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NATIONAL SENIOR CERTIFICATE EXAMINATION
MAY 2024

LIFE SCIENCES: PAPER II

SOURCE MATERIAL BOOKLET FOR QUESTIONS 1, 2 AND 3

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SECTION A

QUESTION 1

Read the information below. Refer to this information, as well as your own knowledge, to answer Question 1 in the question paper.

BIG BIRDS

1. Galápagos Islands

Located some 1 000 km off the Pacific Coast of Ecuador, the Galápagos consists of 59 individual islands. Discovered in 1535, these islands helped to inspire Charles Darwin to formulate his theory of evolution by natural selection. This is because the animals and plants that occur here are adapted to the geography of each island, and many occur nowhere else but are related to animals on the mainland.

These islands were formed by volcanic eruptions under the ocean. These volcanic eruptions eventually produced enough lava (molten rock) to form islands. The islands are characterised by steeply sloped hills and mountains, with heights ranging from a few metres above sea level to more than 1 500 metres above sea level. Geologically, the islands are quite young – probably no more than five million years old. Many volcanoes found here are still active.

Figure 1.1 – Map showing the position of the Galápagos Islands and a detailed map of the islands

[Source: <https://www.cdn.britannica.com>] ; [Adapted: <https://www./southamericatourism.com>]

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2. Darwin's finches

Darwin's Finches, named after Charles Darwin, are a group of 13 species of small birds, all endemic to the Galápagos Islands. It is thought that the ancestor of these birds arrived on one of the Galápagos Islands a few million years ago from South America. The closest relative to this ancestral species is a bird called the dull-coloured grassquit, found on mainland South America.

Figure 1.2 – Dull-coloured grassquit (*Asemospiza obscura*)
[Source: <https://www.i0.wp.com/birdscolombia.com>]

Once the original species of grassquits arrived on one of the Galápagos islands, certain populations underwent divergent evolution, eventually becoming different species. One of the characteristics that differs between the different species of finches today are their different types and sizes of beaks, which are suited to different food types such as large seeds and invertebrates, allowing them to occupy different niches.

Figure 1.3 – Three species of Darwin's finches showing differences in beak structure
[Source: <https://www.s2.thingpic.com>]

These birds are one of evolutionary biologists' most celebrated examples of natural selection in action. There is still a lot to learn about the process of evolution from these birds such as discovering different ways in which sympatric speciation can occur. The Galápagos Islands and their surrounding waters now belong to the South American country of Ecuador. The entire island chain is part of the Galápagos National Park and Marine Reserve. The islands have a population of just over 25 000 people.

Most of the finches are now critically endangered species. The finches are under threat from a range of issues including introduced predators and diseases, and habitat destruction.

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3. Rosemary and Peter Grant

Peter Raymond Grant and **Barbara Rosemary Grant** (both born in 1936) are a married British couple who are evolutionary biologists at Princeton University. Since 1973, the Grants have spent six months of every year on the very small Galápagos island of Daphne Major studying the evolution of different species of Darwin's finches and trying to determine what drives the formation of new species.

The Grants are both Fellows (members) of the Royal Society and have received numerous awards in their field of study. The Royal Society is the United Kingdom's national academy of sciences, which consists of a group of academics that promote science and its benefits and advise on science policy and education.

Figure 1.4 – Rosemary & Peter Grant

[Source: <https://www.utoronto.ca>]

4. Hybrid formation

Speciation typically takes place on timescales that are too long for direct human observation. Until recently, it was only in organisms with very fast generation times, such as viruses and bacteria, that scientists had directly observed speciation taking place. The Grants have shown that evolution can happen much quicker than previously thought.

The Cactus Finch (*Geospiza conirostris*) occurs on a few islands of the Galápagos. Two of these islands are Daphne Major (referred to as population GCD) and Española (referred to as population GCE).

In 1981, the Grants observed a male Cactus Finch arriving on the island of Daphne Major. Genetic tests showed that it had come from the island of Española, more than 100 km from Daphne Major (Figure 1.1). However, the two populations of Cactus Finch on Daphne Major and Española have been separated for a long period of time and have evolved some differences between them – one of the differences is that the males in the GCD have a different song to those of the GCE.

In Darwin's finches, song is learned from the father. As the initial immigrant finch was male, this meant that all of his offspring learned a song that was distinct from the song of other birds on the island.

The bird succeeded in finding a mate and this pair produced offspring. The offspring mated with one another and for more than 30 years, the hybrid line has bred only with one another, exclusively finding mates that are descended from the original pair. These birds are considered hybrids as they are descended from the male from the Española Island population and a female from the Daphne Major population.

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The hybrid birds have a larger body size than the birds in either of the other two populations and are therefore known as 'Big Birds'. Additionally, the immigrant father finch was 70% larger than the other Cactus Finches on Daphne Major. The beak size and shape are also different in these birds – this is significant, as beak size and shape are used by females to choose mates. The 'Big Birds' have extra-glossy feathers and a different diet due to their different beak size and shape – they can eat both large and small seeds. The GCD population tends to eat only small seeds, while the GCE population eats larger seeds.

