



NATIONAL SENIOR CERTIFICATE EXAMINATION
MAY 2022

LIFE SCIENCES: PAPER I

Time: 3 hours

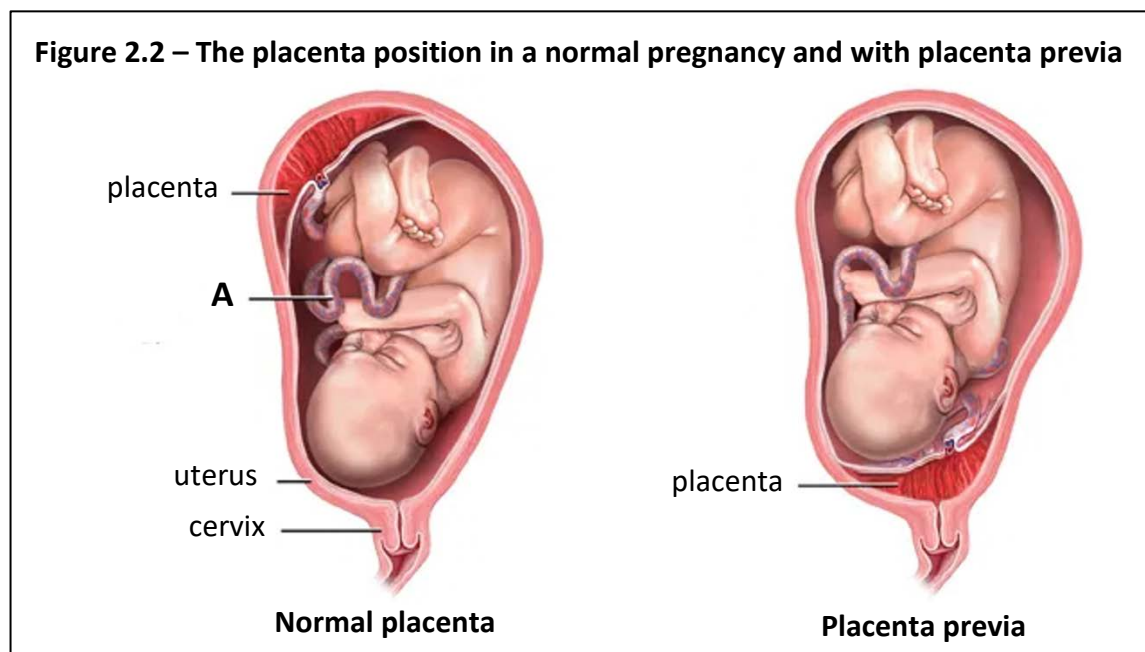
200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 13 pages and a yellow Answer Booklet of 15 pages (i–xv). Please check that your question paper is complete. Detach the yellow Answer Booklet from the middle of the question paper.
 2. This question paper consists of four questions.
 3. Question 1 must be answered in the yellow Answer Booklet provided.
 4. Questions 2, 3 and 4 must be answered in your Answer Book.
 5. Read the questions carefully.
 6. Start **each question** on a **new** page.
 7. Number the answers exactly as the questions are numbered.
 8. Use the total marks that can be awarded for each question as an indication of the detail required.
 9. It is in your own interest to write legibly and to present your work neatly.
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- 2.2 Placenta previa is a complication in pregnancy that can cause bleeding, particularly towards the end of a pregnancy. A caesarean section (surgery to remove the foetus from the abdomen) is recommended to deliver the baby. The condition affects 1 in 200 women during pregnancy.

The two conditions are illustrated in Figure 2.2 below.



