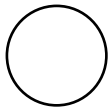




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TOTAL
MARKS

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Sequence
number

NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2025

LIFE SCIENCES: 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 46 pages. Please check that your question paper is complete.
2. Read the questions carefully.
3. **Answer ALL the questions on the question paper in the spaces provided and hand it in at the end of the examination. Remember to write your examination number in the space above.**
4. Use the total marks that can be awarded and the space provided for each question as an indication of the detail required.
5. It is in your own interest to write legibly and to present your work neatly.
6. Two blank pages (pages 43–44) are included at the end of the paper. If you run out of space for a question, use these pages. Clearly indicate the number of the question you are answering should you use this extra space. There are spare copies of graph paper on page 45 and page 46 for graphing questions.

FOR OFFICE USE ONLY: MARKER TO ENTER MARKS

	Q1	Q2	Q3	Q4	Total
Mark					
Marker Initial					
Moderated Mark					
Moderator Initial					
Question Total	80	40	40	40	200
Re-mark					
Initial					
Code					

QUESTION 1

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

COLUMN A**COLUMN B**

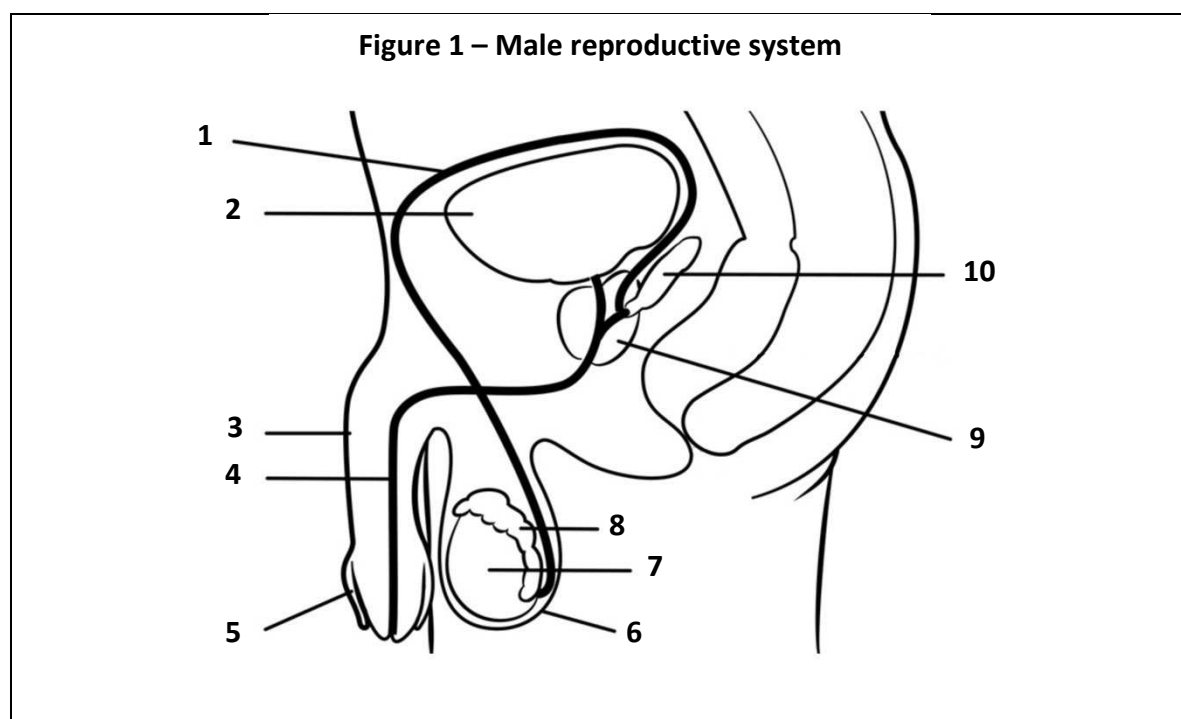
- | | | | |
|-----|--|---|-------------------|
| [] | The hormone that is secreted by the corpus luteum to maintain pregnancy. | A | Menstruation |
| [] | The process of fusion between a sperm cell and an ovum. | B | Ovulation |
| [] | The cell formed from a fertilised ovum/egg cell. | C | Graafian follicle |
| [] | The shedding of the endometrium. | D | LH |
| [] | The structure formed from a follicle in an ovary after it has released an ovum into the oviduct. | E | FSH |
| [] | A hormone that triggers ovulation. | F | Corpus luteum |
| [] | A hormone that stimulates follicle development in the ovary. | G | Puberty |
| [] | The early developmental stage of an animal during pregnancy. | H | Progesterone |
| [] | The time period where sexual maturity is established in humans. | I | Zygote |
| [] | The release of an ovum into the oviduct. | J | Fertilisation |
| | | K | Embryo |

(10)

- 1.2 Five multiple-choice questions follow. Choose the most correct option for each question and write the letter of your choice in the space provided in the table below.