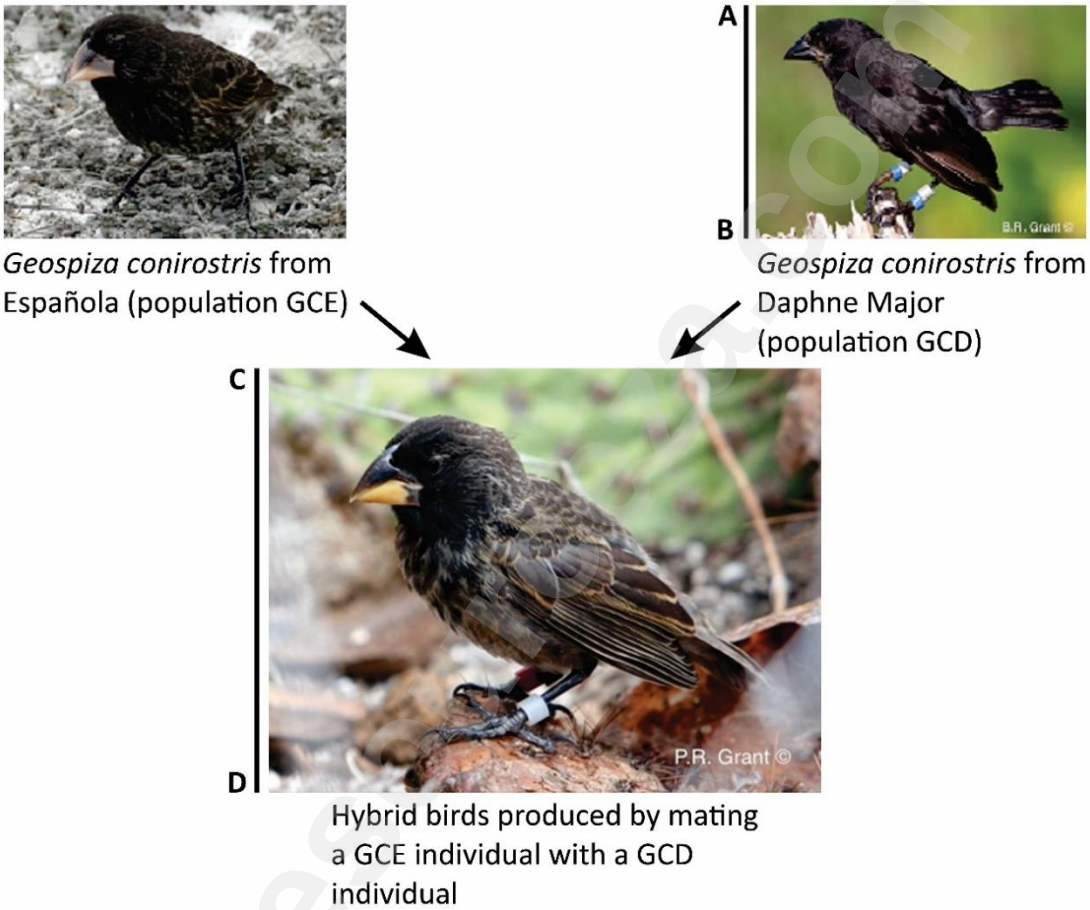

Figure 1.5 – Big Bird and its parents

[Source: <https://www.bbc.com>]

In 2010, 36 individuals, including eight breeding pairs, were present on the island. Despite close inbreeding, members of the hybrid line experienced high fitness, as judged by their reproductive success and the high survival rate of their offspring.

Even so, their survival seemed risky – during droughts on the island in 2002–2003, when the hybrid birds were in their fourth generation, all but two of the birds died – a brother and a sister. However, when the rains came again, the two birds mated with each other and, between 2003 and 2008, produced 26 offspring.

At the Grants' most recent visit to the island, they counted 23 individuals, including eight breeding pairs.

An unresolved question is how long we should wait to see if the 'Big Birds' will stay distinct or become extinct through fitness problems with inbreeding. The Grants have stated that they do not yet want to propose a new name for the species. It is still too soon as they may become extinct as a result of a low degree of genetic fitness – this will be an interesting test to see the effects of low genetic diversity on the survival of organisms.

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QUESTION 2

Read the information below. Refer to this information, as well as your own knowledge, to answer Question 2 in the question paper.

HAWAIIAN FRUIT FLIES

1. Hawaiian Islands

The Hawaiian Islands are a group of eight islands situated about 3 200 km west of California.

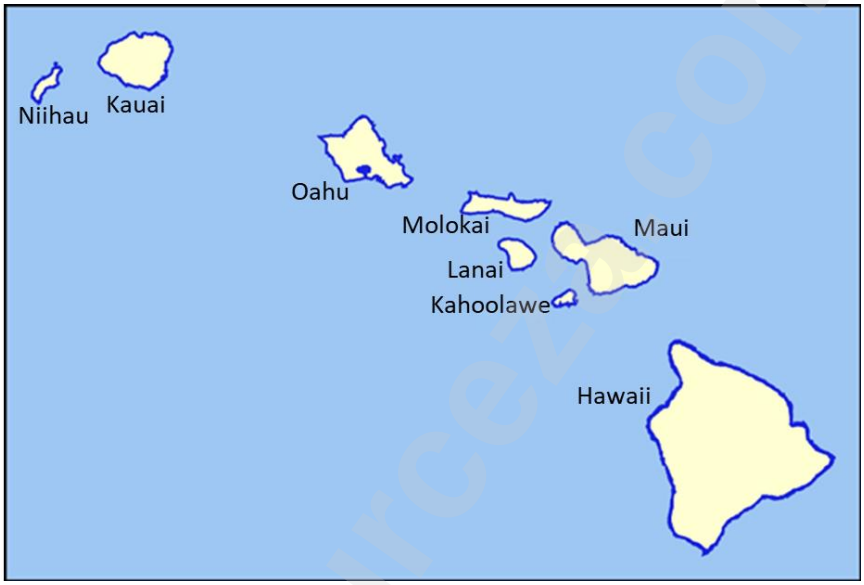

Figure 2.1 – Map of Hawaiian Islands
[Source: <http://www.2.bp.blogspot.com>]

They are all volcanic islands, formed by the buildup of magma (molten rock) under the sea. When the magma breaks through to the surface of the ocean, it cools and forms new land, creating an island.