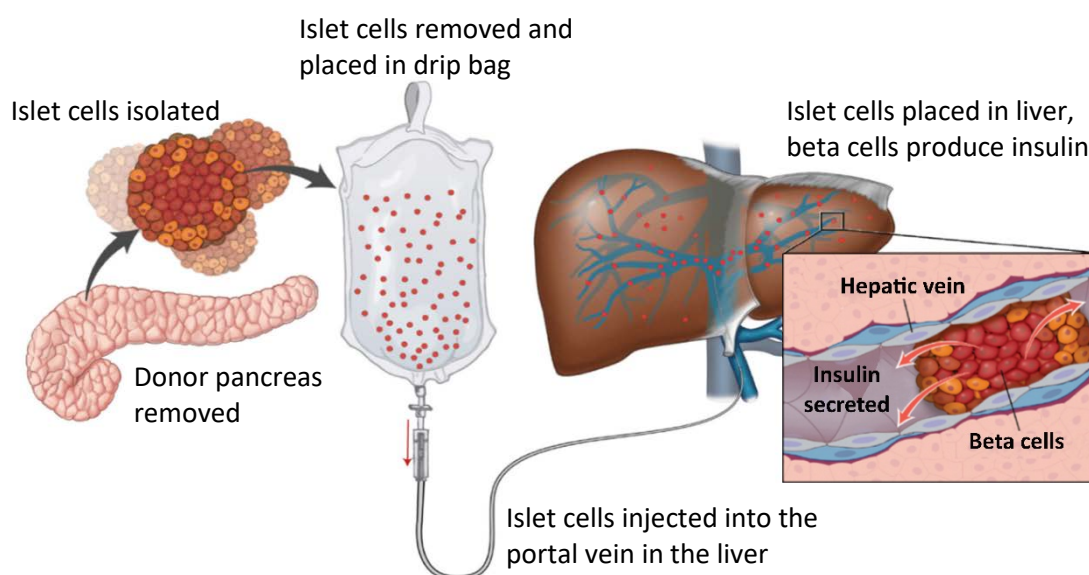
[Adapted: <<http://iahealth.net>>]

- 2.2.1 Give TWO functions of the placenta. (2)
- 2.2.2 Use the information and image above to describe the position of the placenta in a pregnancy with the condition of placenta previa. (2)
- 2.2.3 What percentage of pregnancies are affected by placenta previa? Show all working. (2)
- 2.2.4 Name and state the role of the structure labelled A. (2)
- 2.2.5 Describe how the uterus and cervix function to allow the birth of a baby. (2)

- 2.3 Study the information and Figure 2.3 below on a new treatment for Type 1 diabetes and answer the questions that follow.

Islet cell transplantation is an experimental procedure that has been used by a team of Canadian researchers to treat type 1 diabetes. The procedure involves transplanting islet cells from the healthy pancreas of a deceased donor into the liver of a type 1 diabetic patient to prevent the serious complications of diabetes. The process is outlined in the image below:

Figure 2.3 – Transplantation process of islet cells into the liver of a diabetic



[Image: <<https://consultqd.clevelandclinic.org>>]

The transplant surgery presents few risks and patients can usually return home the day after surgery. The liver is used as the site to place the islet cells as it is an organ that can regenerate itself by making new cells after being damaged. New blood vessels and nerves connect to the transplanted islets in the liver and eventually produce enough insulin for the patient.

[Adapted: <<https://www.nelson.com>>]

- 2.3.1 Outline your understanding of type 1 diabetes. (2)
- 2.3.2 Explain why the islet cell transplantation procedure would be a more suitable treatment for diabetes than insulin injections. (3)
- 2.3.3 Explain why islet cell transplantation is not effective in treating type 2 diabetes. (3)
- 2.3.4 Could islet cell transplantation be considered a form of gene therapy? Provide reasons for your answer. (2)

2.4 The pituitary gland is very important in controlling the balance of many bodily functions and is essential for health and well-being.

2.4.1 Where in the body is the pituitary gland found? (1)

2.4.2 Construct a flow diagram to illustrate how the pituitary gland hormones (FSH and LH) regulate ovum development from the start of the menstrual cycle up to the release of a mature ovum from the ovary. (7)