Question	1.2.1	1.2.2	1.2.3	1.2.4	1.2.5
Answer					

Questions 1.2.1 to 1.2.3 are based on Figure 1 below of the male reproductive system.



[Adapted: <https://o.quizlet.com/NVkkVHOZbRvSVvAYnAyFiw_b.jpg>]

- 1.2.1 Which numbered part in Figure 1 contains the seminiferous tubules?

- A 6
- B 7
- C 8
- D 9

(1)

- 1.2.2 Which numbered part(s) secrete(s) substances to make up the liquid part of semen (excluding sperm cells)?

- A 7 only
- B 9 only
- C 9 and 10
- D 7, 9 and 10

(1)

- 1.2.3 Which option correctly identifies the number and name of the part in Figure 1 that is cut in the procedure called a circumcision?

	Number of part	Name of part
A	1	Sperm duct
B	1	Foreskin
C	5	Sperm duct
D	5	Foreskin

(1)

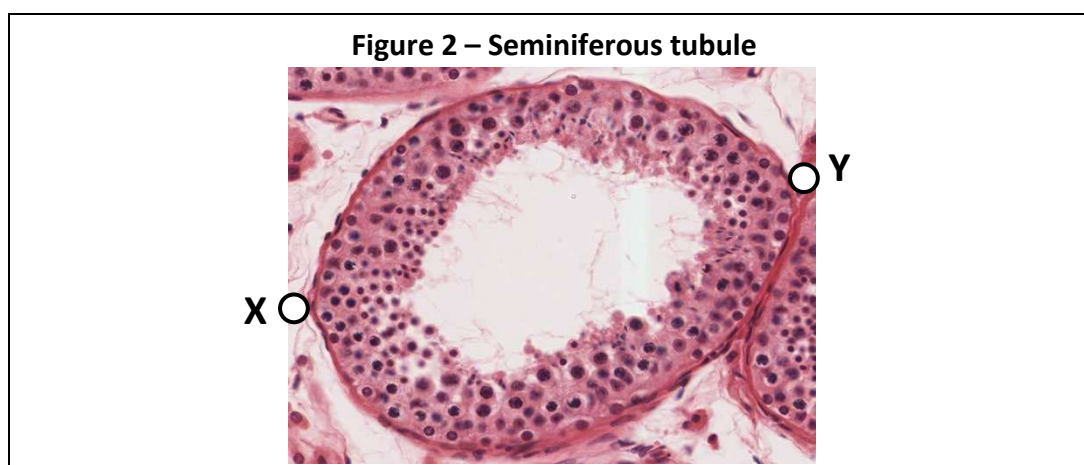
- 1.2.4 A hormone secreted by the testes in males has a negative feedback effect on the secretion of FSH in males.

What will be the most likely effect of **increased** secretion of this hormone on a male's reproductive system?

- A Decreased spermatogenesis
- B Increased spermatogenesis
- C Decreased secretion of testosterone
- D Increased production of nutrients for sperm cells

(1)

- 1.2.5 Figure 2 shows an electron micrograph of a seminiferous tubule. The actual width of the tubule between X and Y is 190 μm . What is its magnification? Choose the range that provides the answer.



[Source: <<https://histology.medicine.umich.edu/sites/default/files/images/slides/6male.jpg>>]

- A 342 → 395 X
- B 190 → 200 X
- C 2,53 → 2,92 X
- D 0,34 → 0,39 X

(1)