The Hawaiian Islands consist of the eight major islands and 124 smaller islands, stretching over 2 400 km. The eight major islands are, from west to east, Niihau, Kauai, Oahu, Molokai, Lanai, Kahoolawe, Maui and Hawaii Big Island. The Hawaiian Islands contain a variety of different environments, from tropical forests, semi deserts, grasslands and high-altitude mountain vegetation.

The islands also contain a very high number of endemic and endangered species of plants and animals.

2. Fruit flies

One of the groups of endemic species on the Hawaiian Islands are members of the genus *Drosophila*. This is one of approximately 10 000 genera in the fly order Diptera, which includes flies, gnats, and mosquitoes. It is a tremendously diverse and successful group of organisms: the fly species on earth far outnumber all the vertebrate species combined.

Drosophila flies are small, typically pale yellow to reddish brown and black, with red eyes. They are commonly known as fruit flies, as they tend to breed in overripe and rotting fruit. There are over 1 500 species of *Drosophila* around the world. Different species occur on all continents except Antarctica and in almost any habitat from deserts to tropical forests. They are poor fliers, and live between 60 and 90 days.

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Figure 2.2 – *Drosophila cilifera*

[Source: <https://www.ncbi.nlm.nih.gov>]

The Hawaiian *Drosophila* is one of the most diverse endemic groups of flies in Hawaii with up to 1 000 different species. The different species of fruit fly range in body length from less than 1,5 millimetres to more than 20 millimetres. Their heads, forelegs, wings, and mouthparts have very different appearances. Hawaiian fruit flies live everywhere, from sea-level rainforests to mountain grassland.

Studies of the physical and genetic differences among the hundreds of species of native drosophilids in Hawaii have led scientists to conclude that all of the native *Drosophila* species in Hawaii appear to be descended from a single ancestral species that colonised one of the islands millions of years ago —perhaps blown there by a storm or carried to the islands in a scrap of fruit stuck to the feathers of a bird.

Since that time, the descendants of the original colonists have diverged to produce various species. New species have evolved and have occupied a wide range of ecological niches on different islands. While the larval stages of most species are saprophytic (feeding on decaying vegetation, such as rotting leaves, bark, flowers, and fruits), some have become highly specialised in their diets, such as being carnivorous on spider eggs, or feeding on green algae growing underwater on stones in streams.

Many small new populations of fruit flies have become established in the different islands. Further speciation would occur on these islands, resulting in many new species.

3. Kīpukas

The Hawaiian Islands contain many active volcanoes, and many of these erupt continuously. These eruptions produce flowing lava 'rivers' called 'lava flows'. Past lava flows that ran through tropical forests have sometimes resulted in sections of the tropical forest becoming isolated and forming 'small islands of vegetation'. The Hawaiian name for these 'small islands of vegetation' are 'kīpukas'.

Once a kīpuka forms, plants and animals that cannot travel long distances on their own, become trapped. Organisms within the isolated kīpuka then have a limited gene pool.

Kīpukas have been described as 'natural laboratories for evolution'. If the environments in the respective kīpukas differed, natural selection could have selected for different characteristics in each kīpuka, resulting in differences between the fly populations in the kīpukas and possible speciation. Kīpukas help explain the Hawaiian Islands' extraordinary rate of speciation.

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As the age of the lava flows can easily be measured, scientists can determine the age of the species in the kīpukas.

Figure 2.3 – View of a forested kīpuka surrounded by lava flows

[Source: <https://www.planeta.com>]

4. Speciation

Drosophila silvestris and *Drosophila heteroneura* are both large species of fruit fly endemic to Hawaii Big Island. They occur in two separate kīpukas as shown in Figure 2.6. The kīpuka inhabited by *D. silvestris* consists of a much cooler rainforest vegetation than the kīpuka inhabited by *D. heteroneura.*

They have many unique mutations in their DNA in common that are not shared with other species of *Drosophila* on the Hawaiian Islands.

Another species of fruit fly called *Drosophila planitibia* is found on the neighbouring island of Maui. Even though it is genetically similar to both *D. silvestris* and *D. heteroneura*, it has fewer unique mutations in common with these two species.