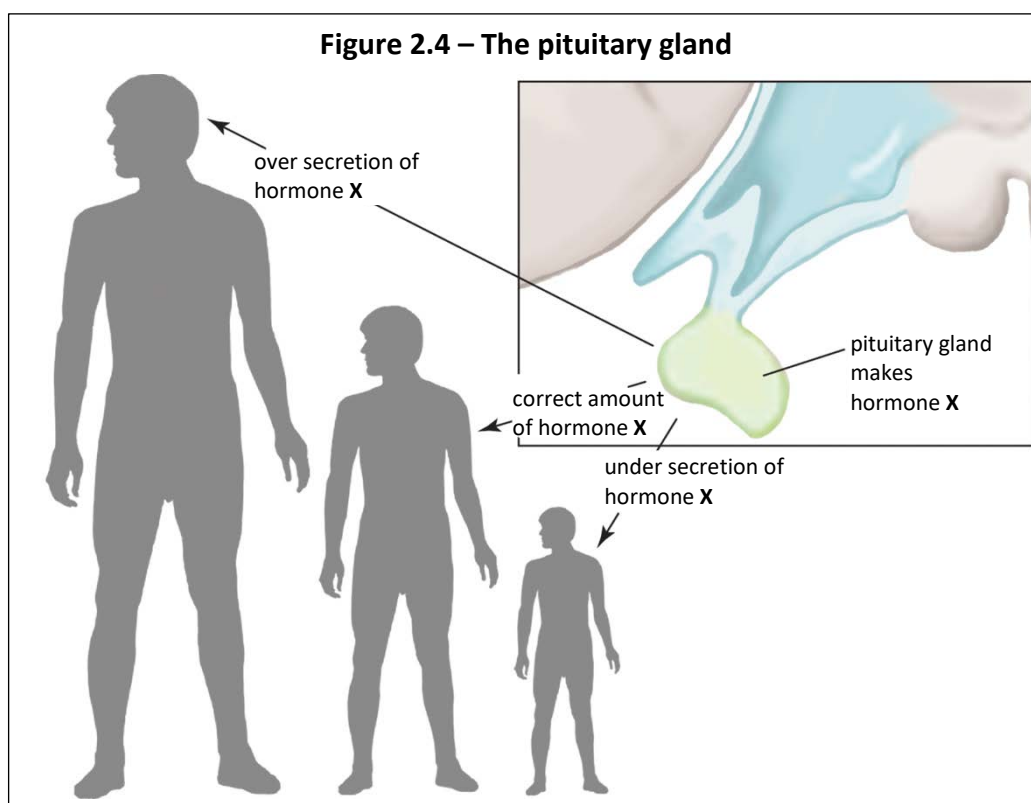
Part of the first step in the flow diagram is given below. Use it to start your flow diagram:

At the start of the menstrual cycle, the pituitary gland secretes ...



2.4.3 Figure 2.4 shows the secretion of a particular hormone (labelled X) and its effect on body size.

Name the hormone labelled X and state the target organ/s of this hormone. (2)



[Adapted: <<https://cdn.britannica.com>>]

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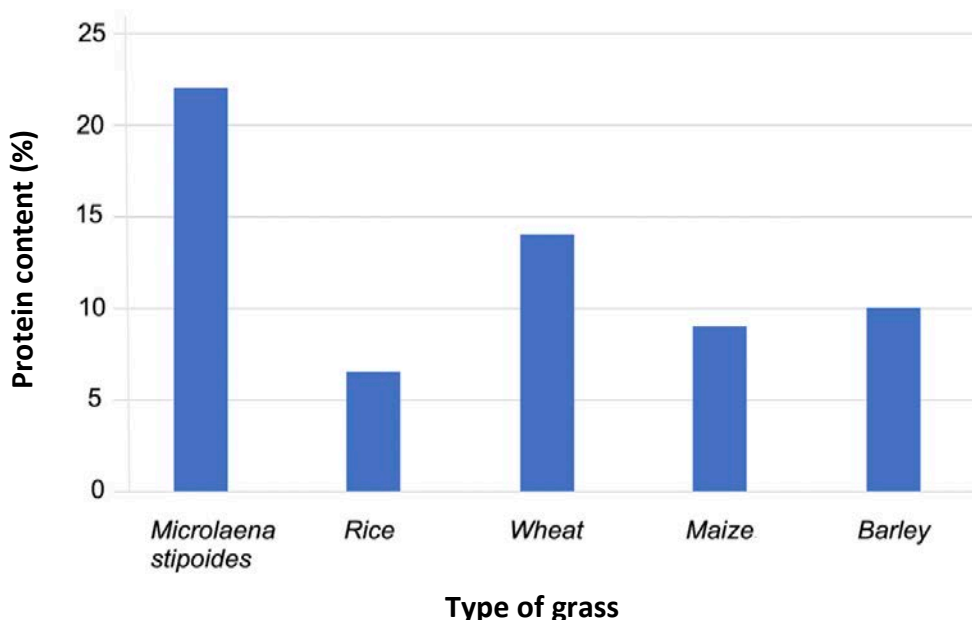
QUESTION 3

- 3.1 Read the information in the textbox below and answer the questions that follow.

