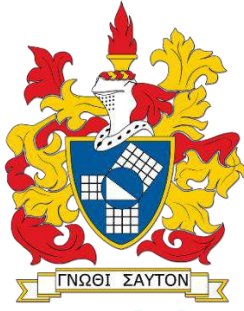




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SAHETI SCHOOL

LIFE SCIENCES PRELIM PAPER 2

JULY 2023

GRADE 12

SOURCE MATERIAL BOOKLET FOR QUESTIONS 1, 2 AND 3

STUDENT NAME:

SECTION A**QUESTION 1**

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

SPECIATION IN THE CAPUCHINO SEEDEATERS**1. Speciation due to tiny differences in plumage and song**

In the Iberá Wetlands in Argentina, two nearly identical species of bird live side by side, spending their days foraging for the same kinds of seeds and nesting in the same kinds of places. These species don't breed with each other. The birds are members of the southern capuchino seedeaters (*Sporophila*). Much like Darwin's finches, which diverged into numerous species that differ in bill shape and size, capuchinos have diversified within the last million years to form ten species that vary in male plumage (feather) colouration and song. This is an example of one of the most recent and fastest radiations on the planet.

Figure 1.1: Map of Iberá Wetlands in Argentina



Figure 1.2: Southern capuchino seed eaters in Iberá Wetlands



Sporophila iberaensis

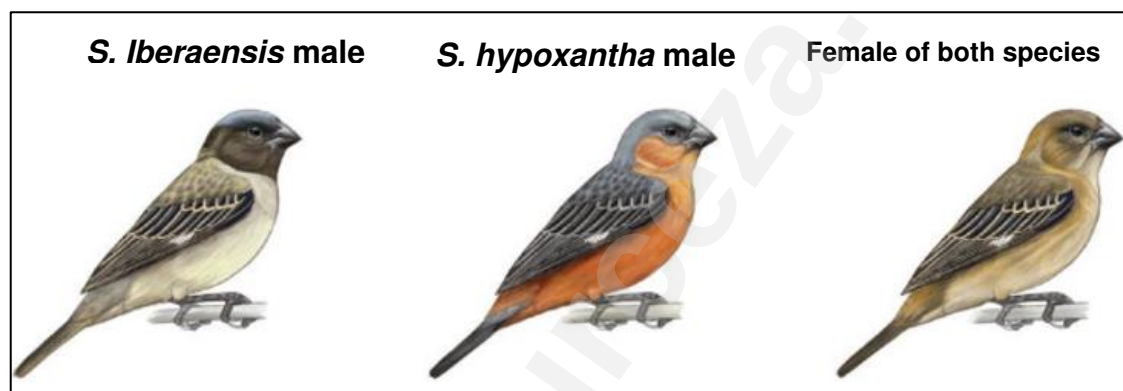
Sporophila hypoxantha

[Image: <https://ripioturismo.com/travel-guide/argentina/ibera-wetlands/>
<https://www.forbes.com/sites/grrlscientist/2021/03/31/>]

Cornell University evolutionary biologist Leonardo Campagna started studying southern capuchino seedeaters about 20 years ago.

Campagna focused his study on two capuchino seedeaters: *Sporophila iberaensis* and *S. hypoxantha*. Females of each species look identical. Both live, breed, and forage in the same part of the Iberá wetlands, so the two species have plenty of time to interact and perhaps mate. The big differences exist between the males: *S. iberaensis* has a sandy-coloured belly and black throat, whereas *S. hypoxantha* has a reddish belly and throat. The whistles of their songs are also put together in different ways.

Figure 1.3: Two different species of southern capuchino seedeaters



[Image: <https://www.forbes.com/sites/grrlscientist/2021/03/31/how-one-becomes-two-genetic-shuffling-gives-rise-to-a-new-bird-species/?sh=4ba6fe022b24>]

Usually, new species form because some members of a population become isolated, by a river or a mountain range. But sometimes—as may be the case with these two southern capuchino seedeaters—no such physical barrier seems to have separated the two species, suggesting that side-by-side speciation has occurred instead. Biologists are intensely curious about how this happens. Speciation is very difficult to observe in action. This study is one of the few that captures two populations of capuchino seedeaters in the act of forming two different species.

2. Testing to see if speciation has occurred

To see whether the two species really didn't mate with each other in the wild, Campagna banded 126 birds of both species, tracked the activities of the adults and 80 of the young produced, and sampled the DNA from each. Genetic analysis confirmed the two species do not interbreed. Females appear to prefer mates of one plumage and song or another.