Drosophila heteroneura

Drosophila silvestris

Drosophila planitibia

Figure 2.4 – *Drosophila heteroneura, D. silvestris* and *D. planitibia*

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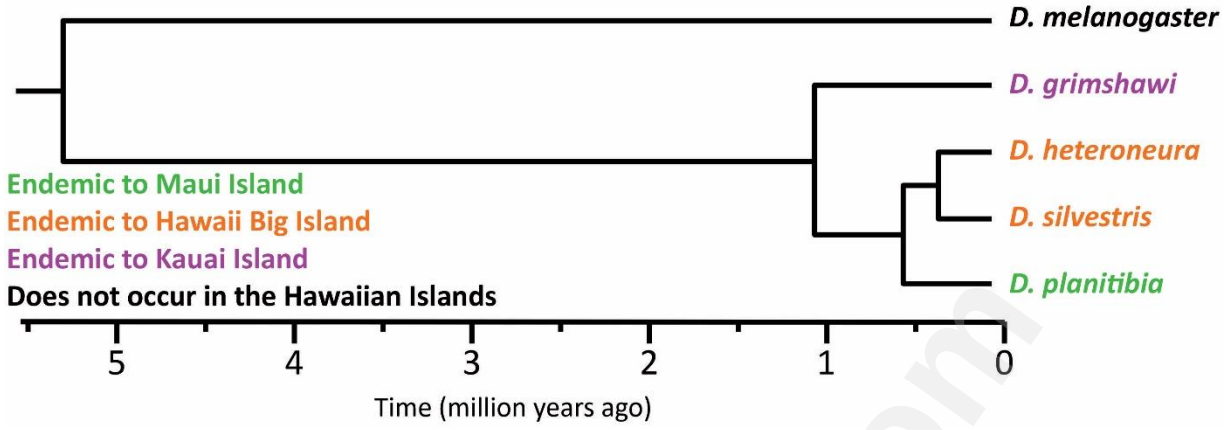

Figure 2.5 – Cladogram showing evolutionary relationships between certain species of *Drosophila*

Figure 2.6 – Two kīpukas

[Adapted: <https://www.ncbi.nlm.nih.gov>]

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Sources for Question 1

[Adapted: Browne J. 2013. Wallace and Darwin. *Current Biology* 23(24): 1071–1072]
[Adapted: Cressey, D. 2009. Darwin's finches tracked to reveal evolution in action. *Nature* 540: 507–515].
[Adapted: Grant, P. R. & Grant, B. R. 2009. The secondary contact phase of allopatric speciation in Darwin's finches. *Proceedings of the National Academy of Sciences USA* 106(48): 141–148]
[Adapted: Lamichhaney, S., Han, F, Webster, M.T., Andersson, L., Grant, B. R.& Grant, P. R. 2017. Rapid hybrid speciation in Darwin's finches. *Science* 359(6372): 224–228]
[Adapted: The four awards bestowed by the Academy of Natural Sciences and their recipients. *Proceedings of the Academy of Natural Sciences of Philadelphia* 156(1): 403-404]
[Adapted: <https://www.bbc.com>]
[Adapted: <https://www.southamericantourism.com>]
[Adapted: <https://www.galapagosconservation.org.uk>]
[Adapted: <https://www.africangamesafari.com>]
[Adapted: <https://www.paw.princeton.edu>]

Sources for Question 2

[Carson, H. L. & Bryant, P. J. 1979. Change in a secondary sexual character as evidence of incipient speciation in *Drosophila silvestris. Proc. Natl. Acad. Sci. USA.* 76(4): 1929–1932]
[Adapted: Kang, L., Settlage, R., McMahon, W., Michalak, K., Tae, H., Garner, H, R., Stacy, E. A., Price, D. K. & Michalak, P. 2016. Genomic signatures of speciation in sympatric and allopatric Hawaiian picture-winged *Drosophila*. *Genome Biol. Evol.* 8(5): 1482–1488]
Adapted: Olson, S. 2004. *Evolution in Hawaii: A supplement to teaching about evolution and the nature of science*. Washington (DC): National Academies Press (US)]
[Roach, M. 2017. Hawaii's must-see lava flows are home to new, startling ecosystems. *Smithsonian Institution*]
[Adapted: Linnean Society of London <https://www.linnean.org>]
[Adapted: An adaptive radiation has led to a dramatic diversification of the Drosophilids in Hawaii
[Endangered and Threatened Wildlife and Plants; Determination of Status for 12 Species of Picture-Wing Flies from the Hawaiian Islands. *Federal Register the Journal of the United States Government*]
[Adapted: <https://www.britannica.com>]
[Adapted: <https://www.nps.gov>]
[Adapted: <https://kids.nationalgeographic.com>]