1.3 A list of terms related to evolution is provided in the text box below.

List of terms

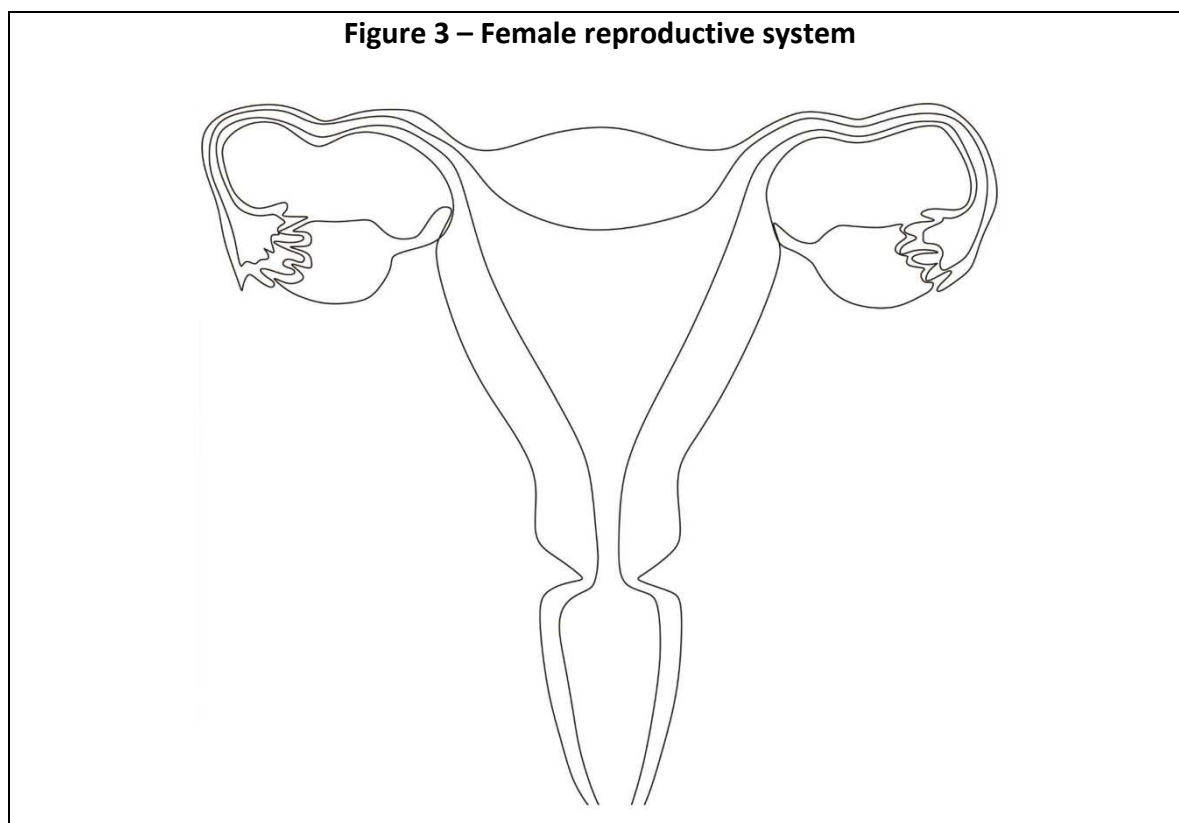
- Gene flow
- Homologous structures
- Biogeography
- Gradualism
- Punctuated equilibrium
- Founder effect
- Outbreeding
- Modification by descent

Select the most appropriate term from the list above that matches the example stated in the table. Write the correct term in the space provided in the table. A term may only be used once.

Example	Answer
The webbed feet of a frog and the webbed feet of a duck.	
A German Shepherd dog that is crossbred with a Golden Retriever dog.	
90% of beetles in a population have the gene for black colouring, and 10% have the gene for brown colouring. Over a period of time, the species changed, and later, brown beetles made up 70% of the population.	
Several species of a marine snail of the genus <i>Littorina</i> develop in a short time period after an extinction event.	
The prevalence of Huntington's disease in the South African Afrikaner population, who descended from a small group of the Dutch colonists in the 1600s.	
A bird carrying pollen from a flower of a plant species across a river to another population of the same flower species in a field over 100 kilometres away.	

(6)

- 1.4 Study Figure 3 of the female reproductive system below. Refer to it and your own knowledge to answer the questions that follow.



[Image: <<https://www.vecteezy.com/vector-art/16818780-continuous-line-art-drawing-of-female-reproductive-uterus>>]

- 1.4.1 On Figure 3 above, complete the following:

- (a) Draw in and label the endometrium. (1)
- (b) Table 1 below lists some contraceptive methods. Using the symbols for each contraceptive method shown in the table, draw the symbol on Figure 3 to show the correct placement of the contraceptive or where it acts/functions.

Table 1

Contraceptive Method	Symbol
Diaphragm	⌒
Intra-uterine device (IUD)	T
Contraceptive Pill	●

(3)

- 1.4.2 A tubal ligation, also known as 'tying the tubes', is a surgical procedure to prevent pregnancy in females. Explain why this procedure is a more reliable method of contraception than the contraceptive pill.

(4)

- 1.4.3 A 23-year-old woman would like to have a tubal ligation. Explain ONE reason why it is unethical for a doctor to perform a tubal ligation on the woman as a means of contraception.

(2)

- 1.5 Erwin Chargaff is a scientist who contributed to the field of genetics. He conducted experiments using DNA sequences from a number of different species. Table 2 below shows Chargaff's data.

Table 2 – Chargaff's data

Species	Percentage composition of nitrogenous bases			
	A	T	G	C
Human	31	31,5	19,1	18,4
Wheat	26,8	27,2	22,8	23,2
Rat	28,7	24,3	25,5	25,6

[Adapted: <<https://ib.bioninja.com.au>>]

- 1.5.1 Give the name of the nitrogenous base that is represented by A.

_____ (1)

- 1.5.2 State ONE similarity in the composition of the complementary nitrogenous bases in all the species shown in Table 2.

_____ (1)

- 1.5.3 What evidence in the data in Table 2 indicates that the DNA molecule is made up of two strands of nucleotides?

_____ (1)

- 1.5.4 If Chargaff had analysed RNA, state TWO differences in the data he would have observed in Table 2.

