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INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION  
MAY 2023

**BIOLOGY: PAPER I**

**EXAMINATION NUMBER**

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Time: 3 hours

200 marks

**PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY**

1. This question paper consists of 36 pages. Please check that your question paper is complete.
2. This question paper consists of four questions.
3. Read the questions carefully and make sure that you answer all parts of all the questions.
4. **Answer ALL the questions on the question paper and hand this in at the end of the examination. Remember to write your examination number in the space provided.**
5. Use the total marks that can be awarded for each question as an indication of the detail required.
6. It is in your own interest to write legibly and to present your work neatly.
7. ONE blank page (page 36) is included at the end of the paper. If you run out of space for a question, use this page. Clearly indicate the number of your answer should you use this extra space.

**FOR MARKER'S USE ONLY**

| Question  | 1  | 2  | 3  | 4  | Total |
|-----------|----|----|----|----|-------|
| Marks     | 80 | 40 | 40 | 40 | 200   |
| Marked    |    |    |    |    |       |
| Moderated |    |    |    |    |       |

**QUESTION 1**

- 1.1 Select the term in Column B that best matches the description in Column A. Write the corresponding letter of the term in the space between the brackets. Each letter may be used only once.

| <b>COLUMN A</b> |                                                                                                     | <b>COLUMN B</b> |                      |
|-----------------|-----------------------------------------------------------------------------------------------------|-----------------|----------------------|
| [ ]             | Fusion of the male gamete and the female gamete in plant reproduction.                              | A               | Cross pollination    |
| [ ]             | Transfer of pollen from the flower of one plant to the flower of another plant of the same species. | B               | Ovule                |
| [ ]             | Part of the flower where pollen is produced.                                                        | C               | Anther               |
| [ ]             | Structure within the flower that becomes the seed.                                                  | D               | Asexual reproduction |
| [ ]             | Collective term for male reproductive structures within a flower.                                   | E               | Fertilisation        |
| [ ]             | Sticky area of the flower that receives the pollen.                                                 | F               | Ovary                |
| [ ]             | Scented parts of the flower to attract pollinating agents such as bees.                             | G               | Sexual reproduction  |
| [ ]             | Type of reproduction that produces offspring that are genetically identical to parents.             | H               | Self-pollination     |
| [ ]             | Structure within the flower that becomes the fruit.                                                 | I               | Stigma               |
| [ ]             | Type of reproduction that allows for genetic diversity in plants.                                   | J               | Petals               |
|                 |                                                                                                     | K               | Sepals               |
|                 |                                                                                                     | L               | Stamens              |

(10)

- 1.2 **EIGHT** multiple-choice questions are given below. Choose the most correct option for each question and write the letter of your choice in the table below.

| Question | 1.2.1 | 1.2.2 | 1.2.3 | 1.2.4 | 1.2.5 | 1.2.6 | 1.2.7 | 1.2.8 |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|
| Answer   |       |       |       |       |       |       |       |       |

- 1.2.1 The best description of a population of wildebeest is provided by which of the following options?

### Species of wildebeest



[Source: <<https://animalia.bio/blue-wildebeest>>]

- A All the blue wildebeest that can breed with one another and are found in Mount Kenya National Park.
- B All the different species of wildebeest such as the black, blue and white-banded wildebeest found throughout Africa.
- C All the wildebeest found in the different national parks across the world.
- D All the black wildebeest on the African continent that share similar traits.

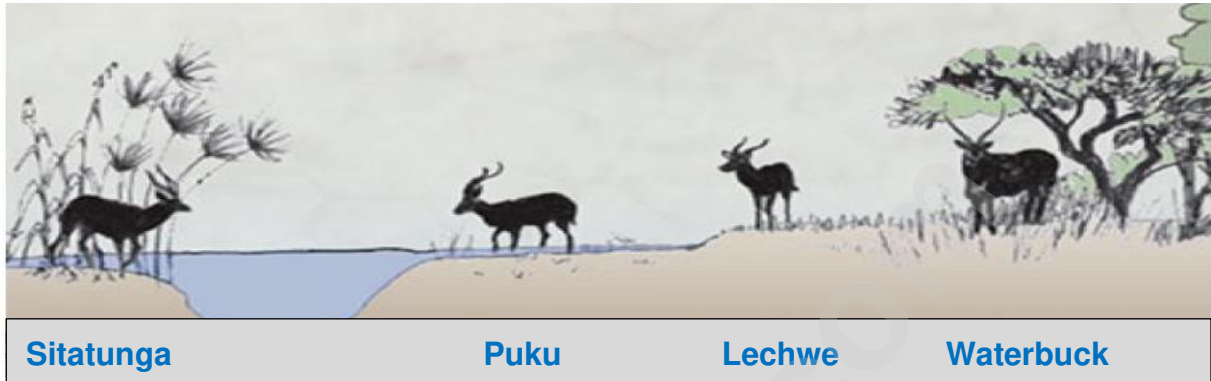
(1)

- 1.2.2 A term to describe the maximum number of giraffe that the Serengeti-Mara ecosystem can support is provided by which option below?

- A Population parameter
- B Stable population
- C Carrying capacity
- D Limiting factor

(1)

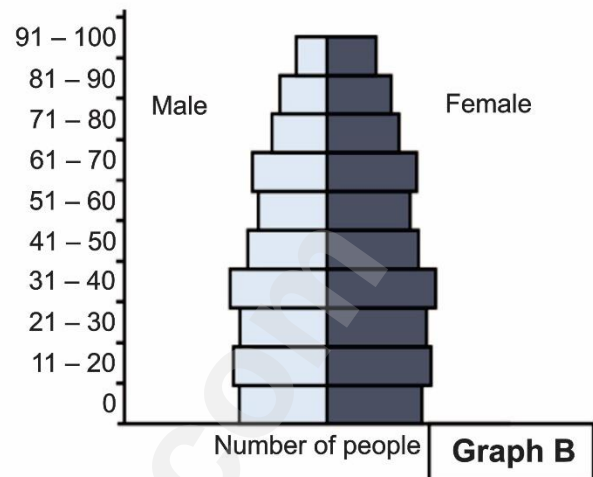
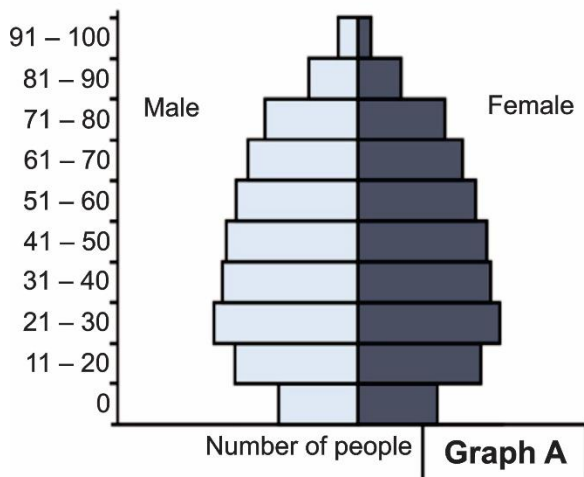
- 1.2.3 The picture below shows four different African antelope species living in the same area in the DRC, competing for the same resources. Which term is best illustrated by the picture?



[Source: <<https://www.biointeractive.org/classroom-resources/niche-partitioning>>]

- A Intraspecific competition  
 B Resource partitioning  
 C Predation  
 D A closed population (1)
- 1.2.4 Which one of the following examples is NOT a natural process that would remove trees in a mature forest and start the process of secondary succession?
- A A flood  
 B The aging and falling of trees  
 C Clearance of land for agriculture  
 D Forest fire caused by a lightning strike (1)
- 1.2.5 What is the term used to describe the movement of an animal that permanently leaves its habitat to find a new, more suitable habitat?
- A Emigration  
 B Immigration  
 C Migration  
 D Open population (1)
- 1.2.6 Termites live in large groups known as colonies. Within the termite colony there is division of tasks amongst smaller groups made up of similar individuals, e.g., soldiers. What is the correct biological term for each of these smaller groups?
- A Swarm  
 B Caste  
 C Pack  
 D Flock (1)

Use the graphs below to answer Questions 1.2.7 and 1.2.8.



1.2.7 Which one of the following features applies to a country represented by Graph A?

- A A reduction in the number of new births.
- B People do not live long.
- C There are significantly more females than males in each age group.
- D The country will need to build more schools in the future.