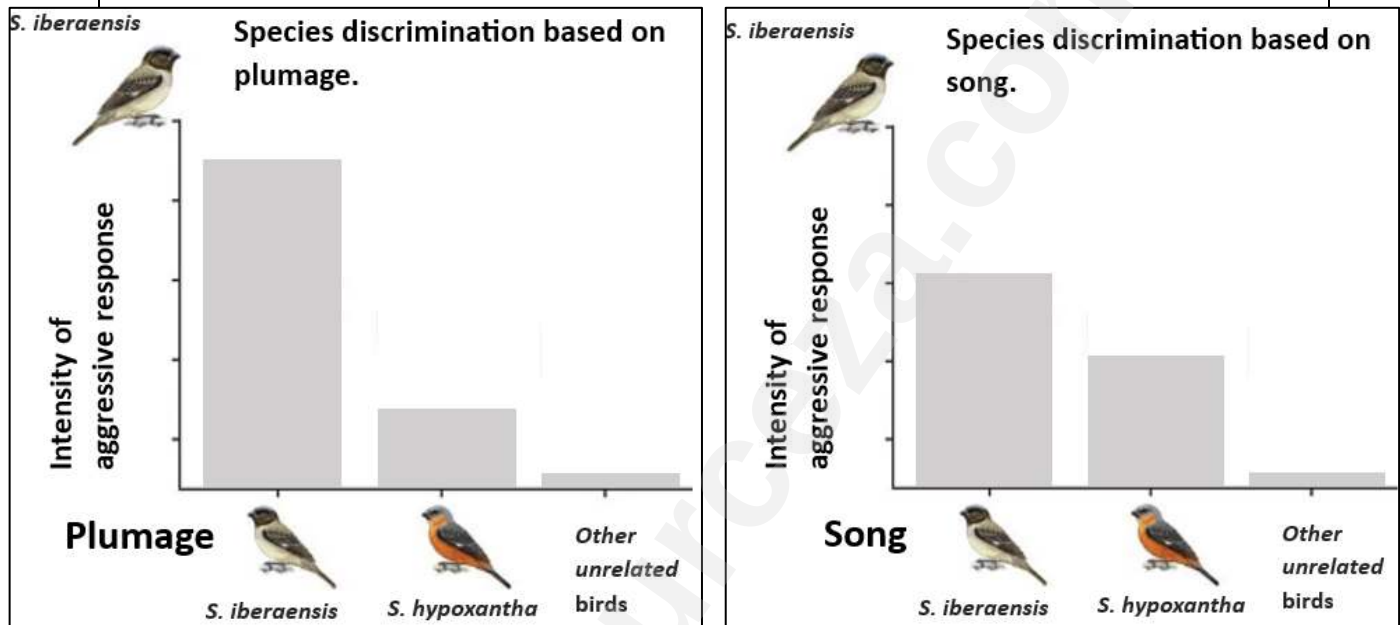
Males establish and protect mating territories. Females only mate with the males who have established and defended certain territories. If a potential rival male enters another's territory, fights often occur. Fights or aggressive behaviour towards another male is an indication of species discrimination. If the sandy-coloured males react less aggressively to the reddish-coloured males that is an indication that the two don't recognise each other as reproductive rivals. If they don't see each other as rivals, then one can assume that mating between members of the two populations is rare.

The bird model experiment

To test this theory, Campagna and his team painted appropriately coloured models of males of both species and then evaluated the responses of actual males to the model. They sometimes played recordings of the song of either species while displaying the models.

The graphs below show the intensity of the aggressive response that sandy-coloured males show towards males of the **same** plumage and song (*S. iberaensis*), males that are reddish-coloured (*S. hypoxantha*) and totally unrelated birds.

Figure 1.4: Graph showing species discrimination based on plumage and song of cappuccino seed eaters.



[Adapted: <https://www.forbes.com/sites/grrlscientist/2021/03/31/how-one-becomes-two-genetic-shuffling-gives-rise-to-a-new-bird-species/?sh=375c5e962b24>]

The researchers then went a step further. They investigated the birds' genomes to see what genes may have played a role in the different plumage pattern. They found that 99% of the genome differences between species occur in the part of the genome known to be involved in creating melanin – the pigments that produce different plumage colours. Females choose mates with desirable plumage colours. This forms a selection pressure for the males, causing them to adapt quickly, driving faster-than-normal speciation in the birds, creating a wide variety of plumage and song types.

