark
Reference to a specific selection pressure, e.g., cold climate / limited food supply / competition.	1 mark
Individuals with advantageous adaptations / alleles (e.g., thicker wool, larger body size) are more likely to survive (and reproduce).	1 mark
These advantageous alleles / genes are passed on to their offspring.	1 mark
Over time / many generations, the frequency of these (advantageous) alleles/traits increases in the population.	1 mark
	Total: 4 marks

(Total for Question 2 is 10 marks)

3. Blue tits, small birds commonly observed in gardens, are often fed nuts by people in the UK using bird feeders, such as the one depicted in the diagram below.



- a) Given that UK blue tits (which frequently use bird feeders) have slightly longer beaks than blue tits in the rest of Europe (where feeders are rare), explain, using Charles Darwin's theory of natural selection, how the availability of bird feeders could have driven this evolutionary change in beak length.

An answer that contains any four from the following points:	
There was variation in beak length within the original blue tit population.	1 mark
due to random mutation.	1 mark
The availability of bird feeders acted as a new selection pressure / provided a competitive advantage.	1 mark
Birds with slightly longer beaks were better able to access food from the feeders.	1 mark
These birds had a higher chance of survival and were more likely to reproduce.	1 mark
They passed on the advantageous alleles / genes for longer beaks to their offspring	1 mark
Over many generations, the frequency of the allele for longer beaks increased in the UK population.	1 mark
	Total: 4 marks

- b) If the design of commonly used bird feeders in the UK changed such that very short beaks became more advantageous for accessing nuts, predict what would happen to the average beak length of the UK blue tit population over many generations. Explain your reasoning.

The average beak length of the population would decrease.	1 mark
Because natural selection would now favour shorter beaks / birds with shorter beaks would get more food, be more likely to survive and pass on their alleles.	1 mark
	Total: 2 marks

(Total for Question 3 is 6 marks)

4. The Marsh Harrier, a magnificent and stunningly beautiful bird of prey, is a notable inhabitant of the UK's wetland ecosystems.

The numbers of Marsh Harriers dropped dramatically in the 19th Century. This was due to both a loss of wetlands and persecution by humans.



It is now illegal to harm these remarkable animals and a lot of work has been done to restore much of the lost wetland habitat.

In 1995, it was estimated that number of breeding pairs of Marsh Harriers in the UK was 160 pairs. Most recent estimates in 2024 suggest that there could be now 600 breeding pairs in the UK.

- a) Calculate the percentage increase in the number of breeding pairs from 1995 to 2024.

Increase = $600 - 160 = 440$	1 mark
$(440 \div 160) \times 100$	1 mark
= 275 (%)	1 mark
Marking note: accept correct answer without working for 3 marks.	
	Total: 3 marks

The Marsh Harrier is superbly adapted to hunting small animals within dense wetland habitats like reedbeds. These birds often fly relatively slowly and low while searching an area for prey.

- b) Explain, using the principles of natural selection, how the evolution of **broad wings** in Marsh Harriers would be advantageous for their survival and reproduction in this specific environment.

An explanation to include any three from the following points:	
Variation existed in the Marsh Harrier population for wing shape / size.	1 mark
Birds with broader wings had an advantage because they could fly more slowly / generate more lift at low speeds / were more manoeuvrable.	1 mark
This made them more successful hunters / better at catching prey in dense reedbeds.	1 mark
These individuals were more likely to survive, reproduce and pass on the alleles/genes for broad wings to their offspring.	1 mark
	Total: 3 marks

Although Marsh Harrier numbers have recovered significantly in the UK, if the current population was found to be largely descended from a very small number of individuals (and therefore closely related), this could make them susceptible to future extinction.

- c) Explain, using your knowledge of natural selection, why being closely related could increase the Marsh Harriers' susceptibility to extinction.