(2)

1.2.8 What is the best way to describe a country represented by Graph B?

- A Still a developing country.
- B Undeveloped with an increasing population.
- C Well-developed and stable.
- D Undeveloped with a decreasing population.

(2)

## 1.3 Study the information below and use it to answer the question that follows.

A study of loggerhead sea turtles in Cape Verde confirmed what many scientists believe – climate change could lead to the extinction of sea turtles. Higher temperatures allow more female turtles to be born. Once the sand in which sea turtles incubate their eggs becomes too warm, the population could become entirely female, and this could risk extinction of the sea turtle as fewer males will mean less mating opportunities. Sea turtle gender is not controlled by sex chromosomes as in humans and most other animals. Instead, the sex of the sea turtle is determined by the temperature of the sand in which the turtle lays its eggs. Dark-coloured sand absorbs more sunlight than light-coloured sand. Loggerhead turtles lay about 70–170 eggs at a time once fertilisation has occurred. Turtles are reptiles, just like snakes, crocodiles, lizards and tortoises. Reptiles have dry scaly skin and lay soft-shelled eggs on land.

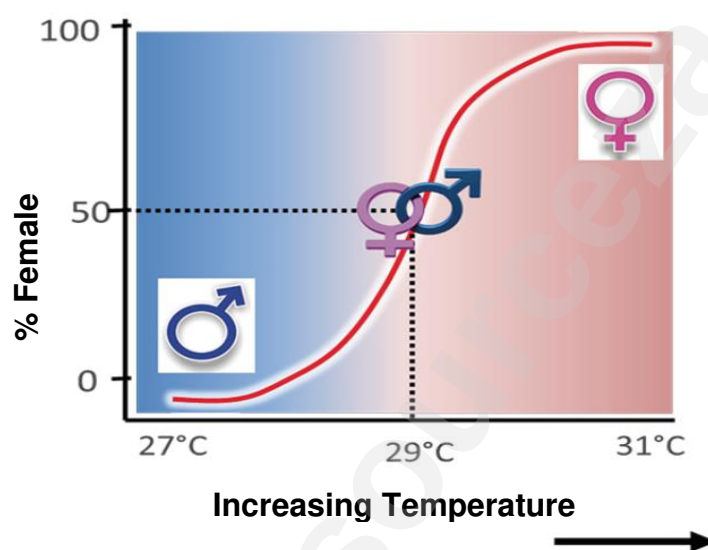


**Figure 1:**  
Percentage of female  
turtle offspring born  
when eggs are  
incubated at different  
temperatures

[Source: <<https://www.theguardian.com/environment/2014/may/20/more-sea-turtles-will-be-born-female-as-climate-warms-study-shows>>]

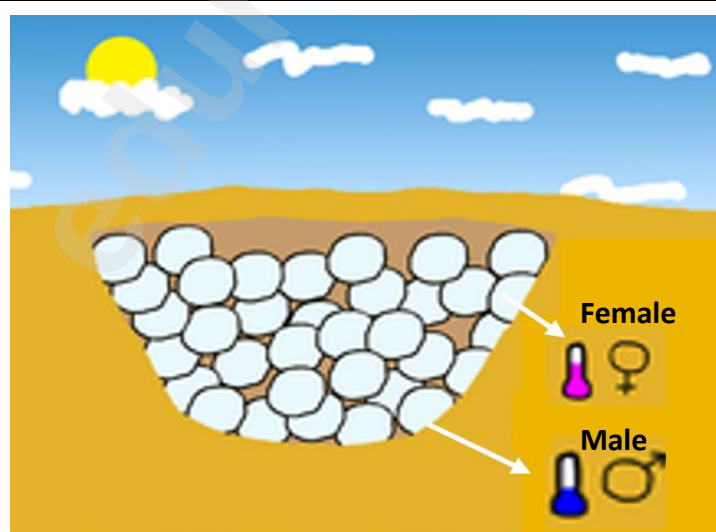


**Figure 2:**  
Turtle eggs laid in  
sand on the shore – the  
eggs positioned at  
various levels of the  
hole are at different  
temperatures

[Source: <<https://www.chegg.com/learn/biology/introduction-to-biology/sex-chromosomes-in-reptiles>>]

Consider the TEN statements in the table below and for each statement decide whether:

- A the statement is supported by the information provided.  
 B the statement is contradicted by the information provided.  
 C the statement is neither supported nor contradicted by the information provided.

|        | STATEMENT                                                                                | A, B OR C |
|--------|------------------------------------------------------------------------------------------|-----------|
| 1.3.1  | Loggerhead sea turtles will definitely become extinct in the next one hundred years.     |           |
| 1.3.2  | Male turtles will hatch from eggs incubated at 27 °C.                                    |           |
| 1.3.3  | Eggs incubated in light-coloured sand will produce female turtles.                       |           |
| 1.3.4  | Turtles are ovoviviparous.                                                               |           |
| 1.3.5  | Fewer males will mean fewer eggs get fertilised.                                         |           |
| 1.3.6  | Sex determination in all reptiles is controlled by temperature.                          |           |
| 1.3.7  | The temperature at the top of the hole in <b>Figure 2</b> is 30 °C or greater.           |           |
| 1.3.8  | At a temperature of 29 °C, the ratio of males to females will be 50:50.                  |           |
| 1.3.9  | Turtles display a k-strategy survivorship.                                               |           |
| 1.3.10 | Besides temperature, there are many other factors that determine the sex of the turtles. |           |

(10)

- 1.4 Study the information provided below. Use this information and your own knowledge to answer the questions that follow.

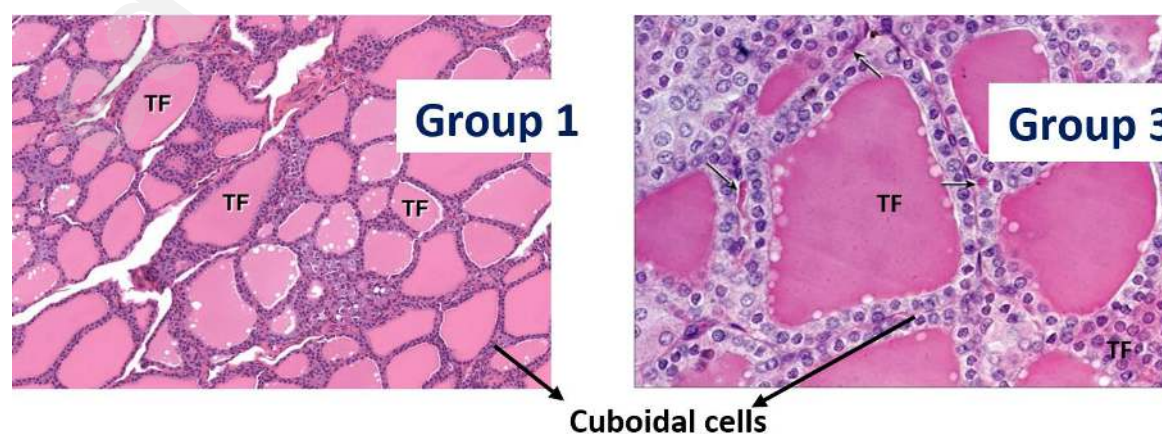
Iodine deficiency disorder (IDD) is a major public health problem throughout the African continent. It is the most common cause of thyroid disorders. IDD can lead to a goitre and other thyroid disorders. A person with a goitre has an enlarged thyroid gland that results in a swelling at the front of the neck. Research has shown that IDD can also be caused by the consumption of certain foods. Researchers hypothesised that some foods grown locally in an iodine deficient area are goitrogenic, i.e., causes a goitre to develop. Goitrogens are naturally occurring substances that suppress the function of the thyroid gland by interfering with iodine uptake. In Africa, goitrogens are found in staple foods like cassava.

Rats that were 28 days old were divided into three groups and fed the following diets to test the effects of goitrogenic food:

| Group | Type of food                                    |
|-------|-------------------------------------------------|
| 1     | 100% rat pellets                                |
| 2     | 25% rat pellet combined with 75% ground cassava |
| 3     | 50% rat pellet combined with 50% ground cassava |

Rat pellets are healthy rat feed, containing high amounts of minerals like calcium and iodine. After 35 days, the results showed that Group 1 was growing optimally while the other two groups showed significant reduction in growth. The thyroid tissue of rats from two groups was isolated and examined (see below).