3. Sexual selection in peacocks

Darwin noticed a similar phenomenon in peacocks. When he studied the peacock and his elaborate feathers, he was puzzled and dismayed. The peacock did not fit into his theory of natural selection. Creationists believe that one of the reasons God created beautiful animals was to make the world more beautiful. Darwin did not agree with this idea, but the peacock seemed to disprove his theory of natural selection. The fancy feathers don't help the peacock survive; the feathers attract predators, slow the bird down, and require energy to maintain. The only benefit is that the feathers help the peacock attract a mate. Darwin called this mechanism of evolution sexual selection, which explains what natural selection cannot.

Figure 1.5: Male peacock engaged in a courtship dance.



[Image: <https://www.joyofanimals.com/how-do-peacocks-mate-reproduce/>]

[Adapted: <https://www.science.org/content/article/tiny-differences-plumage-and-song-have-split-two-nearly-identical-birds-different>

<https://phys.org/news/2017-05-capuchino-seedeaters-big-differences-plumage.html>

<https://www.science.org/doi/10.1126/science.abc0256>

<https://www.frontiersin.org/articles/10.3389/fevo.2021.786868/full>]

QUESTION 2

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

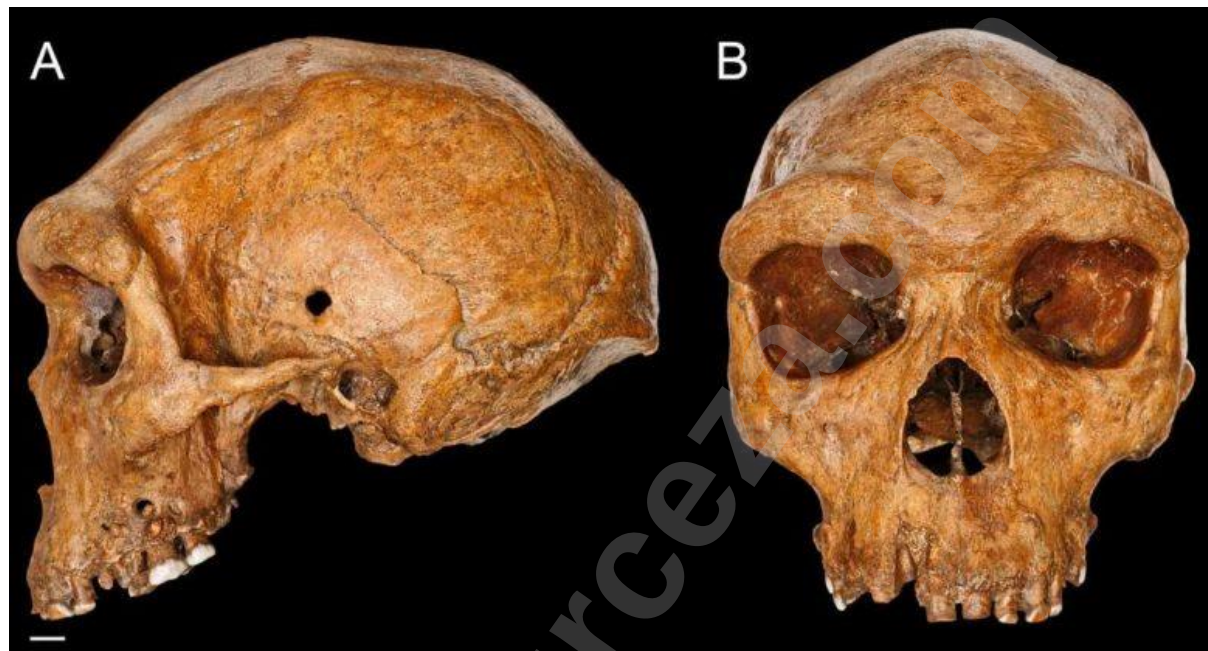
1. Modern Human Ancestry Cast in Doubt After Fossil Skull Discovery

Figure 2.1: The Broken Hill (Kabwe 1) skull is one of the best-preserved fossils of *Homo heidelbergensis*.
[Credit: Natural History Museum London]

Griffith University scientists have led an international team to date the skull of an early human found in Africa, potentially upending human evolution knowledge with their discovery. The Broken Hill (also known as the Kabwe 1) skull is one of the best-preserved fossils of the early human species *Homo heidelbergensis* and was initially estimated to be about 500 000 years old.

Professor Rainer Grün from the Environmental Futures Research Institute led the team which analyzed the skull and other fossil remains found in the vicinity including a tibia and femur midshaft fragment. The femur was orientated to place the knee and centre of gravity below the body; the position of the knee would have also been lower than that of a chimpanzee. Both the femur and tibia would have run in a straight line, the length of both also indicating that the lower limbs were longer than the arms.