An explanation to include any three from the following points:	
The population has low genetic variation / a small gene pool (because they are all descended from a few individuals).	1 mark
If a new selection pressure arises, e.g., a new disease / significant environmental change.	1 mark
It is less likely that any individuals will possess a resistant/advantageous allele.	1 mark
Therefore, the population is unable to adapt (through natural selection) and a single event could wipe out the entire population.	1 mark
	Total: 3 marks

Marsh Harriers, like all species, show variation within their population.

- d) Identify two distinct types of observable physical variation that might be present among individual Marsh Harriers in the UK.

An answer to include any two of the following:	
• Plumage / feather colour / pattern. • Body size / mass. • Wingspan. • Beak size / shape. • Talon / claw size. • Eye colour.	
	Total: 2 marks

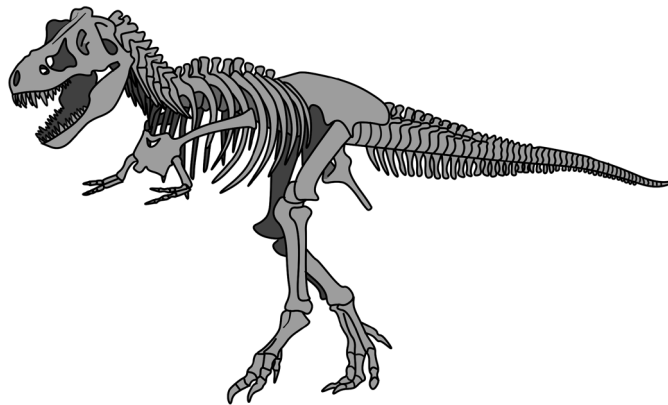
- e) Choose one of the variations you identified in (d) and explain how it could potentially provide an advantage to an individual Marsh Harrier.

A valid explanation linking one of the traits identified in (d) to a survival or reproductive advantage.	
Plumage colour: Better camouflage makes it a more successful hunter / helps it avoid predation.	1 mark
Body size: Larger individuals may be more successful in competing for territory or mates.	1 mark
Wingspan: A slightly larger wingspan may allow for more efficient soaring, saving energy when hunting.	1 mark
	Total: 1 marks

(Total for Question 4 is 12 marks)

5. Skeletons of Tyrannosaurus rex show a large dinosaur, characterised by a massive skull packed with huge teeth, powerful hind legs, and disproportionately tiny, two-fingered forelimbs.

The figure below shows the skeleton of a Tyrannosaurus Rex.



- a) Explain why fossils of dinosaurs like Tyrannosaurus Rex are often found to be incomplete.

An explanation to include any three of the following:	
Soft parts of the body (skin, organs) decay / are eaten before fossilisation can occur.	1 mark
Not all parts of the organism are buried, so some bones are lost.	1 mark
The skeleton may be scattered by scavengers or environmental factors (e.g. water) before burial.	1 mark
The fossil may be damaged or destroyed later by geological activity (e.g. earthquakes, erosion).	1 mark
Not all parts of the fossil are discovered / excavated.	1 mark
	Total: 3 marks

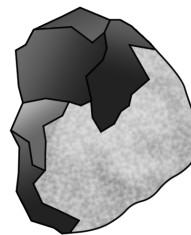
The figure below shows four different Stone Age tools discovered at different archaeological sites throughout Europe.



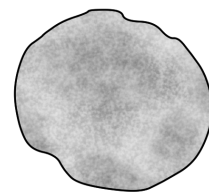
handaxe



arrowhead



cutting stone



hammer stone

- b) Suggest how these tools may have helped early humans to survive.

A suggestion to include two of the following:	
Used for hunting / killing animals (for food).	1 mark
Used for defence against predators.	1 mark
Used for butchering animals / cutting meat / scraping hides.	1 mark
Used for cracking open bones (for marrow) or nuts.	1 mark
Used for making other tools / shaping wood or stone.	1 mark
	Total: 2 marks

- c) In the context of human evolution, explain why mitochondrial DNA is often chosen over nuclear DNA as a source of evidence.