**Figure 3: Normal fluid-filled oval thyroid follicles (TF) lined with cuboidal cells extracted from rats in Group 1 and abnormal thyroid follicles extracted from rats in Group 3. (Both images magnified 1000X)**



[Source:<[https://www.researchgate.net/figure/Struma-colloides-with-cystic-follicles-and-flattened-squamous-epithelial-cells-After\\_fig3\\_321161881](https://www.researchgate.net/figure/Struma-colloides-with-cystic-follicles-and-flattened-squamous-epithelial-cells-After_fig3_321161881)>]

1.4.1 Where in the human body is the thyroid gland located?

\_\_\_\_\_ (1)

1.4.2 Which important mineral is required to produce thyroxine hormone?

\_\_\_\_\_ (1)

1.4.3 Identify the group of rats that made up the control group for the investigation.

\_\_\_\_\_ (1)

1.4.4 List TWO variables that need to be fixed/controlled in the investigation.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2)

1.4.5 Describe ONE visible difference between the thyroid tissue of rats from Group 1 and rats from Group 3 as seen in **Figure 3**.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2)

1.4.6 (a) What is a symptom of having a goitre?

\_\_\_\_\_ (1)

(b) By referring to **Figure 3**, suggest an explanation for the symptom you mentioned in Question 1.4.6 (a) above.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2)

(4)

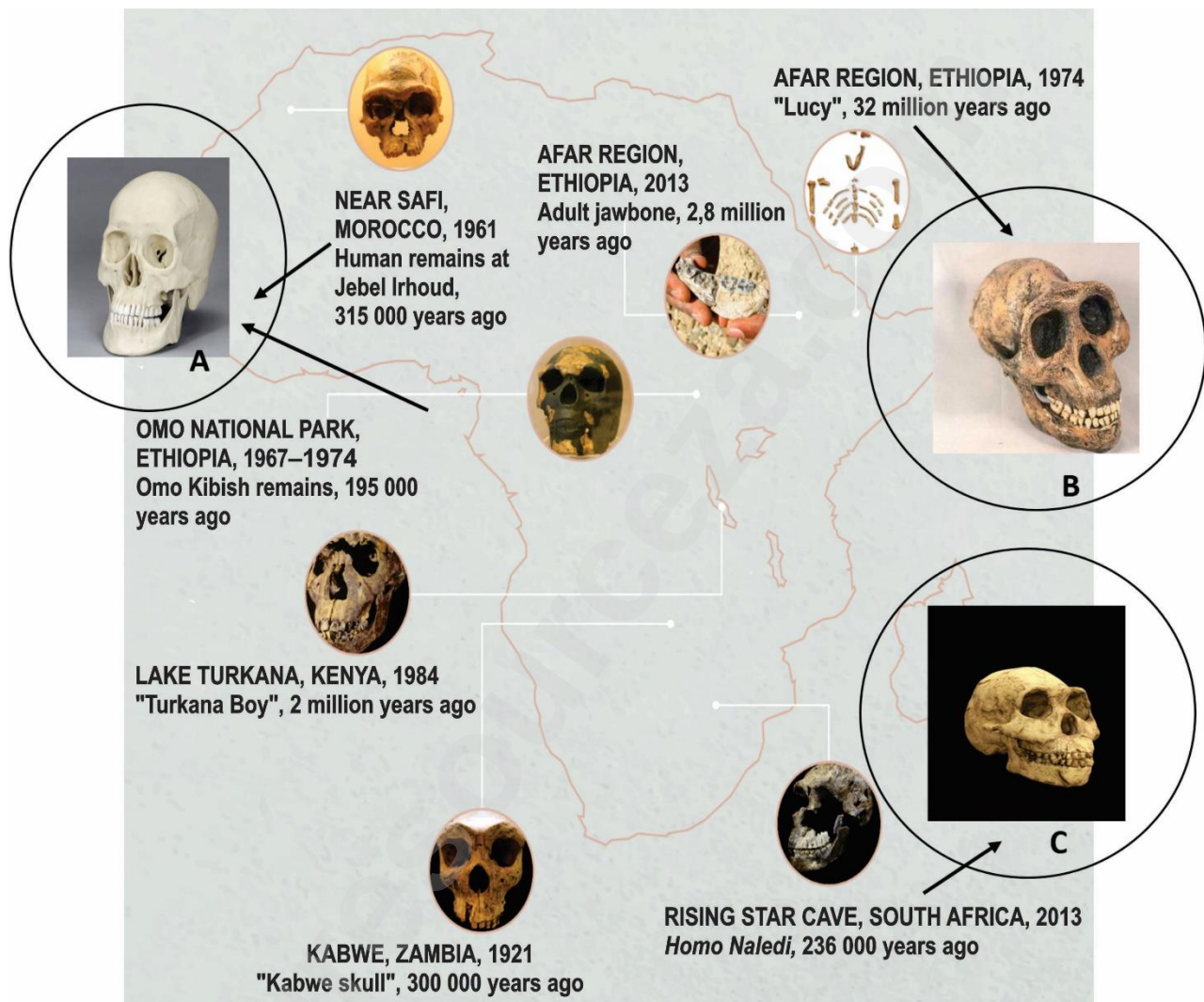
(1)

(2)

- 1.5 Africa is often termed 'The Excavated Continent'. This seems to be an appropriate name given to the continent in terms of human evolution.

\*Excavated – refers to digging in the ground in an area to find buried remains.

**Figure 4: Various evolutionary discoveries made on the African continent**



[Source: <<https://www.the-scientist.com/infographics/infographic-meet-your-ancient-ancestors-and-relatives-in-africa-67880>>]

- 1.5.1 Why is 'The Excavated Continent' an appropriate name for the African continent with regard to human evolution?

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(2)

- 1.5.2 Explain the significance of the position of the foramen magnum (not visible on the skulls) for bipedalism.

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(2)

- 1.5.3 To which species of the *Australopithecus* genus does *Lucy* belong?

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(1)

- 1.5.4 Discuss TWO visible differences between the structures of skulls A and B.

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(4)

- 1.5.5 Many palaeontologists do not agree that skull C is correctly classified under the *Homo* genus. Provide evidence from the skull features in **Figure 4** on page 11 to suggest why this is so.

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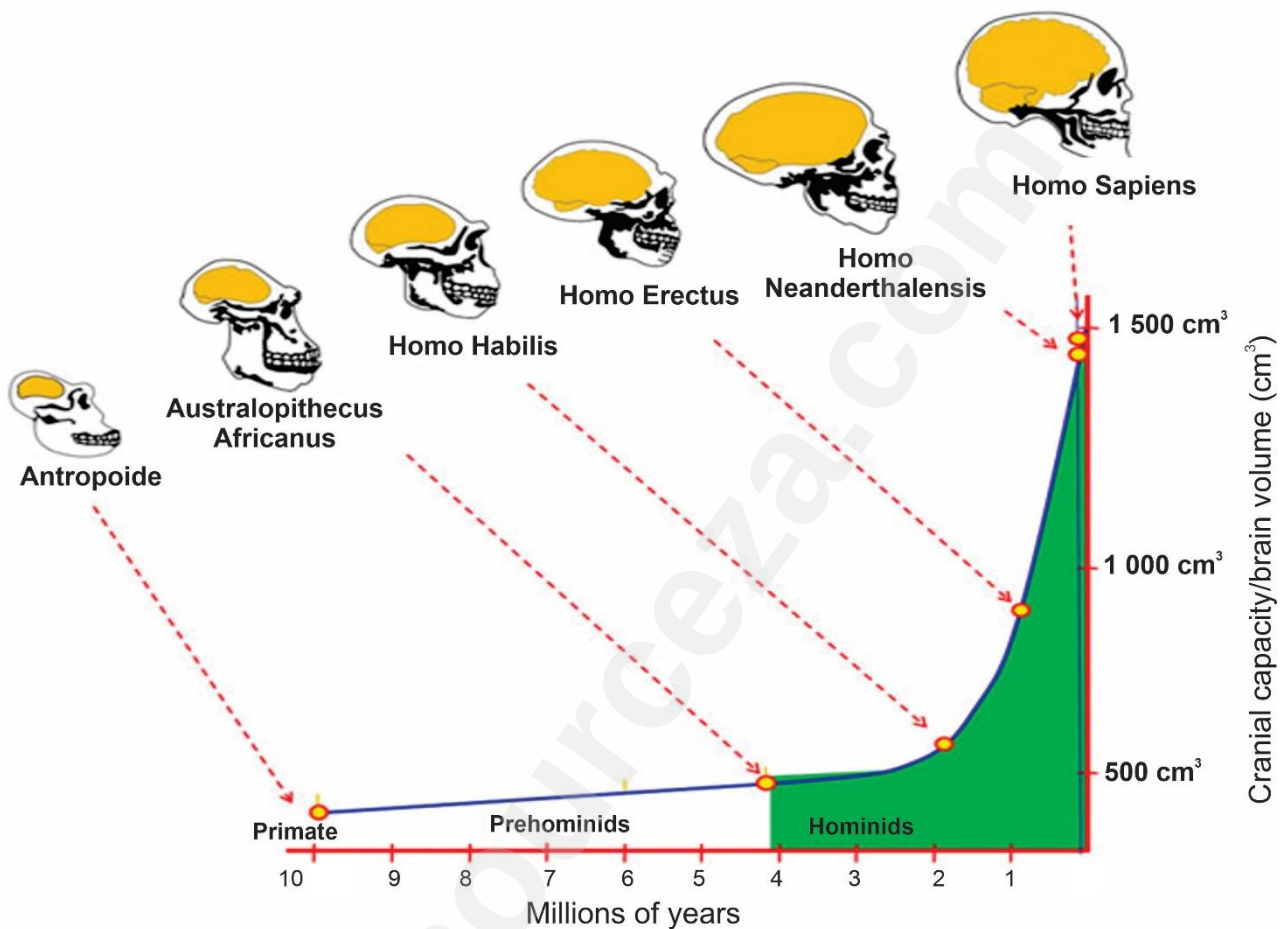
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(2)