Biologists are investigating the use of a 'weeping rice grass', *Microlaena stipoides*, as a pasture grass for livestock. It grows well in a wide variety of soil types and climates. It is drought and frost tolerant and remains green throughout the year. It requires less fertiliser and does not spread in an uncontrollable way like many other grasses. The seeds are similar in shape to rice grains but only half the size of domestic rice grains.

Figure 3.1 below shows the protein content of various crop seeds used for livestock feed.

Figure 3.1 – Bar graph to show protein content (%) of crop seeds



[Adapted: <<https://www.researchgate.net>> ; <<https://pfaf.org>>]

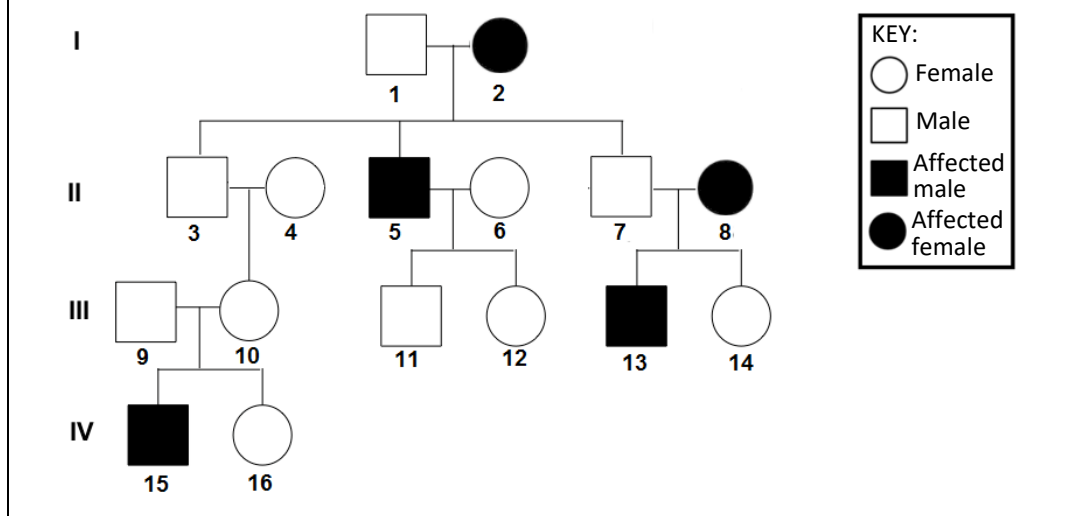
- 3.1.1 Why are seeds an important source of food? (2)
- 3.1.2 List FOUR reasons why farmers may want to use *Microlaena stipoides* as a pasture grass. (4)
- 3.1.3 Biologists want to use selective breeding to produce *Microlaena stipoides* plants with larger seeds.
- (a) What is meant by *selective breeding*? (2)
- (b) Explain how biologists would use selective breeding methods to produce *Microlaena stipoides* plants that have larger seeds. (4)

3.2 Read the following information and answer the questions that follow.

Albinism is a group of inherited disorders that result in a lack of pigmentation, or melanin, in the skin, hair and eyes. Several autosomal genes are involved in the production of melanin. Different types of mutations can occur in any one of these genes.

The type of albinism seen below is caused by a mutation in ONE of the autosomal genes that code for the production of melanin.

The pedigree chart below shows part of a family tree where some members have albinism.