Discovered in 1921 by miners in Zambia, the Broken Hill remains have been difficult to date due to their haphazard recovery and the site being completely destroyed by quarrying (extracting materials directly from the earth's surface).

Using radiometric dating methods, Professor Grün's analyses now puts the skull at a relatively young date, estimating it is between 274 000 and 324 000 years old.

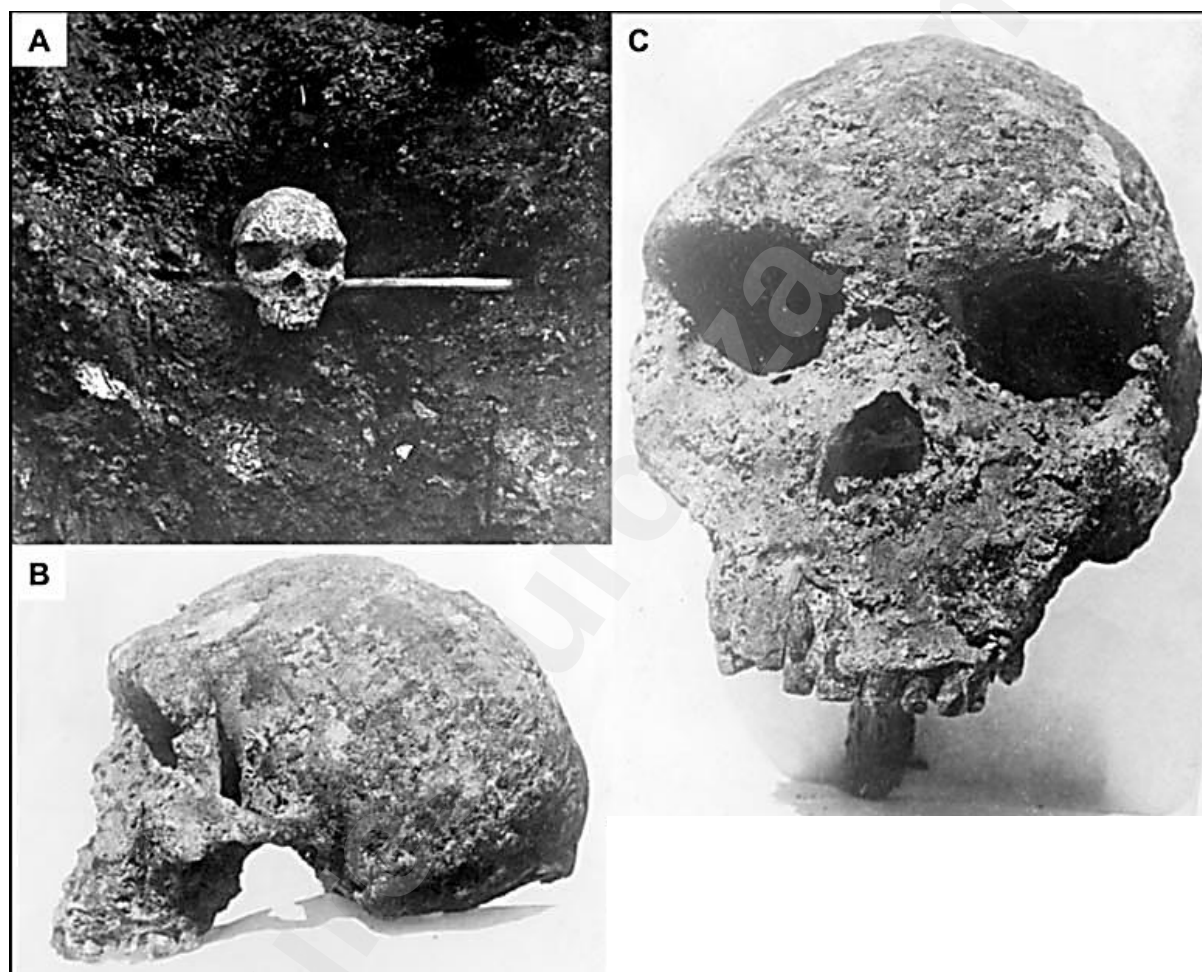


Figure 2.2: Photos of the skull shortly after its discovery.