- 1.5.6 Draw a simple evolutionary timeline to indicate the relative ages of the three hominids at A, B and C. It does not have to be drawn to scale.

1.6 Study the figure below to answer the questions that follow.

**Figure 5: The average cranial capacity (brain volume) of primates and hominids**



[Source: <<https://www.sciencedirect.com/science/article/pii/S0168010219304882>>]

1.6.1 Name any ONE hominid species from the image above.

(1)

1.6.2 Estimate the cranial capacity of the organism labelled as primate on the graph.

(1)

1.6.3 Describe the general trend shown on the graph with regard to brain volume.

(2)

1.6.4 How long ago did *Homo habilis* exist on earth?

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(1)

1.6.5 Which *Homo* species was the first to discover fire?

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(1)

1.6.6 Name ONE fossil of *Australopithecus africanus* discovered in South Africa.

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(1)

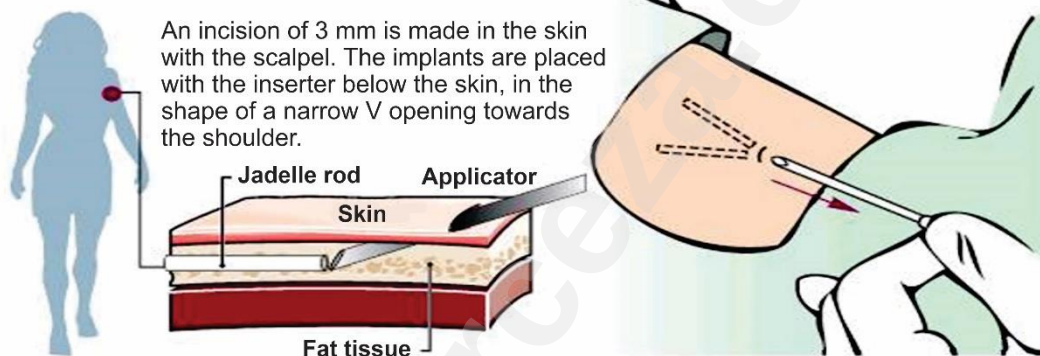
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- 1.7 According to 2022 *Reproductive Health Journal*, the use of modern contraceptives in sub-Saharan Africa has increased. In 2011, hormonal implants in sub-Saharan Africa were used by only 1,1% of women. Since then, a reduction in price of hormonal implants and an increased supply of the contraceptive, as well as governments' commitment to improve family planning, have resulted in up to 6% of women using implants in many countries by 2017. Three countries even reached 11% usage. This has further increased and in 2022 it has been reported that 26,5% of women are using hormonal implants.

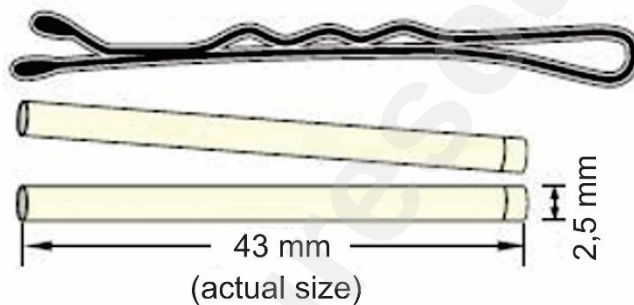
## LONG-TERM OPTION FOR BIRTH CONTROL

Contraceptive implants are growing in popularity in sub-Saharan Africa and have been proven to be the most effective reversible method of contraception.

### THE IMPLANT PROCEDURE



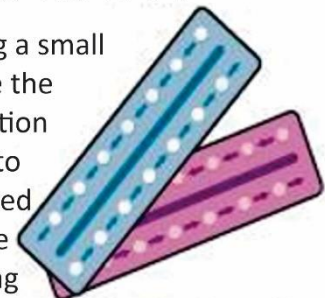
### JADELLE IMPLANT



These implants consist of two flexible white rods, each containing 75 mg of **progesterone**, which continuously release low doses of the hormone into the body to prevent ovulation.

### IMPLANTS VS THE PILL

Although requiring a small surgical procedure the Jadelle administration is effective for up to five years, compared to the daily dosage of a pill, eliminating the chance of human error. Implants can be removed with another small surgical procedure for fertility to resume.



Graphic: THE DOMINION POST

| PROS OF THE IMPLANT                                                                                                                                    | CONS OF THE IMPLANT                                                                                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• 99% effective.</li> <li>• Works for up to 5 years.</li> <li>• Does not reduce long-term fertility.</li> </ul> | <ul style="list-style-type: none"> <li>• Does not protect against STDs.</li> <li>• Causes irregular periods.</li> <li>• May cause skin irritation at point of insertion.</li> </ul> |

[Source: <<https://pubmed.ncbi.nlm.nih.gov/29559495/>>]

[Source: <<https://www.shecares.com/menstruation/birth-control-implants>>]

[Source: <<https://petergriffin.co.nz/2010/10/11/how-the-contraceptive-implant-works-infographic/>>]

- 1.7.1 Provide ONE reason for the increased use of hormonal implants in sub-Saharan Africa by the year 2022.

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(1)

- 1.7.2 (a) Name the female reproductive hormone present in the hormonal implant.

---

(1)

- (b) Explain how the hormone mentioned in Question 1.7.2 (a) above prevents ovulation.

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(2)

- 1.7.3 Would you recommend the hormonal implant to a female friend? Provide ONE reason from the source and ONE reason from your own knowledge to support your answer.

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(2)

- 1.7.4 Explain ONE advantage of using a condom compared to a hormonal implant.

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(1)

- 1.7.5 Name ONE other hormonal contraceptive not mentioned in the source.

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(1)

- 1.7.6 Suggest what is meant by 'human error' when it comes to taking the pill as mentioned in the source.

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(1)

- 1.7.7 How does the hormonal implant empower women to support their reproductive rights?