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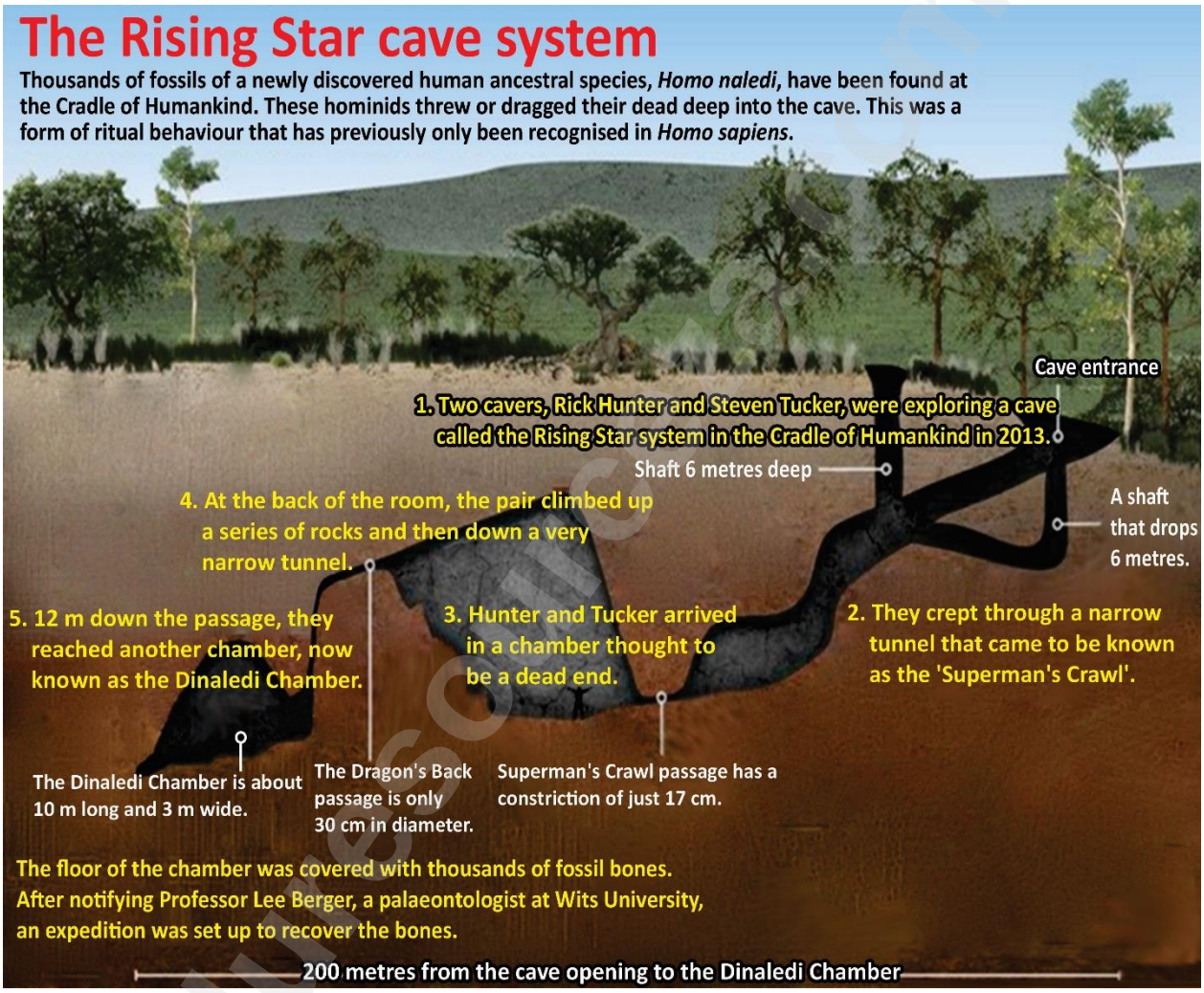
SECTION B

QUESTION 3

Read the information below. Use this information, as well as your own knowledge, to answer Question 3 in the question paper.

SOURCE A Discovery of *Homo naledi*



The team found 1 550 bones, belonging to 24 individuals of all age groups. The bones were scattered throughout the floor of the cave in no particular pattern. In 2015, these were declared to belong to a new species. The species is named *Homo naledi,* after the cave ('naledi' means 'star' in Sesotho).

Since then, further specimens have been found in chambers even deeper into the cave system, including that of a skull of a *Homo naledi* child, called 'Leti', found in a passageway barely 15 cm wide and the remains of another individual, named 'Neo'.

[Source: <https://www.alchetron.com>]

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From left to right: Research team members exploring the cave had to squeeze through spaces barely 15 cm wide; Artist's image of *Homo naledi* skull; The entrance to the Rising Star cave system; Artist's impression of *Homo naledi.*

[Wits University] [<https://www.mpg.de>]

Skeleton of Neo

Artist's impression of Neo

A reconstruction of Leti's skull

H. naledi walked upright, stood about 1,44 m tall and weighed between 40 and 56 kilograms. It had a strange mix of primitive and modern features, with ape-like shoulders and a tiny brain. The remains were dated to between 335 000 and 240 000 years old.

Lee Berger stated that the presence of *H. naledi* in these caves could only be explained as deliberate burial of their dead. However, these caves are dangerous, dark, and the tunnels are very long and narrow!

[Adapted: Berger, L. R. 2013. *Homo naledi*, a new species of the genus *Homo* from the Dinaledi Chamber, South Africa. *eLife* 4]
(*eLife* is a not-for-profit, peer-reviewed, open access, scientific journal for the biomedical and life sciences)
[Adapted: Brahic, C. 2014. Bone bonanza: Chamber of secrets yields human remains. *New Scientist*]
(*New Scientist* is a magazine covering all aspects of science and technology)

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SOURCE B What is meant by *burying* the dead?

Human burial practices are mainly conducted to demonstrate 'respect for the dead'. This respect comes in various forms:

- If left lying on top of the ground, scavengers may eat the corpse, considered disrespectful to the deceased.
- Burial can be seen as an attempt to bring closure to the deceased's family and friends. By interring (burying) a body out of plain view, the pain of losing a loved one can be lessened.
- Many cultures believe in an afterlife. Burial is sometimes believed to be a necessary step for an individual to reach the afterlife.

For most animals, a dead body is simply an object, however …

[<https://www.npr.org>]

Elephants dispose of dead bodies and spend time with them; the reason is unknown.

[<https://welovedolphins.club/>]

Dolphins spend long periods of time with their dead, no actual disposal of bodies though.

Animals that 'bury'

[<https://earthtouchnews.com>]

Mole rats dispose of dead bodies underground to avoid attracting predators.