The cranium at the location in which it was found (A). Frontal view (B) and lateral view (C)

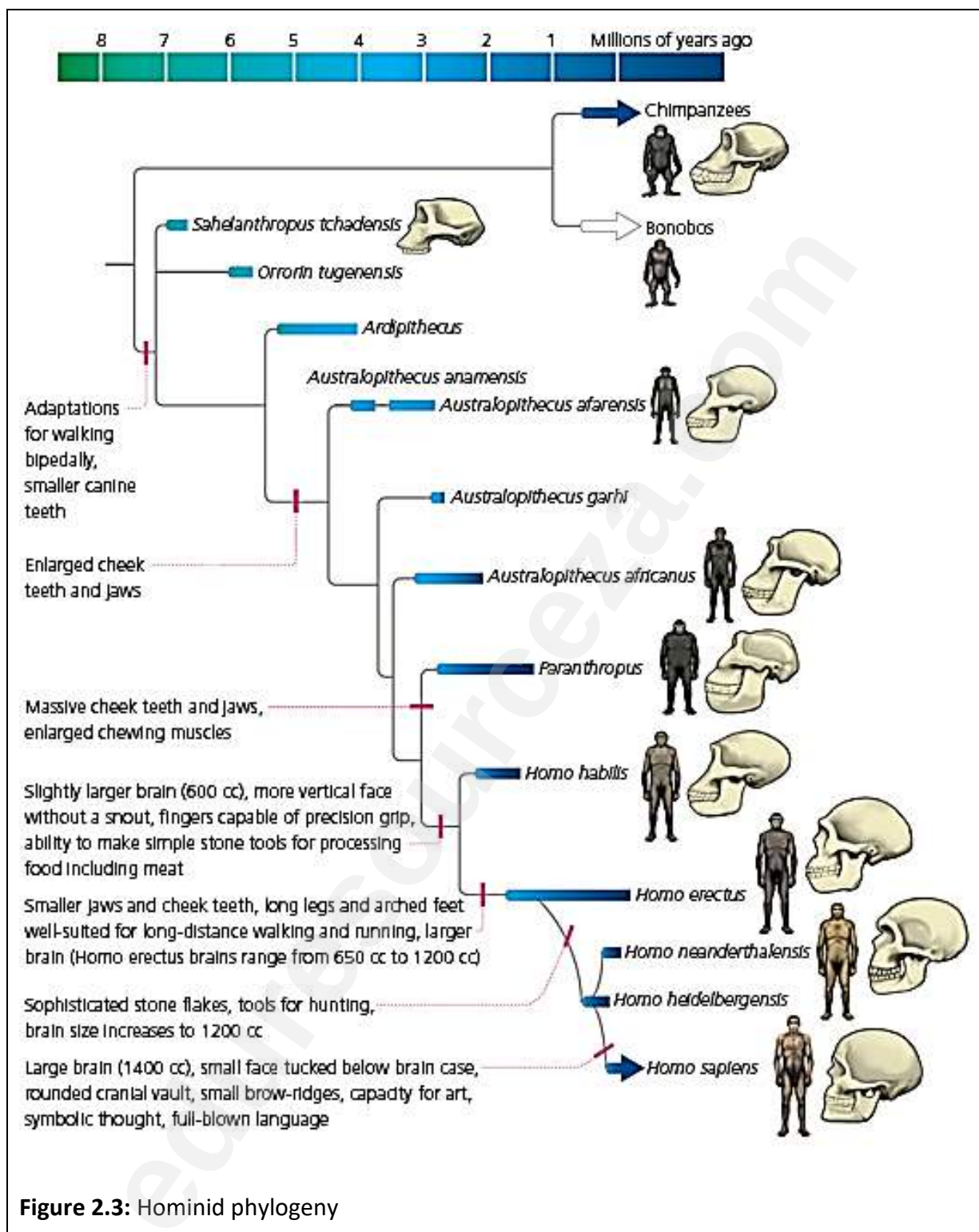
[Credit: Natural History Museum]

Publishing their findings and methodology in *Nature*, Professor Grün said “the new best age estimate of the fossil impacts our understanding of the speed and method of modern human origins. As the Broken Hill human fossils are now within the time range of the early Middle Stone Age, challenging assumptions that only *Homo sapiens* made these stone tools in Africa.”

The research also suggests that human evolution in Africa around 300 000 years ago was a much more complex process, with the co-existence of different human lineages.

Professor Stringer said: “Previously, the Broken Hill skull was viewed as part of a gradual and widespread evolutionary sequence in Africa from archaic humans to modern humans. But now it looks like the primitive species *Homo naledi* survived in southern Africa, *H. heidelbergensis* was in Central Africa, and early forms of our species existed in regions like Morocco and Ethiopia.”