_____ (2)

1.5.5 Consider the list below of contributions by other scientists to the field of genetics:

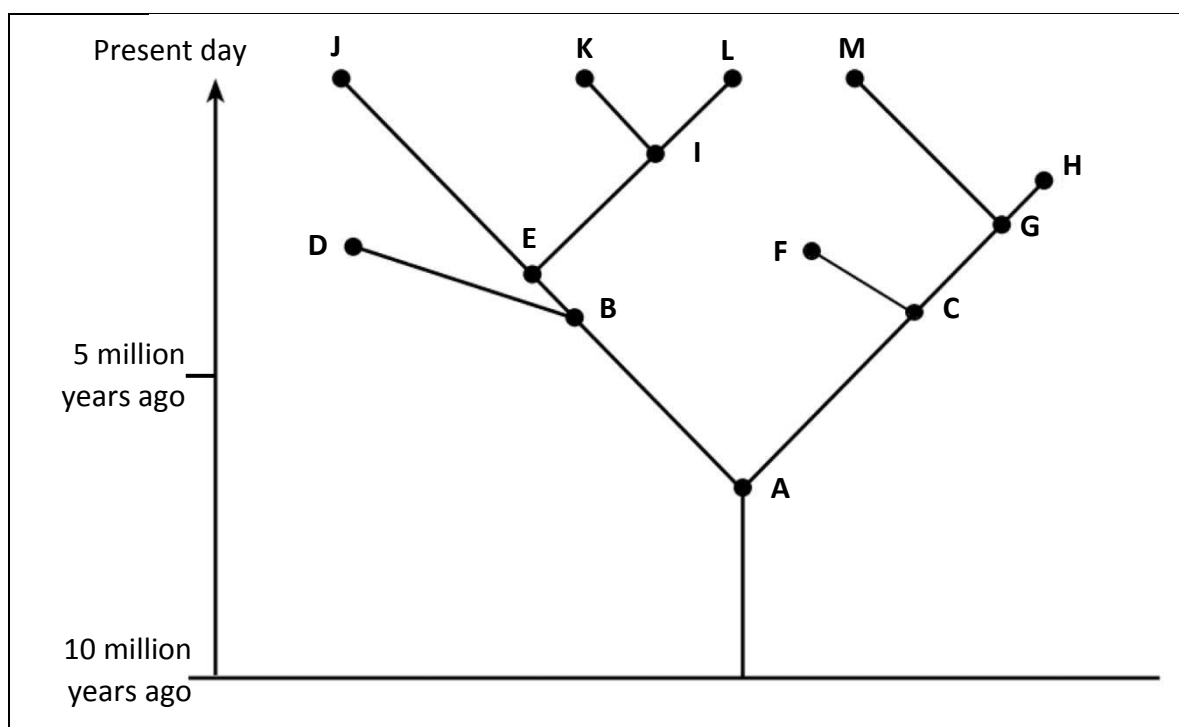
- A Constructed a model to accurately describe DNA structure.
- B Experimented on pea plants to formulate the laws of inheritance.
- C Made images of DNA using X-ray crystallography.

Fill in the following table by writing only the LETTER of the correct contribution made to genetics for each of the scientists named in the table below.

Name of scientist	Letter
Gregor Mendel	
Rosalind Franklin	
James Watson	

(3)

1.6 Study the evolutionary tree below and use it to answer the questions that follow.



[Source: <Examiner's own>]

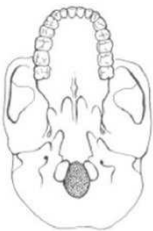
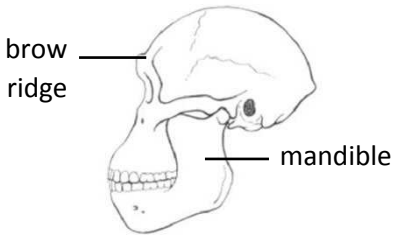
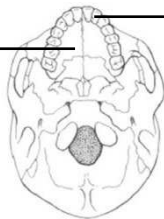
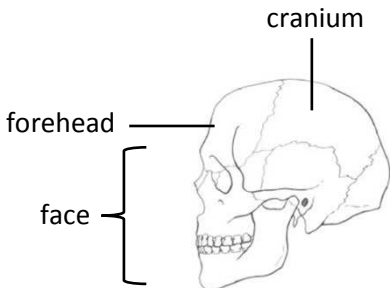
The statements in the table below refer to the evolutionary tree above.
For each statement, decide whether:

- A The statement is supported by the evolutionary tree.
B The statement is contradicted by the evolutionary tree.
C The statement is neither supported nor contradicted by the evolutionary tree.