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Humans bury their dead in specifically arranged sites. Various symbols are associated with human burials – such as language, art and the other aspects that make modern humans unique. The parts of the brain that control this activity were all thought to have emerged around 40 000 years ago, but recent discoveries have pushed this back to 100 000 years or more. Symbolic thought allows humans to remember the past and visualise the future. Mourning the dead involves remembering the past and imagining a future in which we too will die.

[<https://chroniclelive.co.uk>]
Decorated graves

[<https://www.upload.wikimedia.org>]
Ancient Egyptian funeral

[<https://reddit.com>]
Gravestones

[<https://www.upload.wikimedia.org>]
Pots on grave of an Iron Age person

[<https://www.icheg.bbci.co.uk>]
Grave goods from Pharaoh Tutankhamun's grave

[<https://britishmuseum.org>]
Body buried with various items to use in afterlife

A collection of symbolic items used by different human cultures in burials

Until the 1960s, toolmaking was widely considered something that only humans did. Then Jane Goodall (a chimpanzee expert) witnessed chimpanzees modifying materials to make tools of their own. In response to the news, her mentor Louis Leakey (a famous anthropologist) stated: 'Now we must redefine what a tool is and redefine what it means to be humans.' In the same manner, could we also disprove the statement that burying their dead is something that is unique to humans?

[Madison, P. 2018. Who first buried the dead? <https://www.sapiens.org>]
(*Sapiens* is a popular digital anthropology magazine with articles written by journalists)
[<https://www.nationalgeographic.com>]
(*National Geographic* was founded as a scholarly journal, but is now a popular magazine)
[Egeland, C. P., Domínguez-Rodrigo, M. Pickering, T. R., Menter, C. G. & Heatone, J. L. 2018. Hominin skeletal part abundances and claims of deliberate disposal of corpses in the Middle Pleistocene. *Proc. Natl. Acad. Sci. USA.* 115(18): 4601–4606]
(*Proceedings of the National Academy of Sciences of the United States of America* is a peer-reviewed multidisciplinary scientific journal. It is the official journal of the National Academy of Sciences and publishes original research, scientific reviews, commentaries, and letters)

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SOURCE C Oldest known symbolic burials

The earliest evidence of burials is from two caves in Israel – Skhul and Qafzeh – where the skeletons of 120 000-year-old *Homo sapiens* were found in what are clearly human-made hollows.

Burial from Skhul Cave

The corpses were placed into a prepared pit, grave gifts were inserted, and the pit was filled. The gifts offered to the dead might be referring to some kind of religious belief in rebirth and afterlife.

Another example is at Raqefet Cave in Israel, which revealed 11 700–13 700-year-old remains from individuals who were placed in a flower-lined grave.

Burial at Raqefet Cave, Israel (Actual bones; Artist's impression of bodies)

None of these burials are as old as the remains of *Homo naledi*. In addition, the *H. naledi* 'burials' lack any evidence of the symbolism that is present in the human burials mentioned above.

[Lawton, G. 2012. Death: The evolution of funerals. *New Scientist*]
[Adapted: Reynolds, S. C. & Gallagher, A. 2012. *African Genesis*: *Perspectives on Hominin Evolution.* 554–570. Publisher: Cambridge University Press]
(Sally C. Reynolds is an honorary research staff member of the Institute for Human Evolution, University of the Witwatersrand, South Africa and Liverpool John Moores University, UK. Andrew Gallagher is a Postdoctoral Fellow in the Department of Anthropology and Development Studies, University of Johannesburg)

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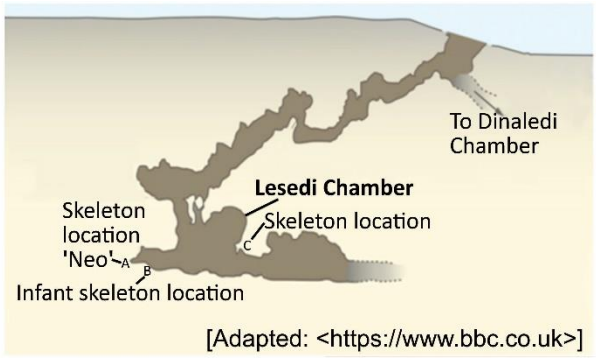
SOURCE D If *Homo naledi* were not buried in the Lesedi and Dinaledi chambers, how did they get there?

Other entrances to the caves?



[Adapted: <https://www.bbc.co.uk>]

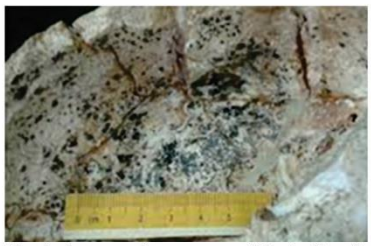
No other entrances have been found into either the Lesedi or the Dinaledi chambers, suggesting that individuals could not have fallen into the chambers from outside.

Complete lack of scavenger markings on the bones also suggests that no other entrance was present.

If there was an easier cave entrance, then there should also be outside debris – rocks from outside the caves, twigs, and leaves of local plants.

No other animal remains have been found in the chambers, indicating no other entrance was present.

[Adapted: <https://www.media.cheqqcdn.com>]


Black dots on bone, possibly indicating lichen growth

Mysterious black spots found on *Homo naledi* bones from the Dinaledi Chamber could be due to the presence of lichen growing on the bones (lichen is a combination of a fungus and photosynthetic partner alga). Lichen needs light to grow – so there must have been some light penetrating into the Dinaledi Chamber, indicating an old opening into the chamber, which was closed by rockfalls, however, geologists still say there is ABSOLUTELY no evidence of a previous entrance.