[Adapted: “Dating the skull from Broken Hill, Zambia, and its position in human evolution” by Rainer Grün, Alistair Pike, Frank McDermott, Stephen Eggins, Graham Mortimer, Maxime Aubert, Lesley Kinsley, Renaud Joannes-Boyau, Michael Rumsey, Christiane Denys, James Brink, Tara Clark and Chris Stringer, 1 April 2020, *Nature*]



[From Source: *The Tangled Bank*, then used with permission of the author, Carl Zimmer, and publisher, Roberts & Company, Greenwood Village, Colorado]

SECTION B

QUESTION 3

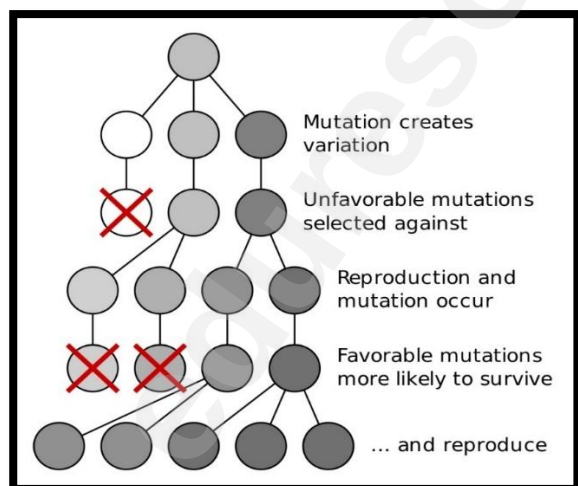
Read the information below. Use this information, as well as your own knowledge, to answer Question 3 in the question paper.

SOURCE A Humans have stopped evolving.

Why human evolution pretty much stopped about 10,000 years ago.

The British geneticist Steve Jones has recently given a lecture at University College London entitled “Is human evolution over?” His answer to his own question is in the affirmative. His argument is that human evolution, at least in the western societies, has stopped or slowed down because very few older men in such societies reproduce. Sperm of older men carry many more mutations than those of younger men. Mutations provide the source of genetic variations on which natural selection works. Hence, no older fathers, no genetic mutations, no evolution.

Figure 3.1: Mutations and human natural selection



[Adapted:<Why human evolution pretty much stopped about 10,000 years ago | Psychology Today South Africa>]

[Psychology Today is a magazine, not peer-reviewed, but all expert author content is reviewed, edited and fact-checked for accuracy, objectivity and to ascertain that the author has relevant domain expertise by the editorial staff. Psychology Today features many of its contributors as experts in their fields who hold academic degrees.]

[Image: <Future of Human Evolution | Biology | Visionlearning> Human natural selection]

Sir David Attenborough (an English broadcaster, biologist, natural historian and author), whose new show concentrates on the ascent (rise) of man, said he believed humans had now stopped evolving in physical terms, after developing means to keep even the weakest of the species alive. Since we are now able to rear up to 99% of our babies, people were no longer subject to Darwinian theories of natural selection.



Figure 3.2: *Sir David Attenborough at home in Richmond (Photo: Eddie Mulholland)*

Instead, he proposed, humans would continue to develop in a cultural sense; inheriting knowledge from previous generations and building upon it.

In an interview with the Radio Times this week, Sir David said: “I think that we’ve stopped evolving.

“We are the only species to have put a halt to natural selection, of its own free will, as it were. Stopping natural selection is not as important, or as depressing, as it might sound – because our evolutionary process is now cultural. “Humans have a great cultural inheritance as well as a physical, genetic inheritance – we can inherit a knowledge of computers or television, electronics, aeroplanes and so on.

[Adapted: <<http://www.telegraph.co.uk/news/science/evolution/10297124/Sir-David-Attenborough-Humans-have-stopped-evolving.html>>]

SOURCE B**Evidence that humans continue to evolve****Human Evolution 'Definitely Not' Over, Expert Says**

Humans are evolving at an increasing rate, thanks to medical advances and a larger population, Briana Pobiner at the Smithsonian's National Museum of Natural History said. But just as humans are continuing to evolve, human parasites are evolving, too.

"I invite you to look into the eyes of our ancient relatives," Pobiner said. "Why did most human ancestors go extinct, while homo sapiens survived? The answer has a lot to do with human brains."

The human brain represents only about 2% of the body's weight but consumes 20% of its energy. The biggest evolutionary changes have occurred in the neocortex, the brain's outer wrapping that processes abstract thinking, long-term planning, empathy and language, Pobiner said.