	Statement	A, B or C
1.6.1	Species D and species F became extinct more than 5 million years ago.	
1.6.2	Species J and species K are more closely related than species L and species M.	
1.6.3	Species K and species L share the same most recent common ancestor.	
1.6.4	Convergent evolution is evident between species M and species H.	
1.6.5	Climate change is the cause of divergence between species K and species L.	
1.6.6	Species M and species H are still alive today and are descendants of species A.	

(6)

- 1.7 The table below shows images of fossilised skulls of two different extinct genera of hominids – genus *Australopithecus* and genus *Homo*. Study the images and answer the questions that follow. Note: the skulls are not drawn to scale.

Hominid	View of skull from underneath	Side view of skull
A	Dated: 3 – 4 mya 	 brow ridge mandible
B	Dated: 0 – 0,5 mya  palate teeth	 cranium forehead face

[Adapted: <<https://pbs.twimg.com/media/E8pQ41vWUAIxoeq.jpg>>]

- 1.7.1 Label the foramen magnum on the skull of hominid A in the table above. (1)

- 1.7.2 (a) Describe the position of the foramen magnum in hominid B compared to hominid A.

(1)

- (b) How does the position of the foramen magnum indicate that hominid B habitually walked upright on two legs?

(2)

1.7.3 (a) Provide the term that describes 'habitually walking upright on two legs'.

_____ (1)

(b) Describe and explain TWO advantages that walking upright afforded to hominids.

_____ (4)

1.7.4 Write in the genus name of the hominid to which each skull belongs:

Skull	Genus of hominid
A	
B	

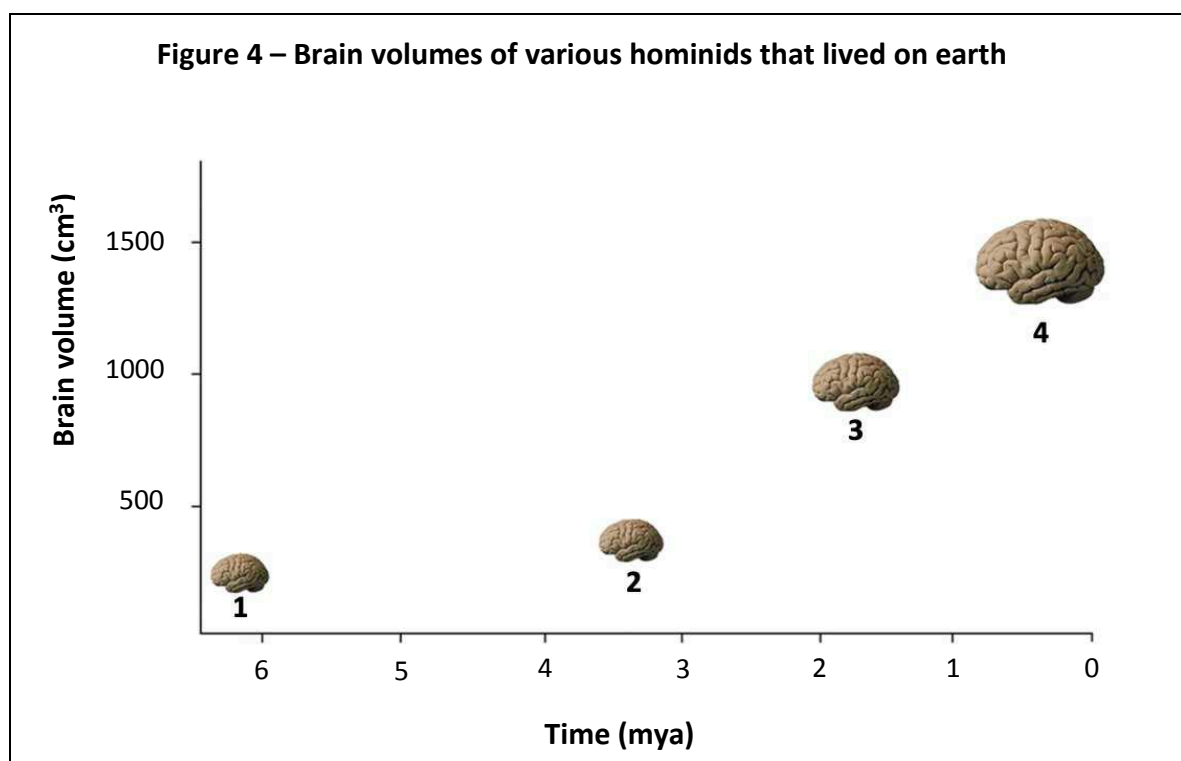
(2)

1.7.5 Construct a table of THREE differences, other than foramen magnum position, between the skulls of hominid A and hominid B.

Use the labelled features to guide you.
No table heading is required.

(4)

- 1.8 Study Figure 4 below which shows the brain volume of various extinct hominid species (numbers 1 to 4) and when they existed in the timeline. Use Figure 4, skulls A and B on page 11 and your own knowledge to answer the questions that follow.