[Adapted: Thackeray, J. F. 2016. The possibility of lichen growth on bones of *Homo naledi*: Were they exposed to light? *S. Afr. J. Sci.* 112: 7–8]
(*The South African Journal of Science* is a multidisciplinary journal published by the Academy of Science of South Africa)

[Adapted: Val, A. 2019. Deliberate body disposal by hominins in the Dinaledi Chamber, Cradle of Humankind, South Africa? *Journal of Human Evolution* 96:145–148]
(*The Journal of Human Evolution* is a peer-reviewed scientific journal that concentrates on publishing papers covering all aspects of human evolution)

[Adapted: <https://www.nhm.ac.uk>]
(Natural History Museum website)

Perhaps individuals hid deep in the cave to escape from predators.

Without light and climbing equipment, once deep in the cave, there may have been no way back.

Over hundreds or thousands of years, this behaviour could have led to an accumulation of bodies deep in the cave.

[Adapted: Dirks, P. H. G. M. 2015. Geological and taphonomic context for the new hominin species *Homo naledi* from the Dinaledi Chamber, South Africa. *eLife* 2015: 4]

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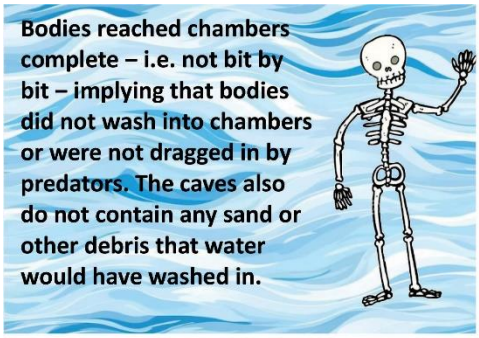
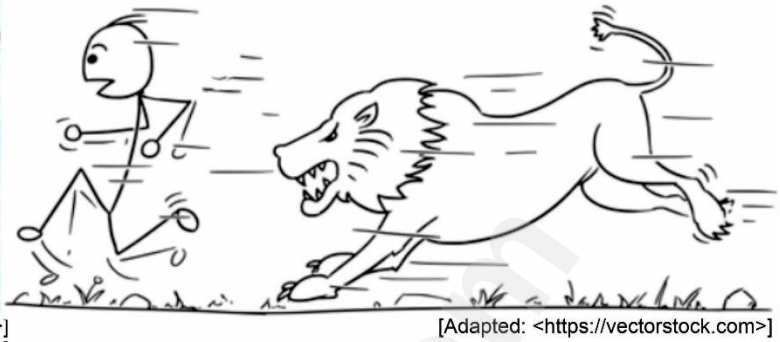
SOURCE E Other possible explanations?

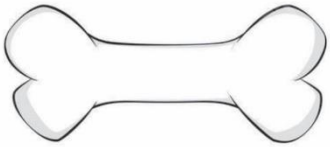


[Adapted: <https://freepik.com>]
[Adapted: <https://alamy.com>]

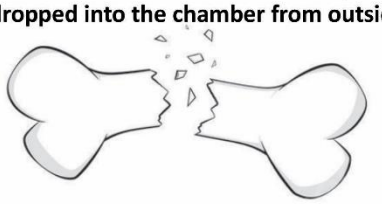


[Adapted: <https://vectorstock.com>]

The bones do not contain any evidence of gnaw marks that would have been made by predators. There are also no remains of any carnivores in the caves. Even if predators were responsible for the presence of *H. naledi* in the caves, surely there should be another prey present as well – no predator eats only hominids!



The bones show no evidence of trauma, which would have occurred if they were dropped into the chamber from outside



[Adapted: <https://pngtree.com>]

[Adapted: <https://journals.plos.com>]

[Adapted: <https://cavepeopleandstuff.wordpress.com>]

Possibly *H. naledi* were buried by other close *Homo* relatives who were alive at the time, such as the ancestors of modern humans, to remove decaying bodies from a settlement to prevent scavengers.

[Adapted: Berger, L. R. 2013. *Homo naledi*, a new species of the genus *Homo* from the Dinaledi Chamber, South Africa. *eLife* 4]

[Adapted: Dirks, P. H. G. M. et al. 2015. Geological and taphonomic context for the new hominin species *Homo naledi* from the Dinaledi Chamber, South Africa. *eLife* 2015: 4]

[Pappas. S. 2021. 240 000-year-old 'Child of Darkness' human ancestor discovered in narrow cave passageway. *Live Science*]

(*Live Science* is a science news website. It publishes stories in a wide variety of topics)

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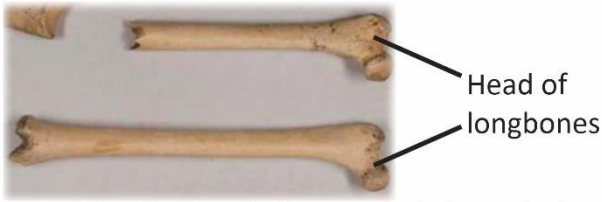
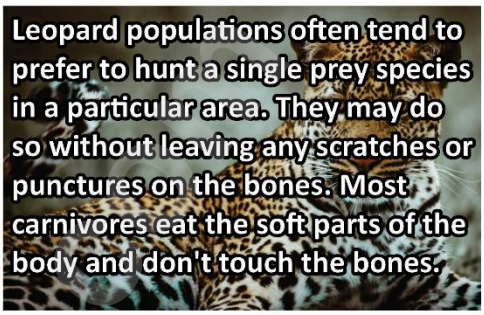
The absence of heads on many long bones is a typical sign of predation in other animals.