As human brains continue to evolve, will humans eventually develop gigantic heads and scrawny bodies, as depicted in some sci-fi films? Historically, the birthing process has limited brain size, because babies' heads had to fit through the birth canal.

Today, however, Caesarean sections avoid that process. As many as 46% of babies born today in China are delivered via C-section, Pobiner said. With advances in fertility and better postnatal medical care, she asked, "Are we screwing with natural selection?"

The world population is growing, and a bigger population also evolves faster, Pobiner said. But, with rising sea levels and less land available, waterborne and airborne illness could spread more easily, Pobiner said.

And human evolution persists in other areas too, such as sexual selection. A recent study found that beards become more attractive when they're rare in a population. When "peak beard" is reached, they become less attractive, the study found. Economic conditions may also influence beardedness, as unemployed men may use beards as a sign of masculinity, Pobiner said.

So, is human evolution over? "Definitely not," Pobiner said. "As long as there are humans, there will be human evolution."

[Adapted: <https://www.livescience.com/45685-human-evolution-not-over.html>>]

[Live Science is one of the biggest and most trusted popular science websites operating today, reporting on the latest discoveries, groundbreaking research.]

5 Signs Humans Are Still Evolving

1. We Drink Milk

Historically, the gene that regulated a human's ability to digest lactose shut down as they were weaned off of their mother's breast milk. But when we began domesticating cows, sheep and goats, being able to drink milk became a nutritionally advantageous quality, and people with the genetic mutation that allowed them to digest lactose were better able to spread their genes. A 2006 study suggests this tolerance for lactose was still developing as early as 3,000 years ago in East Africa. That genetic mutation for digesting milk is now carried by more than 95 percent of Northern European descendants.

2. We're Losing Our Wisdom Teeth

Our ancestors had much bigger jaws than we do, which helped them chew a tough diet of roots, nuts and leaves. They tore apart the meat they ate with their teeth, which led to worn down teeth that needed replacing. A third set of molars, wisdom teeth, is believed to be the evolutionary answer to accommodate our ancestors' eating habits. One estimate says 35 percent of the population is born without wisdom teeth, and some say they will disappear altogether.

3. We're Resisting Diseases

In 2007, a group of researchers looking for signs of recent evolution uncovered 1,800 genes that have only become prevalent in humans in the last 40,000 years, many of which are devoted to fighting infectious diseases like malaria. More than a dozen new genetic variants for fighting malaria are spreading rapidly among Africans. Another study found that natural selection has favoured city-dwellers by producing a genetic variant that allows us to be more resistant to diseases like tuberculosis and leprosy.

4. Our Brains Are Shrinking

The average volume of the human brain has decreased from 1,500 cubic centimetres to 1,350 cubic centimetres. One group of researchers suspects our shrinking brains mean we are in fact getting dumber. Historically, brain size decreased as societies became larger and more complex, suggesting that the safety net of modern society negated the correlation between intelligence and survival. But another, more encouraging theory says our brains are shrinking not because we're getting dumber, but because smaller brains are more efficient.

5. We Have Blue Eyes

Originally, we all had brown eyes. But about 10,000 years ago, someone who lived near the Black Sea developed a genetic mutation that turned brown eyes blue. While the reason blue eyes have persisted remains a bit of a mystery, one theory is that they act as a sort of paternity test. “There is strong evolutionary pressure for a man not to invest his paternal resources in another man’s child,” says the lead author of a study on the development of our baby blues. Because it is virtually impossible for two blue-eyed mates to create a brown-eyed baby, our blue-eyed male ancestors may have sought out blue-eyed mates as a way of ensuring fidelity.

[Adapted: < <http://mentalfloss.com/article/30795/5-signs-humans-are-still-evolving>>] Hullinger, Jessica

SOURCE C**Natural selection and evolutionary pressures**

For those who dream of a better life, science has bad news: this is the best it is going to get. Our species has reached its biological pinnacle and is no longer capable of changing.

That is the stark, controversial view of a group of biologists who believe a Western lifestyle now protects humanity from the forces that used to shape *Homo sapiens*. 'Things have simply stopped getting better, or worse, for our species.'

However, this view is controversial. Other scientists argue that mankind is still being influenced by the evolutionary forces that created the many species which have inhabited Earth over the past three billion years.

'If you had looked at Stone Age people in Europe a mere 50,000 years ago, you would assume the trend was for people to get bigger and stronger all the time,' said Prof Chris Stringer, of the Natural History Museum, London. 'Then, quite abruptly, these people were replaced by light, tall, highly intelligent people who arrived from Africa and took over the world. You simply cannot predict evolutionary events like this. Who knows where we are headed?'