[Adapted: <<https://www.mayoclinic.org>> ; <<https://www.khanacademy.org>>]

3.2.1 Explain what is meant by an *autosomal gene*. (2)

3.2.2 What term can be used to describe a trait, such as skin colour, that is controlled by more than one gene? (1)

3.2.3 Provide ONE piece of evidence from the pedigree chart that shows that albinism is a recessive trait. (2)

3.2.4 Use the key below for the alleles to help you answer the following questions:

A – normal

a – albino

(a) What is the genotype for individual 2 in the pedigree chart above? (1)

(b) Use a Punnett diagram to determine the probability of parents who are heterozygous for albinism having a child with albinism. Show the ratios of all the phenotypes from this cross. (6)

3.2.5 Another form of albinism is inherited by a gene mutation on the X-chromosome and is therefore sex-linked. Write the genotype for individual 15 from the chart above if the form of albinism in the pedigree was sex-linked. (1)

3.3 Read the information in the text below and answer the questions that follow.

Antibiotic resistance is the ability of a microorganism to withstand the effects of an antibiotic drug. Antibiotic resistance evolves naturally via natural selection. Efforts to fight antibiotic resistance have involved developing new antibiotic medicines, but for every antibiotic used, bacteria still develop resistance.

A new strategy to combat antibiotic resistance has been suggested: to inhibit evolution in microorganisms. Researchers have found that if the gene coding for a specific protein called *Mfd* is present in a bacterial genome, then resistance to antibiotic drugs also occurs. Scientists suggest that using 'anti-evolution' drugs that remove or inactivate *Mfd* will be more effective than limiting the overuse of antibiotic drugs to try to combat drug-resistant bacteria.

[Adapted: <<https://www.cell.com>>]

3.3.1 Explain, in terms of natural selection, how bacteria can develop resistance to antibiotics. (5)

3.3.2 Suggest ways in which the actions of humans have contributed to the increase of antibiotic-resistant bacteria. (2)

3.3.3 A part of the DNA that codes for the *Mfd* protein is shown below:

TAC GGC TAT

(a) Use the DNA sequence above to write the corresponding mRNA sequence. (3)

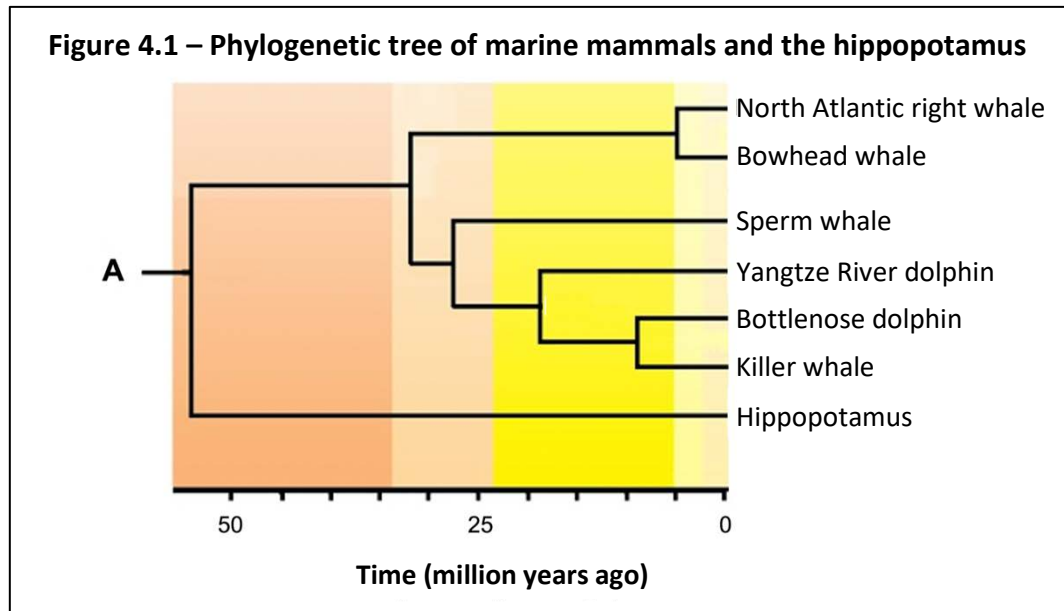
(b) State ONE difference between the structure of a DNA molecule and an RNA molecule. (1)

(c) Describe the process that occurs to form the *Mfd* protein after the DNA has been transcribed in the nucleus. (4)

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QUESTION 4

- 4.1 Figure 4.1 below is a phylogenetic tree showing the relationship between species of marine mammals and the hippopotamus. Use this phylogenetic tree to answer the following questions.