[Adapted: < https://www.researchgate.net/figure/A-crude-plot-of-average-hominid-brain-sizes-over-time-Although-after-an-initial_fig2_265057343>]

- 1.8.1 Select the most appropriate brain in Figure 4 (numbered 1 to 4) that best matches with the skulls shown on page 11. Write only the correct number for each skull.

Skull	Number
A	
B	

(2)

- 1.8.2 The recent hominid discovery in South Africa of *Homo naledi* showed it had a brain volume of between 460–510 cm³. *Homo naledi* is not drawn on Figure 4. *Homo naledi* is also dated to have lived around 300 000 years ago.

Draw an X on Figure 4 to indicate where the brain of *Homo naledi* would be correctly placed.

(2)

1.8.3 The earliest evidence of campfires is associated with a hominid to which brain number 3 in Figure 4 belongs. Fossils of this hominid have been discovered in Africa and Asia.

- (a) State TWO advantages that a campfire would provide for a hominid.

(2)

- (b) Provide the scientific name of the hominid to which brain number 3 belongs.

(1)

- (c) The hominid you identified in 1.8.3 (b) above was responsible for the dispersion of modern humans across the world. There are two possible explanations to explain this migration into Europe. Name and describe these two hypotheses for human population migration.

Hypothesis 1:

Hypothesis 2:

(4)

- (d) Mitochondrial DNA is used as a line of evidence to explain human population movement. Explain why mtDNA is useful as a line of evidence.

(2)

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

Blombos Cave is a famous archaeological site on the coast in the Western Cape of South Africa. The cave is located in a private nature reserve that is not open to the public.

Blombos Cave is located on a cliff, 34,5 metres above sea level and about 100 metres from the shore. The cave has a single main accessible chamber with a floor area of 39 m². To one side, the cave floor expands into an antechamber, though its full extent is unknown due to sand filling it. As of 2011, about 19,5 m² of the cave has been excavated.

Archaeologists have discovered some of the earliest evidence of modern human behaviour here, including symbolism, advanced thinking, and technological innovation. The cave was occupied during the Middle Stone Age, between 100 000 and 70 000 years ago, although earlier human activity might still be uncovered as excavations continue. The cave was first excavated in 1992, but the site is still being explored and may take another decade to fully study.

Significant discoveries include:

- A piece of engraved ochre, the earliest known of its kind, dated to 75 000 years ago.
- The oldest known drawing, resembling a hashtag, dated to 73 000 years ago.
- Some of the earliest evidence of body decoration, including perforated shell beads.

Blombos Cave was declared a Provincial Heritage Site in 2015 and is on UNESCO's proposed list for World Heritage status, expected to be officially recognised in the near future.

[Adapted: <<https://www.sahistory.org.za>>]

- 1.9.1 Give ONE reason why caves are often suitable locations for archaeologists to study aspects of human evolution.

(1)

- 1.9.2 The text states that the site is still being explored and may take another decade to study fully. Suggest THREE reasons why it will take so long to study the Blombos Cave and its archaeological evidence.

(3)

- 1.9.3 The Blombos Cave is not open to the public. Why is this scientifically important?

(2)

- 1.9.4 Ochre and bead artefacts were found in Blombos Cave. Propose a reason why the use of ochre and beads could be seen as an advantage in the cultural evolution of early humans.

(1)
[80]

QUESTION 2

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

The Bonsmara cattle breed is a prime example of artificial selection. It was developed in South Africa between 1937 and 1963 as a scientific experiment of Professor Jan Bonsma at Mara Research Station. The breed originated to meet the specific needs of farmers in harsh environmental conditions in South Africa by crossbreeding local African cattle like Afrikaners, with European breeds like Hereford and Shorthorn. Bonsma aimed to combine the desirable traits of these breeds to produce a cattle breed that is adaptable to the heat of a subtropical climate and with a high meat production.

Figure 5 – Traits in the three cattle breeds that are used to breed the Bonsmara

Afrikaner	Hereford	Shorthorn
 • Tender meat • Heat tolerant • Tick resistant • Some difficulties in calving	 • Excellent mothers • High fertility rate • Fast growing • High muscle mass and meat quality	 • High feed efficiency (converts food into muscle) • Calm and docile • Easy calving ability • High muscle mass

Bonsmara cattle grow fast and require less feed to gain weight, making them economically valuable for beef production.



A Bonsmara bull

The ease of calving and increased fertility in Bonsmara also allows for more productive herds.

The excellent traits of the Bonsmara, especially its adaptability to climates, are known worldwide. These animals have adapted to areas where the temperature drops below 0°C and to areas that also have high humidity and dry heat of above 50°C.

[Adapted: <<https://www.thebeefsite.com>> ; <<https://www.thecattlesite.com>>
Images: <https://upload.wikimedia.org/wikipedia/commons>]

2.1.1 What is meant by the term artificial selection?

(2)

2.1.2 State TWO appropriate ethical guidelines for performing crossbreeding experiments such as those done by Professor Jan Bonsma.