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(2)

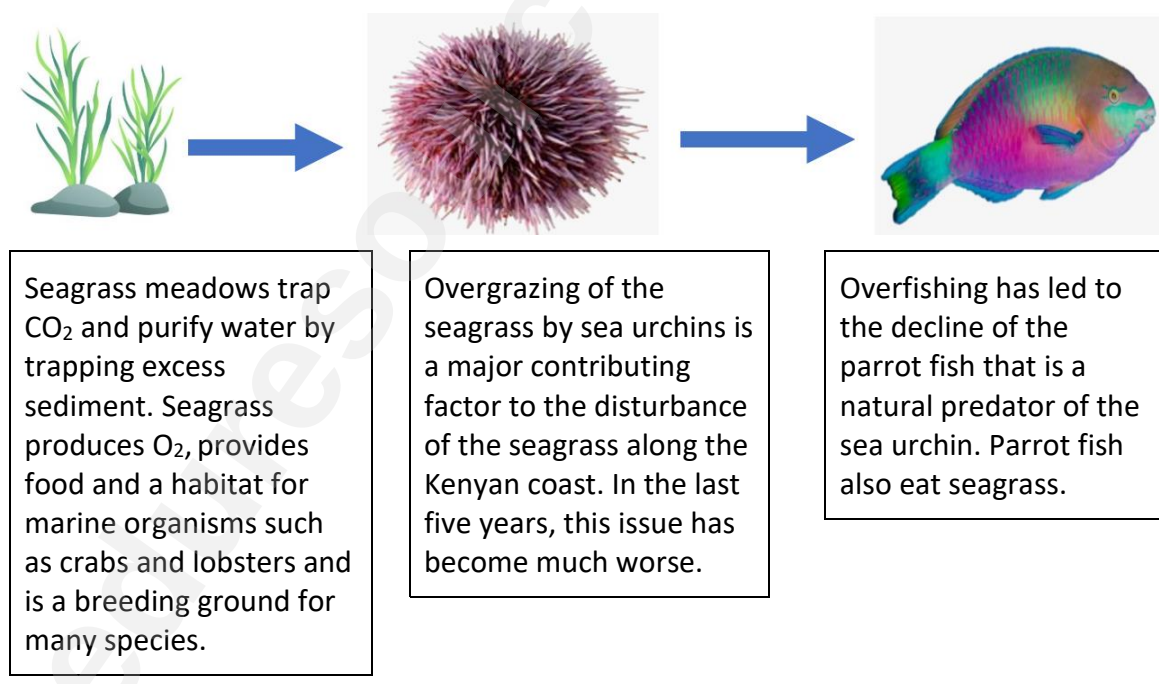
**QUESTION 2**

- 2.1 Read the following information and use it and your own knowledge to answer the questions that follow.

Seagrass is a flowering marine plant found in shallow, sandy, bottom habitats in oceans. It can spread over large areas and form extensive dense 'meadows' – large beds of seagrass. It is an important producer in oceans. In 2020, the United Nations Environmental Programme released a report warning that fishing boats, seaweed farming and tourism on the coast of Kenya and Tanzania are threatening the survival of seagrass. The east coast of Africa has 12 known species of seagrass that covers an area of 317 km<sup>2</sup>, but 7% of this seagrass habitat is being lost each year. Besides frequent disturbances by humans on the seagrass meadows, there are also natural disturbances such as grazing by sea urchins.

Continuous human disturbance of the seagrass meadows has resulted in fragmentation (breaking up) of the seagrass beds. The Kenya Marine and Fisheries Institute has found a way to restore the seagrass in areas where seagrass loss is extensive. This restoration process involves planting seagrass seedlings in large bags on the ocean floor.

**Figure 6: Simple food chain in a marine ecosystem**



[Source: <<https://www.newscientist.com/article/2186605-seagrass-loss-off-the-coast-of-Kenya-is-fuelling-climate-change/>>]

- 2.1.1 Circle the correct answer from the options provided below.

The most suitable definition for the ecological niche of seagrass is:

- A The role seagrass has in its community, such as trapping CO<sub>2</sub> and producing O<sub>2</sub>.
- B The sandy seabed on which the sea urchin lives.
- C The 12 different species of seagrass found along the Kenyan coast.

- 2.1.2 List THREE density independent factors, mentioned in the text on page 17, that can reduce the seagrass population.

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(3)

- 2.1.3 Provide THREE roles played by the seagrass meadows along the Kenyan coastline.

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(3)

- 2.1.4 (a) Calculate the area of seagrass habitat that is being lost each year along Africa's east coast. Show all working.

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(3)

- (b) If no conservation efforts are put in place, determine, on average, how many years it will take for all the seagrasses to disappear along Africa's east coast.

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(1)

- 2.1.5 Identify the type of competition that exists between the crabs and lobsters.

---

(1)

2.1.6 Study the information provided in **Figure 6** on page 17 to answer the following questions.

(a) Using the food chain in **Figure 6**, complete the table below:

| Organism on the food chain | Trophic level on the food chain |
|----------------------------|---------------------------------|
| Sea urchin                 |                                 |
|                            | Producer                        |
|                            | Omnivore                        |

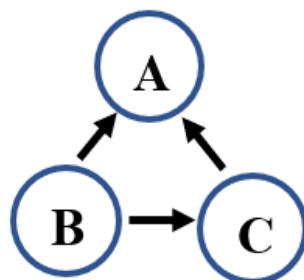
(3)

(b) Sketch a simple graph to show the changes in the seagrass population and the sea urchin population over the last five years.

- Provide a heading.
- Label both axes.
- Label the seagrass and sea urchin graph lines.

(6)

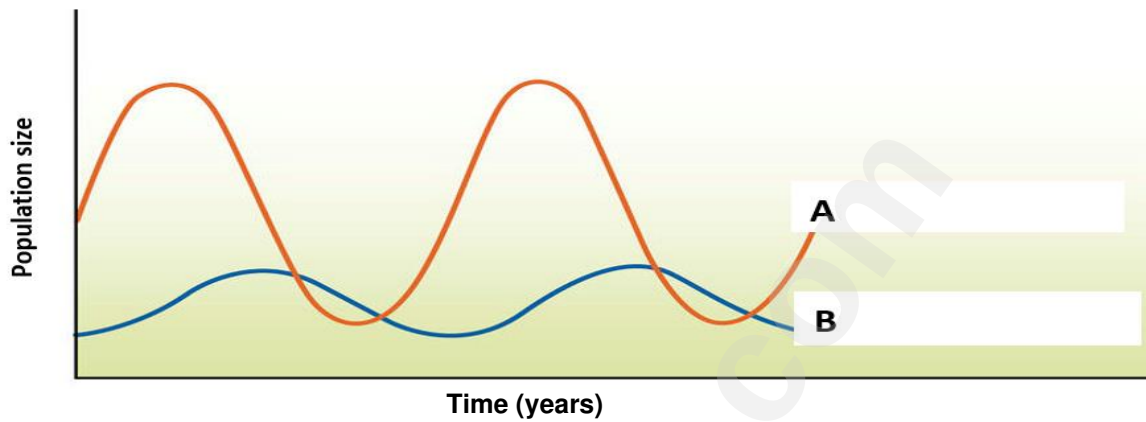
(c) The figure below shows the feeding relationship represented in **Figure 6**. Which letter, A, B or C, correctly represents the parrot fish?



(2)

2.1.7 Study **Figure 7** below to answer the questions that follow.

**Figure 7**



[Source: <<https://biologydictionary.net/>>]

- (a) Identify the relationship shown in the graph.

\_\_\_\_\_ (1)

- (b) Which organism, A or B, is the sea urchin?

\_\_\_\_\_ (1)

- (c) Explain your answer to Question 2.1.7 (b) above.

\_\_\_\_\_  
\_\_\_\_\_ (2)

- 2.1.8 To estimate the density of seagrass at a site along the east coast of Africa, the quadrat method was used as shown below. The total area of this site was  $40 \text{ m}^2$ . The quadrat had an area of  $2 \text{ m}^2$ . The following data was collected from 6 quadrat samples:

**Data collected from the site along the east coast of Africa**

| Quadrat | Number of seagrass plants |
|---------|---------------------------|
| 1       | 22                        |
| 2       | 36                        |
| 3       | 15                        |
| 4       | 21                        |
| 5       | 18                        |
| 6       | 32                        |

**Quadrat method**



Use the data in the table and the information provided to calculate the estimated number of seagrass plants at this site. Show all your working.

|  |
|--|
|  |
|--|

(4)

- 2.1.9 Identify the type of succession, primary or secondary, that is taking place in the seagrass meadows when seagrass restoration is practised. Explain your answer.