[Adapted: <<https://advances.sciencemag.org>>]

- 4.1.1 What term would describe the organism at A in this phylogenetic tree? (1)
- 4.1.2 According to the phylogenetic tree, which named animal evolved the earliest? (1)
- 4.1.3 Name the organism that is most closely related to the sperm whale. (1)
- 4.1.4 How long ago did the lineage of the bowhead whale and the North Atlantic right whale diverge? (2)

- 4.2 Read the information below and use this information and your own knowledge to answer the questions that follow.

Bushbabies are small nocturnal primates that live in the savannah and forests of sub-Saharan Africa. They live most of their lives in trees but may descend to the ground to feed or cross open spaces if necessary.

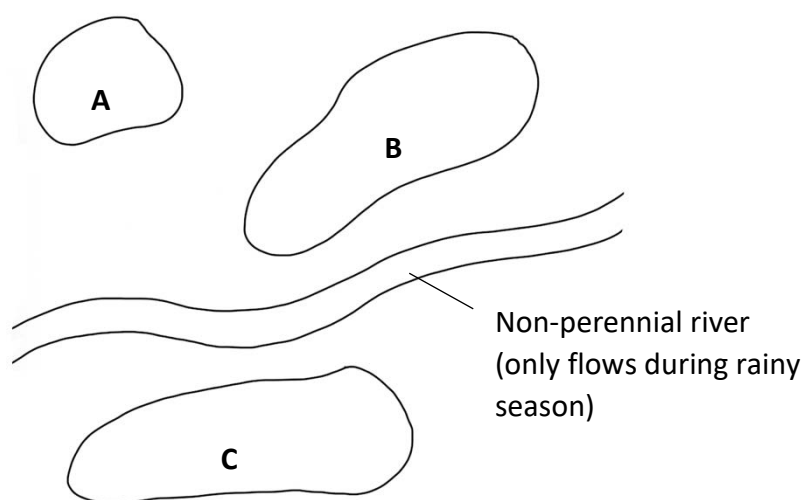
Figure 4.2 below shows the location of three different groups of bushbabies in a region in Africa. Table 4.2 shows the fertility of the offspring produced when the individuals of the different groups interbreed.



A bushbaby

[Source: <<https://i.pinimg.com>>]

Figure 4.2 – The location of three bushbaby populations (A, B and C)



[Source: Examiner's own]

Table 4.2 – Fertility results of mating between individuals of different populations

| Populations | Fertility of offspring |
|-------------|------------------------|
| A and B | Infertile offspring |
| B and C | Fertile offspring |
| A and C | Infertile offspring |

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

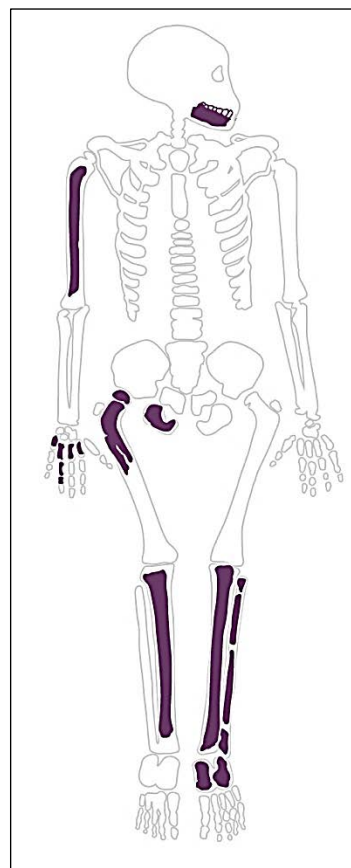
- 4.2.1 Suggest the number of different species that are represented in Figure 4.2. Explain your answer. (3)
- 4.2.2 Speciation relies on variation. Describe TWO causes of variation in organisms. (4)
- 4.2.3 If the river in Figure 4.2 became a permanent barrier, describe the type of speciation that would occur between populations B and C. (5)

4.3 Read the information below and answer the questions that follow.

In 2017 an international team of 52 scientists announced the discovery of further fossil remains of the hominid, *Homo naledi*, in a series of caves northwest of Johannesburg, South Africa. This find expands the fossil record originally reported from a different chamber of the cave in 2015 by Prof. Lee Berger.