(2)

2.1.3 Suggest why the following traits from the cattle breeds used in the crossbreeding to create the Bonsmara were selected by Jan Bonsma.

(a) Heat tolerance: _____

_____ (1)

(b) High muscle mass: _____

_____ (1)

(c) Tick resistance: _____

_____ (1)

- 2.1.4 State FOUR reasons why the Bonsmara breed are regarded as an example of hybrid vigour.

(4)

- 2.1.5 During the process of artificial selection and breeding experiments, there is a risk of inbreeding. Explain why inbreeding can limit the potential for evolution in a species.

(3)

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

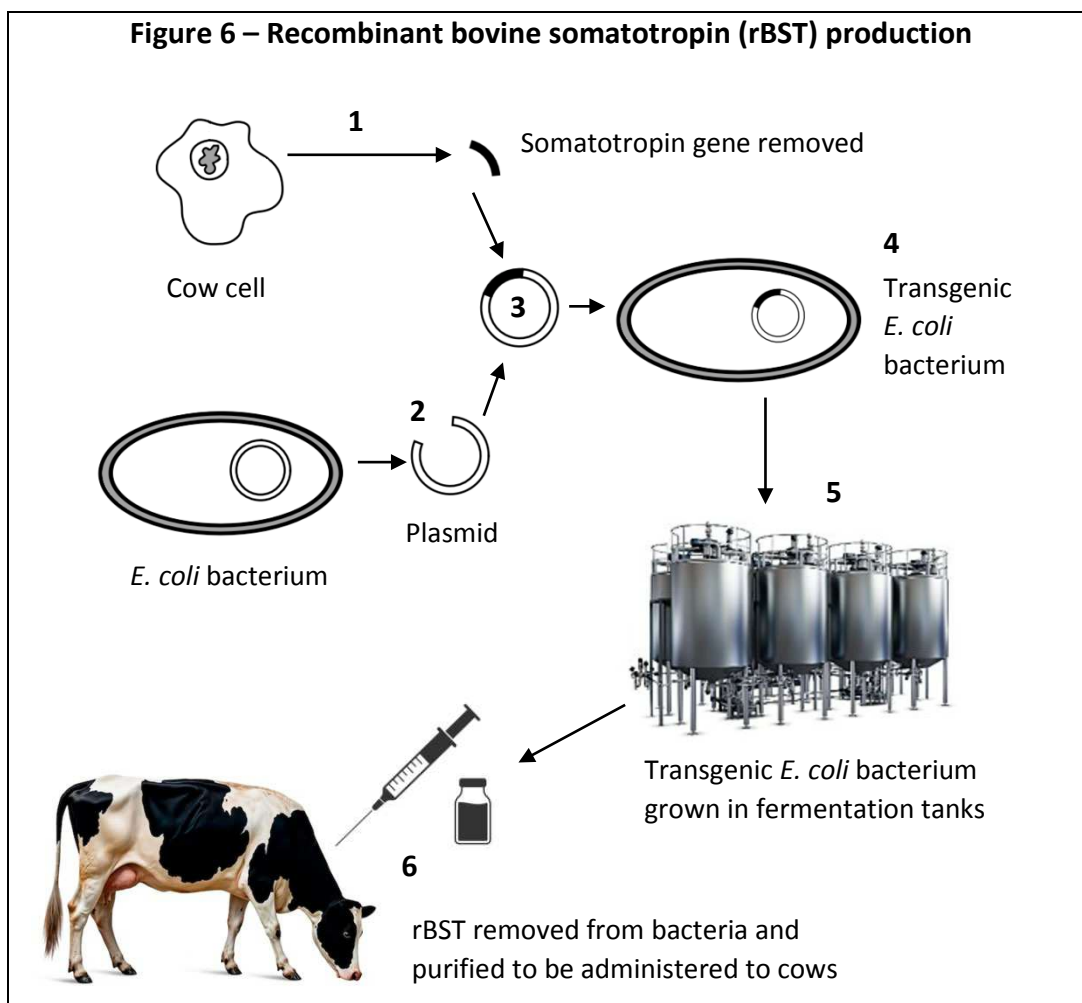
Livestock are often treated with hormones to enhance growth, reproduction, and milk production. Growth hormones are used to promote faster weight gain and improve feed efficiency, allowing animals to reach market size more quickly. In dairy cattle, hormones like recombinant bovine somatotropin (rBST) are used to boost milk production. rBST is a type of growth hormone (GH).

[Adapted: <<https://www.fao.org/4/x6533e/x6533e01.htm>>]

2.2.1 List TWO features of a hormone.

(2)

2.2.2 Figure 6 below represents the process of how rBST is manufactured using *Escherichia coli* (*E. coli*) in recombinant DNA technology.