An explanation to include two of the following:	
There are many mitochondria in a cell, so there are many copies of mitochondrial DNA (mtDNA).	1 mark
This makes it more likely to be recovered from ancient / degraded samples (than nuclear DNA).	1 mark
It is inherited solely from the mother / maternally,	1 mark
which allows for tracing of a clear line of ancestry. It does not undergo recombination / mixing.	1 mark
	Total: 2 marks

- d) How does the fossil record provide evidence for the evolutionary changes that have occurred in the human lineage over time?

An answer to include three from the following points:	
Fossils can be dated / arranged in chronological order (based on the rock layers they are found in).	1 mark
This shows gradual changes in anatomy / features over millions of years.	1 mark
A specific example of a trend, e.g., skulls have become larger / brain volume has increased OR the skeleton has become more adapted for walking upright / bipedalism.	1 mark
	Total: 3 marks

(Total for Question 5 is 10 marks)

6. Explain Darwin's theory of evolution by natural selection.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Identifies one or two relevant, isolated points (e.g., variation, survival). The points are not linked to form a coherent explanation.
Level 2	3 - 4	A good explanation that includes several key stages, but the sequence may be incomplete or not fully logical.
Level 3	5 - 6	A detailed and logical sequence covering all key stages of natural selection. Correct scientific terminology is used throughout.

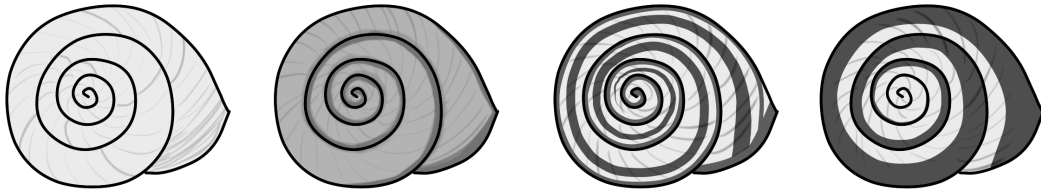
Indicative content:	
• There is (genetic) variation within a population / species. • This variation is caused by (random) mutation(s). • Individuals produce more offspring than can survive. • This leads to competition for limited resources (e.g., food, mates, territory). • Due to a specific selection pressure, some individuals have characteristics / alleles that make them better adapted to the environment. • These individuals are more likely to survive ('survival of the fittest'). • And are therefore more likely to reproduce. • They pass on their advantageous alleles / genes to their offspring. • Over time / many generations, the frequency of the advantageous allele(s) in the population increases, leading to evolution.	
	Total: 6 marks

(Total for Question 6 is 6 marks)

7. A group of students investigated variation in a species of snail, *Cepaea nemoralis*.

The snails show variation in the colour of their shells and whether their shells have dark bands or not.

The figure below shows examples of *Cepaea nemoralis* snail shells.



- a) State what is meant by the term 'variation'.

Differences between individuals (of the same species).	1 mark
	Total: 1 mark

- b) Give **two** causes of variation in organisms.

Correctly identifies two causes of variation:	
Genetic factors / inheritance.	1 mark
(Random) mutations.	1 mark
Environmental factors / the environment.	1 mark
Sexual reproduction / meiosis.	1 mark
	Total: 2 marks

The students collected 50 snails from a woodland area and 50 snails from a grassland area.

They recorded the shell colour and the presence or absence of bands for each snail.

Their results for the woodland area are shown in the table below.

Shell Feature	Number of Snails
Yellow shell	8
Pink shell	6
Brown shell	36
Total	50

- c) The students concluded that shell colour in *Cepaea nemoralis* is an example of discontinuous variation. Explain why the data in Table 1 supports this conclusion.

The shell colours fall into distinct / discrete categories.	1 mark
There are no intermediate colours / values in between these categories.	1 mark
	Total: 2 marks

- d) Calculate the percentage of snails from the woodland area that had a **brown** shell. Show all of your working.