|  |
|--|
|  |
|--|

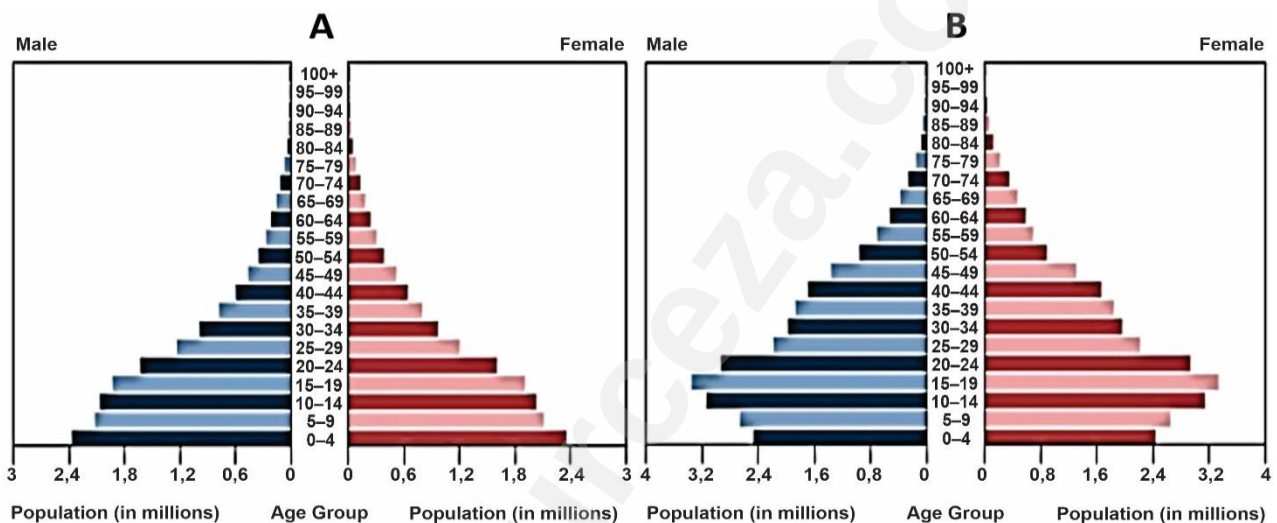
(2)

2.2

In 2012, the government of Kenya implemented a policy to manage its rapid population growth. The new policy aims to reduce the number of children a woman has over her lifetime, from five in 2009 to three in 2030. Kenya's long-term development plan recognises that rapid population growth could seriously affect the quality of life of all Kenyans with regard to sustainability of available resources. The multi-branched approach to address these concerns included education, buy-in from religious and cultural leaders as well as improved access to contraceptives for men and women.

[Source: < <https://www.prb.org/resources/new-kenyan-population-policy-a-model-for-other-countries/> >]

**Figure 8: Population pyramids of Kenya from two different time periods**



[Source: < <https://www.chegg.com/homework-help/questions-and-answers/environmental-resource-public-policies-influencing-population-pyramid-patterns-kenya-unite-q42272100> >]

2.2.1 Which of the pyramids shown above, A or B, would most likely represent the population of Kenya in 2030? Provide evidence, from the information provided and the pyramids, to support your answer.

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(3)

2.2.2 How many males are there in the 15- to 19-year-old age group in pyramid B?

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(1)

2.2.3 Do you think the new Kenyan population policy would be a good 'model' for other African countries? Motivate your answer.

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(2)

**QUESTION 3**

- 3.1 Read the following information and use it and your own knowledge to answer the questions that follow.

Female genital schistosomiasis (FGS) is a disease caused by *Schistosoma haematobium*, which is a waterborne parasite that infects the urinary and genital tract of an infected individual. It is one of the most neglected reproductive diseases in sub-Saharan Africa. In most African countries, health professionals are not familiar with FGS, so it is often not reported, is misdiagnosed and mostly untreated.



Almost fifty-six million women and girls in sub-Saharan Africa are estimated to be affected by FGS.



FGS leads to stigma (a mark of disgrace) as symptoms are similar to those caused by sexually transmitted diseases. In addition, FGS leads to social exclusion due to infertility and depression.

FGS occurs when the parasite's eggs cause damage to the reproductive organs and this can result in the following **primary symptoms** in women and young girls:

- Vaginal discharge
- Blood in urine
- Abdominal and pelvic pain
- Open sores and inflammation

If FGS is not treated, further complications can occur, such as:

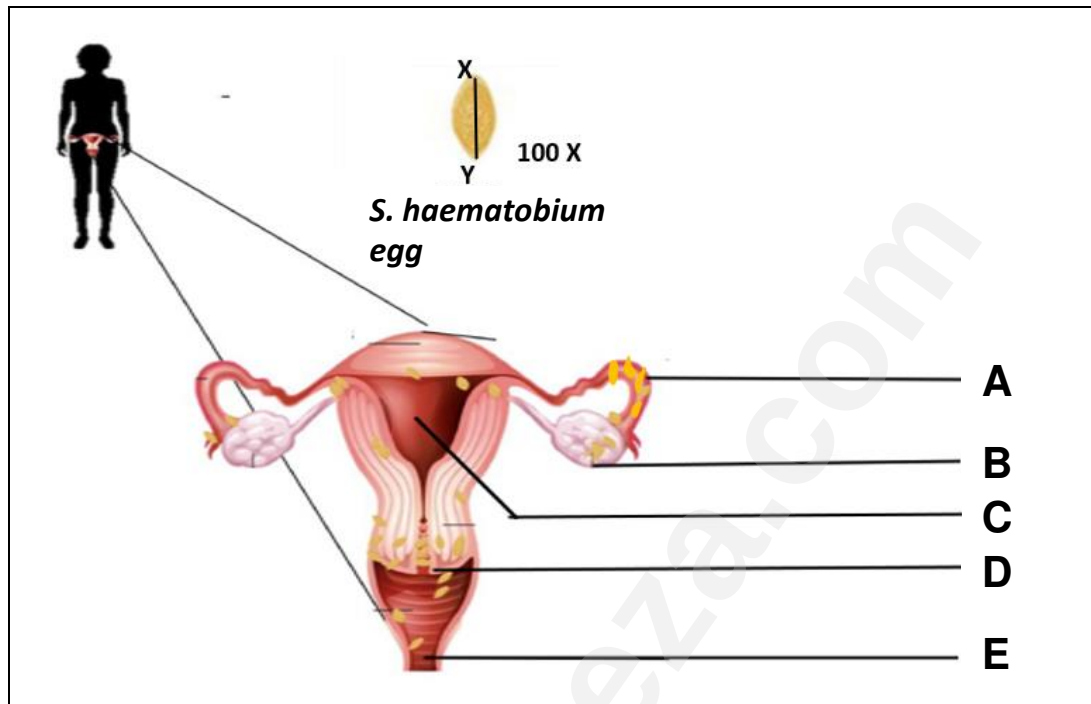
- Infertility
- Miscarriage
- Ectopic pregnancy
- Increased risk of viral infections such as HIV and HPV

FGS also affects the uterine environment during pregnancy. Pregnant women suffering from FGS develop anaemia, have low birth weight babies and there is an increased risk of infant and maternal mortality. The adult *S. haematobium* parasitic worms can be found within the placenta.

[Source: <<https://www.sciencedirect.com/science/article/abs/pii/S1471492211001863>>]

[Source: <<https://www.frontiersin.org/articles/10.3389/fitd.2022.821463/full>>]

**Figure 9: Front view of the female reproductive system showing infection with female genital schistosomiasis (FGS)**



[Source: <<https://schistosomiasiscontrolinitiative.org/ntds-female-genital-schistosomiasis>>, <<https://www.sciencedirect.com/science/article/pii/S0001706X19314391#fig0002>>]

3.1.1 Refer to **Figure 9** and complete the table below by providing **the letter** of the structure referred to in Column A, in Column B.

|     | Column A – structure                                                     | Column B – letter of structure |
|-----|--------------------------------------------------------------------------|--------------------------------|
| (a) | This is where fertilisation takes place.                                 |                                |
| (b) | It contains the Graafian follicle.                                       |                                |
| (c) | It is a reproductive opening for the parasite to enter the woman's body. |                                |
| (d) | It is lined by a layer of tissue called the endometrium.                 |                                |

(4)

- 3.1.2 Using evidence from **Figure 9**, provide ONE well-explained reason why the location of the *S. haematobium* eggs within the female reproductive system could result in infertility in women.

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(2)

- 3.1.3 Calculate the actual length of the *S. haematobium* egg by using the magnification provided in **Figure 9**. Show all working.

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(3)

- 3.1.4 Why do you think FGS is common in sub-Saharan African countries?

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(1)

- 3.1.5 Provide ONE well-explained reason why so many cases of FGS are not reported.

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(2)

- 3.1.6 Explain how the primary symptom of open sores and inflammation discussed in the source on page 23 can result in an increased risk of HIV in FGS patients.