The details of the 2015 discovery were published in two papers from the research team. The fossil remains include one of the most complete skeletons of *H. naledi* and are dated between 236 000 and 335 000 years old. This means that *H. naledi* might have coexisted, for a period of time, with *Homo sapiens*, the species of modern humans. The cranial capacity of *H. naledi* is between 465 cm³ and 610 cm³.

Researchers from the University of the Witwatersrand, James Cook University in Australia and the University of Wisconsin, Madison, have not yet been able to date the fossils from the Lesedi Chamber. The team believes that the excavation of this new chamber provides further evidence that *H. naledi* deliberately buried its dead in these remote, hard-to-reach caves.



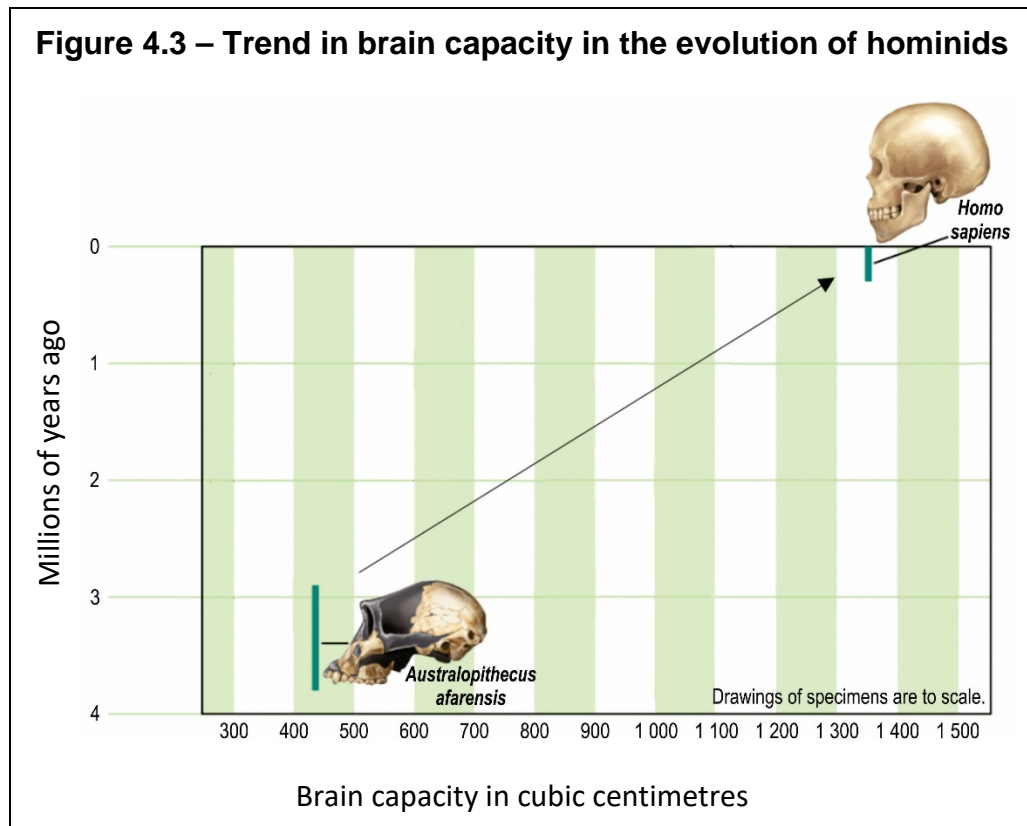
***Homo naledi* fossil**

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

[Image: <<https://www.nationalgeographic.com>>]

- 4.3.1 Describe THREE features of hominid fossils, like *Homo naledi*, that differ from that of a gorilla. (6)
- 4.3.2 Why is *Homo naledi* not considered a direct ancestor of modern humans? (1)
- 4.3.3 What evidence in the text shows that the information is scientifically reliable? (2)
- 4.3.4 Some scientists do not agree with the hypothesis that *Homo naledi* buried their dead. Discuss why debate about scientific ideas is important in the scientific community. (5)