[https://www.collections.peabody.harvard.edu>]

The distribution of *H. naledi* fossils is similar to the accumulation of baboon carcasses that accumulate in caves (either by natural death or by a leopard dragging in carcasses).

There is evidence of damage done by beetles, beetle larvae, and snails (which help decompose bodies); but, there is no evidence of the bodies of these organisms. This indicates decomposition of bones in the chamber – evidence that they didn't die in the chamber.



[https://www.krugerpark.co.za>]

[Adapted: https://www.nhm.ac.uk>]

A site in Spain called Sima de los Huesos – (the pit of bones) contains the remains of at least 28 *Homo heidelbergensis*, a probable ancestor of both *Homo sapiens* and Neanderthals dating to 200 000 years ago. Most of the skeletons are adolescent males or young men, and many show signs of bone disease or deformity. The best explanation is that this was a disposal site for outcasts.

[Adapted: Dirks, P. H. G. M. et al. 2015. Geological and taphonomic context for the new hominin species *Homo naledi* from the Dinaledi Chamber, South Africa. *eLife* 2015: 4]

SOURCE F Fire use allows navigation through the dark caves

Archaeological evidence suggests that *Homo naledi* used fires to cook food and navigate in the darkness of underground caves. Two tiny fireplaces with burnt antelope bones were found in the Lesedi Chamber. This meant that they were able to make their way through the dark tunnels.

Many researchers thought it was impossible for such a small-brained hominid to make and use fire. The first recorded **use** of fire is by *Homo erectus* in Kenya as far back as 1,5 million years ago. The strongest evidence for early **control and actual making** of fires comes from an archaeological site in Israel called Gesher Benot Ya'aqov, where experts say early human relatives used fire to cook fish about 780 000 years ago. In addition, Berger claims to have discovered an actual grave in the chamber.

Burnt bone, charcoal and ash found in the Rising Star cave system in South Africa.
[Lee R. Berger/National Geographic]

[Adapted: Barras, C. 2019. Our ancestors may have begun barbecuing 1.5 million years ago. *Journal of Archaeological Science*]
(*The Journal of Archaeological Science* is a peer-reviewed journal that covers archaeology)
[Adapted: George, A. 2022. *Homo naledi* may have used fire to cook and navigate 230 000 years ago. *New Scientist*]

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Archaeologists would expect to find thousands of stone tools in a place where human relatives were using fire for light and cooking. However, at this stage no stone tools have been found in the caves. Stone tools *have* been found in the general landscape outside the caves.

Many researchers do not agree with the evidence for the use of fire to light their way through the caves. How did they put up with the smoke?

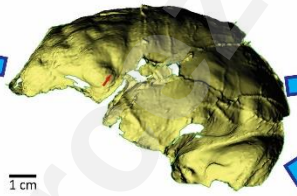
[<Adapted: <https://www.washingtonpost.com>]
(newspaper)

The decision to announce the fire discovery to the media, prior to the publication of the formal scientific analysis, has proved controversial. Chris Stringer at the Natural History Museum in London said, 'With all due respect to Lee and his teams for a series of great finds, this is not the way to conduct science or progress scientific debate about very important discoveries.'

[Adapted: Callaway, E. 2023. Sharp criticism of controversial ancient-human claims tests *eLife's* revamped peer-review model. *Nature* 1476: 1–10]
(*Nature* is a high-impact peer-reviewed journal publishing information from all fields of science]

SOURCE G Brain size

Brain is of the same volume as that of *Australopithecus* (one third human brain volume).



Inner mould of *Homo naledi's* skull showing brain's shape
[Adapted: <https://www.nhm.ac.uk>]

Despite the size, *Homo naledi's* brain looked quite different from *Australopithecus's* brain and much more like *Homo sapiens's*.

Structure of *Homo naledi's* frontal lobe was similar to that of *Homo sapiens's*. The frontal lobe contains several structures with roles in language, social behaviour, and the kinds of motor planning needed in order to make stone tools.

Based on frontal-lobe development from other *Homo* species, there is evidence that the capacity for at least simple language may stretch back around 1,8 million years.

Adapted: Holloway, R., Hurst, S. D., Garvin, H. M. & Hawks, J. 2018. Endocast morphology of *Homo naledi* from the Dinaledi Chamber, South Africa *Proc. Natl. Acad. Sci. U S A.* 115(22): 5738-5743]

SOURCE H No other explanation?

Many possible explanations have been considered to explain how *Homo naledi* appeared in the Rising Star cave system. Researchers like Lee Berger have considered these and have stated that not one of them is possible. This led Lee Berger to state that the only remaining possibility is that they buried their dead in the caves.
However, to make a conclusion like this based on elimination of explanations rather than direct proof is not scientifically correct:

1. It is not possible to find *every* possible explanation for a phenomenon.
2. It is not possible to *correctly* disprove *every* possible explanation, except the true one.

Just because all *proposed* explanations for *Homo naledi* being in the caves have supposedly been shown to be false does not mean that there is only *one* other explanation (that they buried their dead).

[Egeland, C. P., Domínguez-Rodrigo, M., Pickering, T. R., Menter, C. G. & Heatone, J. L. 2018. *Proc. Nat. Acad. Sci USA.* 115(18): 4601–4606]

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