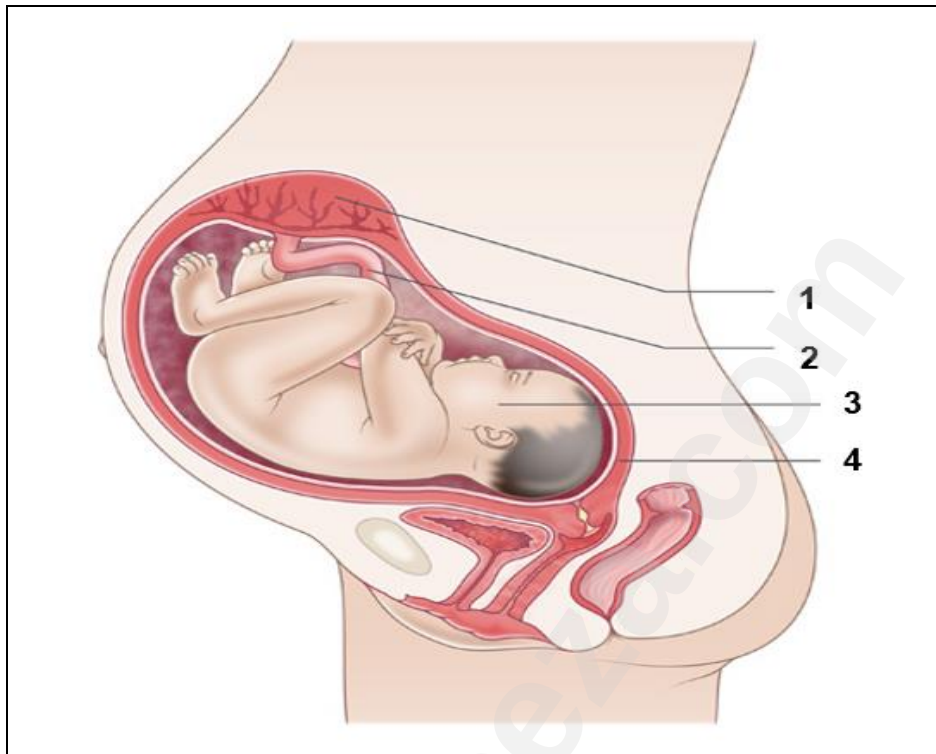
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(2)

**Figure 10: A diagram showing a pregnant woman**

[Source: <<https://raisingchildren.net.au/pregnancy/week-by-week/third-trimester/33-weeks>>]

3.1.7 Study **Figure 10** and answer the following questions.

- (a) Clearly mark with an 'A' on **Figure 10** where the adult parasitic worms can be found in the uterus of a pregnant woman.

(1)

- (b) Describe TWO functions of **structure 2**.

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(4)

- (c) Provide a label for **structure 4**.

3.1.8 Describe the changes that occur in structure D in **Figure 9** on page 24 during the natural childbirth process.

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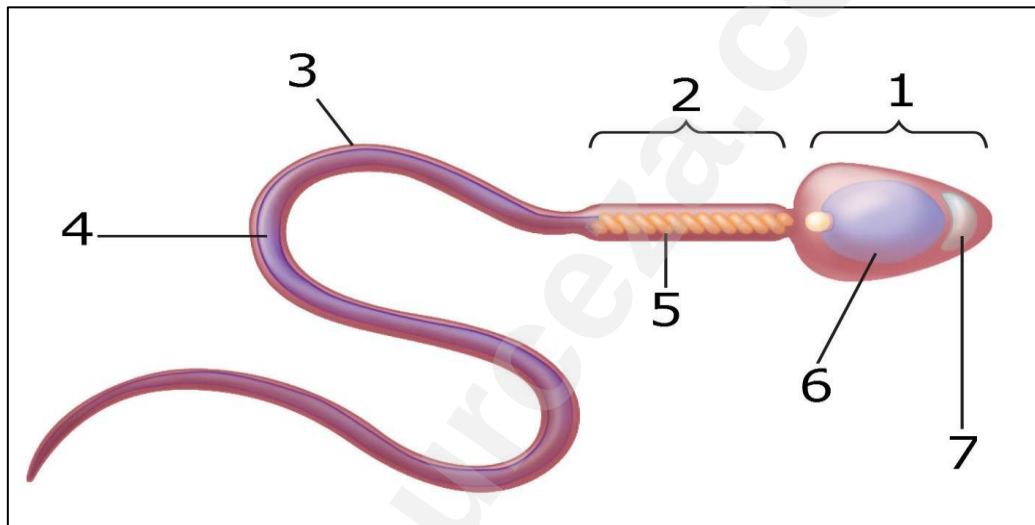
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(2)

3.2 Study the diagram of the sperm and answer the questions that follow.



[Source: <<http://www.biology.lifeeasy.org/95/what-is-the-structure-of-a-mature-human-sperm-cell>>]

3.2.1 Provide labels for parts:

4

6

7

(3)

3.2.2 Explain the importance of the structures found within part 2.

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(3)

- 3.3 Draw a flow chart showing the passage of sperm, from the time of sperm production until sperm leaves the male body. Remember to include a heading for your flow chart.

(5)

## 3.4 Read the source below and answer the questions that follow.

The Bawku district in Ghana lacks safe treatment methods for *S. haematobium* in pregnant women. An investigation in this hospital, over a period of one year, compared the effects of *S. haematobium* in causing preterm deliveries and also on the birth weights of babies in full-term deliveries. Of the 200 pregnant women in the study, 4,5% of the women were infected with *S. haematobium*. The infected women formed the experimental group and showed a higher number of preterm deliveries – 34,8% compared to 23,8% for the control group. The average birth weights of the babies for the experimental group were 2,5 kg compared to 3,2 kg for the control group.

[Source: <<https://pubmed.ncbi.nlm.nih.gov/1356302/>>]

3.4.1 How many of the pregnant women were infected with *S. haematobium*?

(1)

## 3.4.2 Identify the independent variable in this investigation.

(2)

## 3.4.3 Do you think this study can be regarded as scientifically reliable? Provide TWO well-explained reasons to justify your answer.

(4)

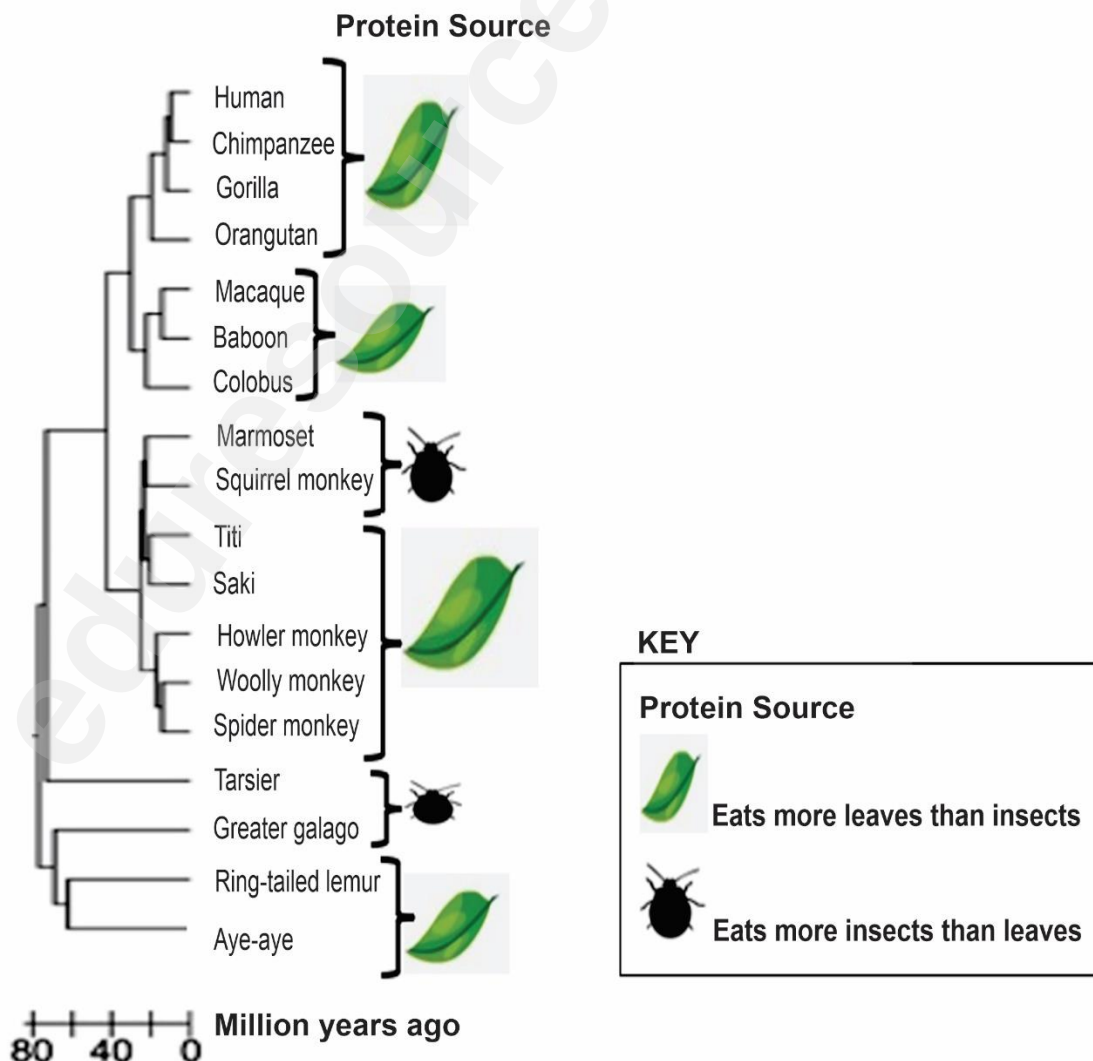
[40]