According to Darwin's theory, individual animals best suited to their environments live longer and have more children, and so spread their genes through populations. This produces evolutionary changes. For example, hoofed animals with longer necks could reach the juiciest leaves on tall trees and therefore tended to eat well, live longer, and have more offspring. Eventually, they evolved into giraffes. Those with shorter necks died out.

Similar processes led to the evolution of mankind, but this has now stopped because virtually everybody's genes are making it to the next generation, not only those who are best adapted to their environments.

'Until recently, there were massive differences between individuals' lifespans and fertility,' said Jones. 'In London, the death rate outstripped the birth rate for most of the city's history. If you look at graveyards from ancient to Victorian times, you can see that a half of all children died before adolescence, probably because they lacked genetic protection against disease. Now, children's chances of reaching the age of 25 have reached 98%. Nothing is changing. We have reached stagnation.'

However, such arguments affect only the Western world - where food, hygiene and medical advances are keeping virtually every member of society alive and able to pass on their genes. In the developing world, no such protection exists.

If people start to live to 150 and can produce children for more than 100 of those years, the effects could be dramatic, he says. 'People will start to produce dozens of children in their lifetimes, and that will certainly start to skew our evolution. These people will also have more chance to accumulate wealth as well. So, we will have created a new race of fertile, productive individuals and that could have dramatic consequences. 'However, that will only come about when we directly intervene in our own evolution, using cloning and gene therapy. Without that, nothing will happen.'

[Adapted:< Is human evolution finally over? | Genetics | The Guardian>
[The Guardian is national newspaper in the United Kingdom]

SOURCE D**No recent biological change**

In 2000, the palaeontologist, Stephen Jay Gould, famously declared that “there’s been no biological change in humans in 40,000 or 50,000 years,” suggesting that evolution in humans is slow or has perhaps stopped altogether.

[Adapted: <Is there any evidence that humans are still evolving? >(medicalnewstoday.com)]

Quora

**Jeff Lewis**

Studied at University of Maryland, College Park · Author has **1.6K** answers and **7.1M** answer views · 4y

First, some perspective. 5000 years is not long at all in evolutionary terms. Here's a tablet from 5000 years ago. Keep in mind that the ancient Egyptians practiced stylized art, but the people depicted in that carving look practically indistinguishable from people today. In a long lived species like humans, 5000 years simply isn't long enough for big evolutionary changes.



Image Source: [Wikipedia](#)

[Adapted <<http://Quora.com>>]

[Quora is a question-and-answer website where people go to find information. Every piece of content on the site is generated by users, meaning it is created, edited, and organized by the same people that use the website.]

SOURCE E DNA clues and “negative selection”**Scientists Find DNA Clues That Show How Humans Are Evolving Right Now**

A team of researchers from the Queensland Brain Institute studied the genomic (DNA) data from 126,545 individuals. They closely examined 28 complex traits, such as heel bone mineral density, male pattern baldness, BMI, female age at first menstruation and menopause, female age when giving live birth for the first time, grip strength, and hip-to-waist ratio. By studying the genes associated with these traits in individuals at different ages, it's possible to see differences between generations. "In natural selection, or 'survival of the fittest', characteristics that improve survival are more likely to be passed on to the next generation,"

"The opposite also occurs, DNA mutations with a detrimental effect on fitness are less likely to be passed on, by a process called negative selection. Negative selection prevents 'bad' mutations from spreading through the population, meaning that common DNA variants are likely to have small or no effect on traits.

The researchers said they found evidence of negative selection - the removal of harmful gene variants - in several traits. The strongest evidence was in traits related to cardiovascular function and reproductive function.

But female age at menopause - associated with fertility - showed the strongest change. Age at first menstruation and age at first live birth also showed markers - which, the researchers said, made sense, since there's a strong correlation between fertility and genetic fitness.

Last year, researchers from the University of California, Irvine studied the DNA of over 500,000 individuals, looking for both positive and negative selection. They found that evolution was favouring a higher BMI in men - probably due to muscle mass - and women that give birth younger. Don't get too excited, though. Other scientists found in a 2011 study that evolutionary changes develop fairly frequently, but don't "stick" - it takes about a million years for an evolutionary trait to develop and last.

The point of the study isn't necessarily to determine changes we're going to see make a huge impact anytime soon, but to learn more about evolution, and how selection works.

[Adapted: < Scientists Find DNA Clues That Show How Humans Are Evolving Right Now : ScienceAlert>
[*Science Alert* is a top-rated science journal covering all aspects of the sciences]