$(36 \div 50) \times 100$	1 mark
$= 72 (\%)$	1 mark
	Total: 2 marks

In the grassland area, the students found a higher proportion of snails with yellow, banded shells compared to the woodland area.

- e) Suggest an environmental factor that could cause this difference in the proportion of yellow, banded snails between the two areas. Explain your answer.

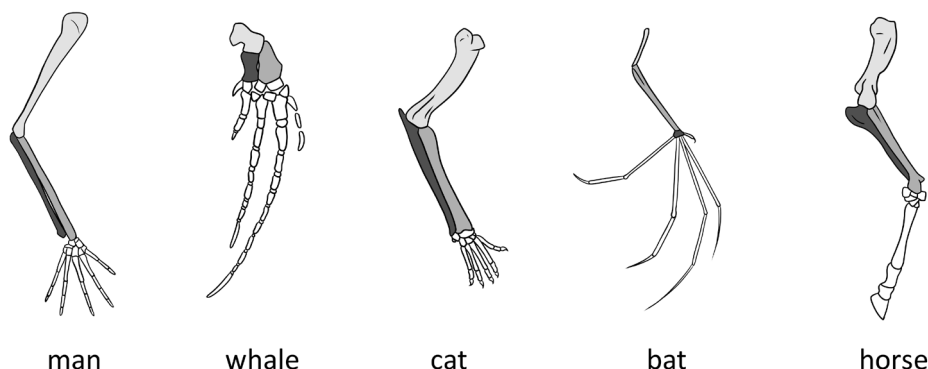
An explanation to include:	
Predation / predators (e.g. birds) are the selection pressure.	1 mark
Yellow, banded snails are better camouflaged in the grassland environment (e.g. against dry grass).	1 mark
So they are less likely to be seen / eaten by predators.	1 mark
This means they are more likely to survive, reproduce and pass on the alleles for yellow, banded shells.	1 mark
	Total: 3 marks

- f) Variation can be caused by sexual reproduction.
Describe how sexual reproduction leads to variation in offspring.

A description to include:	
Involves the fusion of two gametes (from two different parents).	1 mark
This causes mixing of genetic information / alleles, creating a unique combination in the offspring.	1 mark
	Total: 2 marks

(Total for Question 7 is 12 marks)

8. The diagram shows some limbs of modern-day animals.



Explain in detail how these observations of limb structures in different vertebrates provide significant evidence to support the theory of evolution.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	A simple statement is made, identifying that the animals have similar bones or are related. The explanation lacks detail and does not link the observation to the principles of evolution. The use of scientific terminology is minimal.
Level 2	3 - 4	A good explanation is given. The answer identifies that the limbs have the same basic structure despite having different functions. An attempt is made to link this to a common ancestor, but the explanation may lack clarity or detail.
Level 3	5 - 6	A detailed and coherent explanation is provided that is logically structured. The answer clearly explains that the limbs are homologous structures (or pentadactyl limbs) with the same underlying bone structure but are adapted for different functions. This is explicitly and confidently linked to inheritance from a common ancestor as strong evidence for evolution.

Indicative content:	
- The limbs in all these vertebrates have the same basic bone structure / plan. - This specific structure is called the <u>pentadactyl limb</u>. (For example) they all have one bone in the upper limb, two in the lower limb, followed by wrist/ankle bones and then digits. - These structures are known as homologous structures. - Despite the similar underlying structure, the limbs are adapted for very different functions (e.g., flying in a bat, swimming in a whale, running in a horse, grasping in a human). - The similarity in structure is very unlikely to have arisen by chance in each species independently. - The best explanation is that these vertebrates have all evolved from a common ancestor that possessed this pentadactyl limb. - The limb structure has been inherited and then modified over millions of years through natural selection to suit the different environments and ways of life of the animals. - This is an example of divergent evolution / adaptive radiation.	
	Total: 6 marks

(Total for Question 8 is 6 marks)