**QUESTION 4**

- 4.1 Read the following information and use it and your own knowledge to answer the questions that follow.

Evidence shows that the evolution of the umami (strong savoury) taste receptor can be traced back to Central Africa. Umami, which corresponds to the taste of monosodium glutamate (MSG), is the fifth taste sensation. The ancestors of large primates, such as the western chimpanzee from Guinea, the blue monkey and the Anubis baboon from Uganda, evolved their umami taste receptors to sense glutamate. Glutamate is an amino acid found in many foods, including leaves and fruit. These ancestral primates initially relied on a diet mainly of insects, but as this resource became limited, primates evolved over time, which allowed them to select a new type of food source that would still provide the necessary proteins required. A mutation that occurred in the taste receptor gene, T1R1/T1R3, allowed primates to move from an insect diet and overcome the bitter and unpleasant taste present in leaves.

**Figure 11: An evolutionary tree showing the evolution of the response to glutamate in species of leaf-eating primates and non-primates**



[Source: <<https://www.sciencedirect.com/science/article/pii/S0960982221010745#fig3>>]

4.1.1 Explain the meaning of the term *mutation*.

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(2)

4.1.2 Identify the selection pressure that drove the evolution of umami taste receptors.

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(1)

4.1.3 Refer to the evolutionary tree shown in **Figure 11** when answering the following questions.

(a) Identify which TWO closely related organisms did not acquire the umami taste characteristic.

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(2)

(b) What evidence in **Figure 11** indicates that humans are more closely related to chimpanzees than to gorillas?

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(2)

(c) Which species shown in **Figure 11** is the most primitive species? Explain your answer.

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(3)

(d) Is the howler monkey or the woolly monkey more closely related to the spider monkey? Explain your answer using evidence from **Figure 11**.

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(3)

(e) Provide another name for the evolutionary tree shown in **Figure 11**.

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(1)

4.1.4 Explain how the process of natural selection resulted in primates being able to develop the characteristic of being able to taste umami.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. A faint, diagonal watermark reading "iceza.com" is visible across the center of the page.

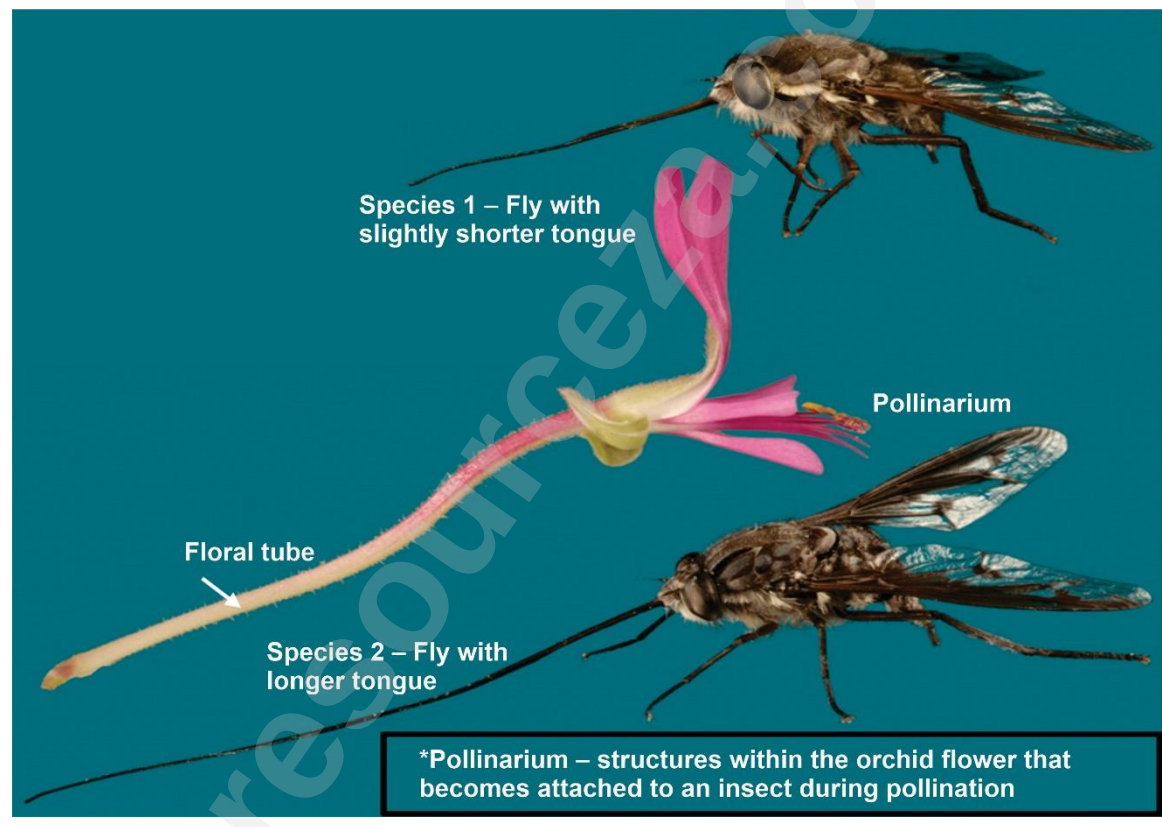
(6)

4.2

The critically endangered African orchid, found in Nigeria and South Africa, is specialised for pollination by the long proboscis (tongued) fly. African orchids contain large amounts of nectar. The length of the floral tube is 42 mm, which is very similar to the length of the fly's proboscis of 40 mm.

Speciation over the last twenty years has resulted in hundreds of species of orchids with longer floral tubes and 14 species of the long proboscis flies. This mostly occurred within the same geographical region of Etosha National Park in Namibia. Scientists have noticed that some of the flies have a longer proboscis than others.

**Figure 12: Pollination of the African orchid by the long proboscis fly**



[Source: <<https://onlinelibrary.wiley.com/doi/abs/10.1111/plb.13145>>]

4.2.1 Provide a definition for the term *species*.

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(3)

(b) Describe the process of sympatric speciation that occurred in the long proboscis flies.

(6)

#### 4.2.3 How would Lamarck have explained the evolution of the long-tongued fly?

(5)

- 4.2.4 Explain why the evolution of the long-tongued fly in **Figure 12** on page 33 can be considered an example of microevolution.

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(2)

- 4.2.5 Read the information below and answer the question that follows.

Hummingbirds, just like the long proboscis fly, are attracted to long tubular flowers. The proboscis of the fly and the beak of the hummingbird are considered analogous structures.



[Source: <<https://www.audubon.org/content/how-create-hummingbird-friendly-yard>>]

Discuss what is meant by analogous structures in this example.

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(3)  
[40]

**Total: 200 marks**

**REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE ADDITIONAL SPACE TO COMPLETE THE ANSWER. THIS WILL ENSURE THAT ALL ANSWERS ARE MARKED.**

[illegible]