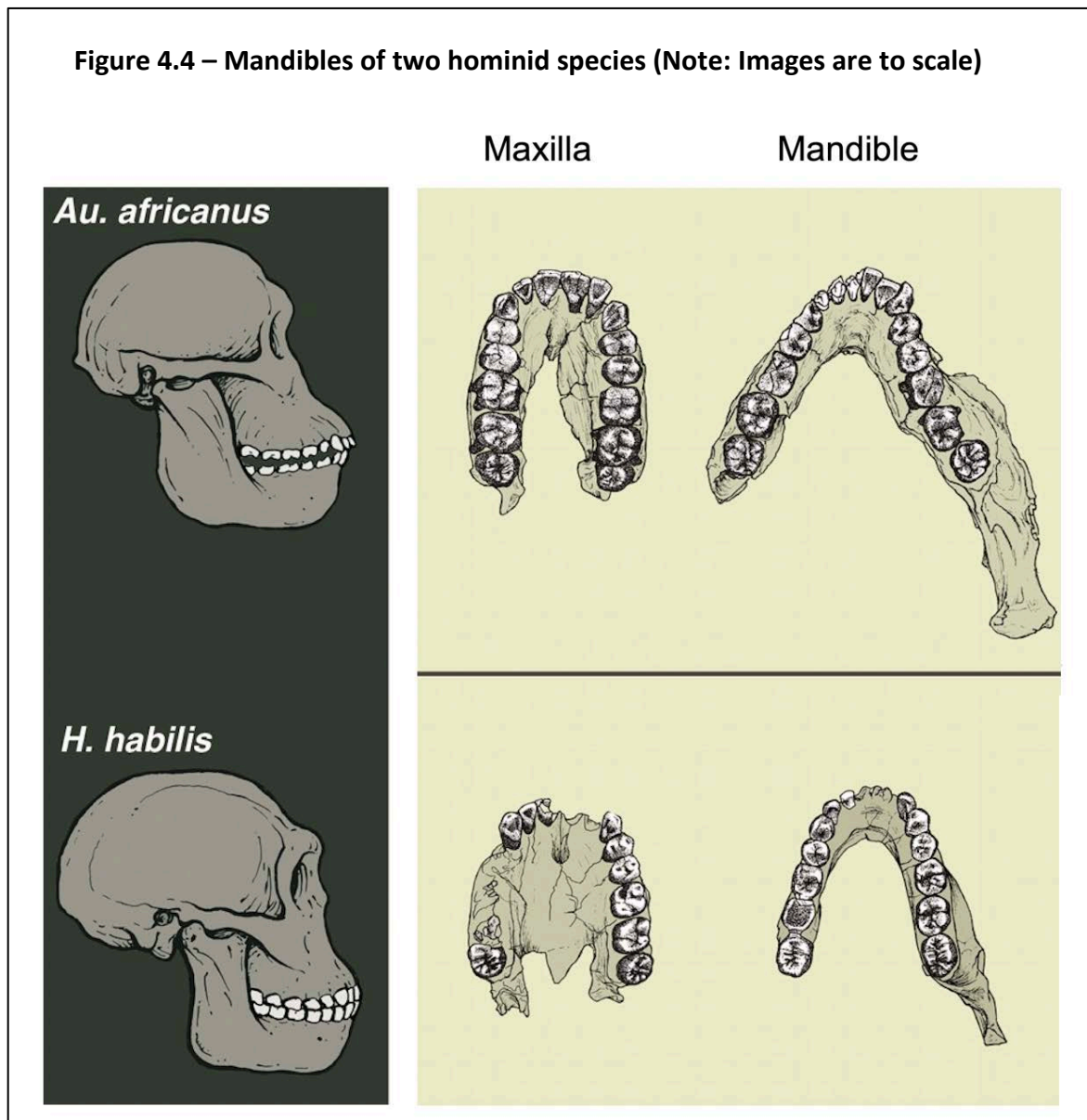
- 4.3.5 Figure 4.3 shows the trend in the brain size of hominids. Use Figure 4.3 and your own knowledge to explain how the *Homo naledi* discovery challenges the current understanding of hominid evolution.



[Adapted: <<https://www.britannica.com>>]

(3)

- 4.4 Study Figure 4.4 below and, based on the images, draw up a table of TWO differences between *Australopithecus africanus* and *Homo habilis*.



[Adapted: <<https://science.sciencemag.org>>]

(6)
[40]

Total: 200 marks