[Source: <Examiner's own> and <<https://www.freepik.com>>]

- (a) Why is the *E. coli* bacterium at step 4 considered transgenic?

(2)

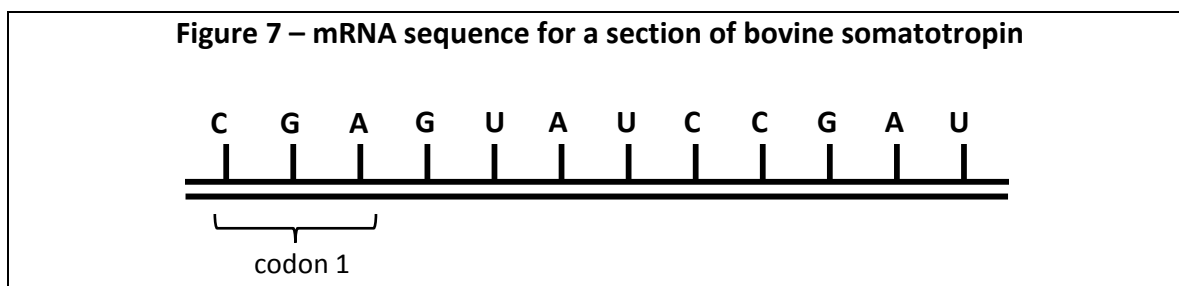
- (b) Describe fully what occurs during the numbered steps to produce the transgenic *E.coli* bacterium.

(5)

- (c) Suggest why consumers might object to drinking milk or eating meat from cows who have been treated with rBST.

(2)

- 2.3 Bovine somatotropin is a protein hormone. Figure 7 below shows a section of the mRNA sequence that is used in the synthesis of bovine somatotropin.



- 2.3.1 Name the stage of protein synthesis that forms mRNA.

_____ (1)

- 2.3.2 Complete the table below to show the DNA sequence and the tRNA anticodon for codon 1 of mRNA above.

DNA sequence	
tRNA anticodon	

(2)

- 2.3.3 Explain the consequence of a mutation that deletes the base A from the mRNA codon 1.

 _____ (2)

- 2.3.4 More mRNA molecules are synthesised in cells than tRNA molecules. Suggest a reason for this.

 _____ (2)

2.3.5 Ribosomes are organelles that are involved in protein synthesis. Describe the events of protein synthesis that occur in the ribosomes.

(2)

2.4 Study the information in the table below.

Column 1 describes the **location** of endocrine glands.

Column 2 lists the **functions** of some hormones from these endocrine glands.

Column 1	Column 2
A In the pancreas.	1 Control metabolism.
B In the neck.	2 Promotes bonding between mother and child.
C A gland below the hypothalamus in the brain.	3 Decreases blood glucose levels.
D On top of the kidneys.	4 Converts glycogen into glucose.
	5 Stimulates growth of bones and muscles.
	6 Increases the rate of breathing.

Select the appropriate **LETTER** from Column 1 and the matching **NUMBER** from Column 2 that describes the hormone listed in the table.

Write your answer in the space provided in the table below. (A letter and number can only be used once).

Hormone	LETTER from Column 1	NUMBER from Column 2
Oxytocin		
Adrenalin		
Glucagon		

(6)
[40]

QUESTION 3

- 3.1 Two Grade 12 learners were asked to draw a diagram to show the process of crossing over during meiosis. They used the key shown below.

Study the diagrams of Learner A and Learner B and use them and your own knowledge to answer the questions that follow.

Key:



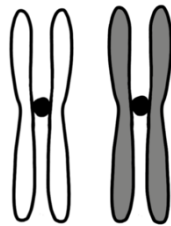
Paternal chromosome



Maternal chromosome

Learner A

Homologous chromosome pair

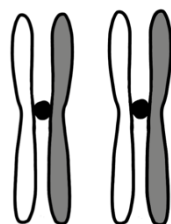


Crossing over



Learner B

Homologous chromosome pair



Crossing over



[Images: <Examiner's own>]

- 3.1.1 Describe what is meant by crossing over.

(2)

3.1.2 Name the phase when crossing over takes place in meiosis.

(1)

3.1.3 Evaluate which learner, A or B, represented the process at the start of crossing over correctly. Explain your reasoning fully by referring to the diagrams of **both** Learner A and Learner B.

(5)

- 3.2 Read the information below on Edwards syndrome and answer the questions that follow.

Edwards syndrome

Edwards syndrome (also known as trisomy 18) is a very severe genetic condition. It is caused by abnormal meiosis which results in a sex cell having two copies of chromosome 18. The condition is most commonly diagnosed in pregnancy. The majority of trisomy 18 pregnancies do not survive full term due to complications. The survival rate of those children who are born with trisomy 18 is extremely low, with very few surviving past the first year.

A study conducted on the incidence of trisomy 18 pregnancies indicated that it is linked to maternal age. The study produced the following results:

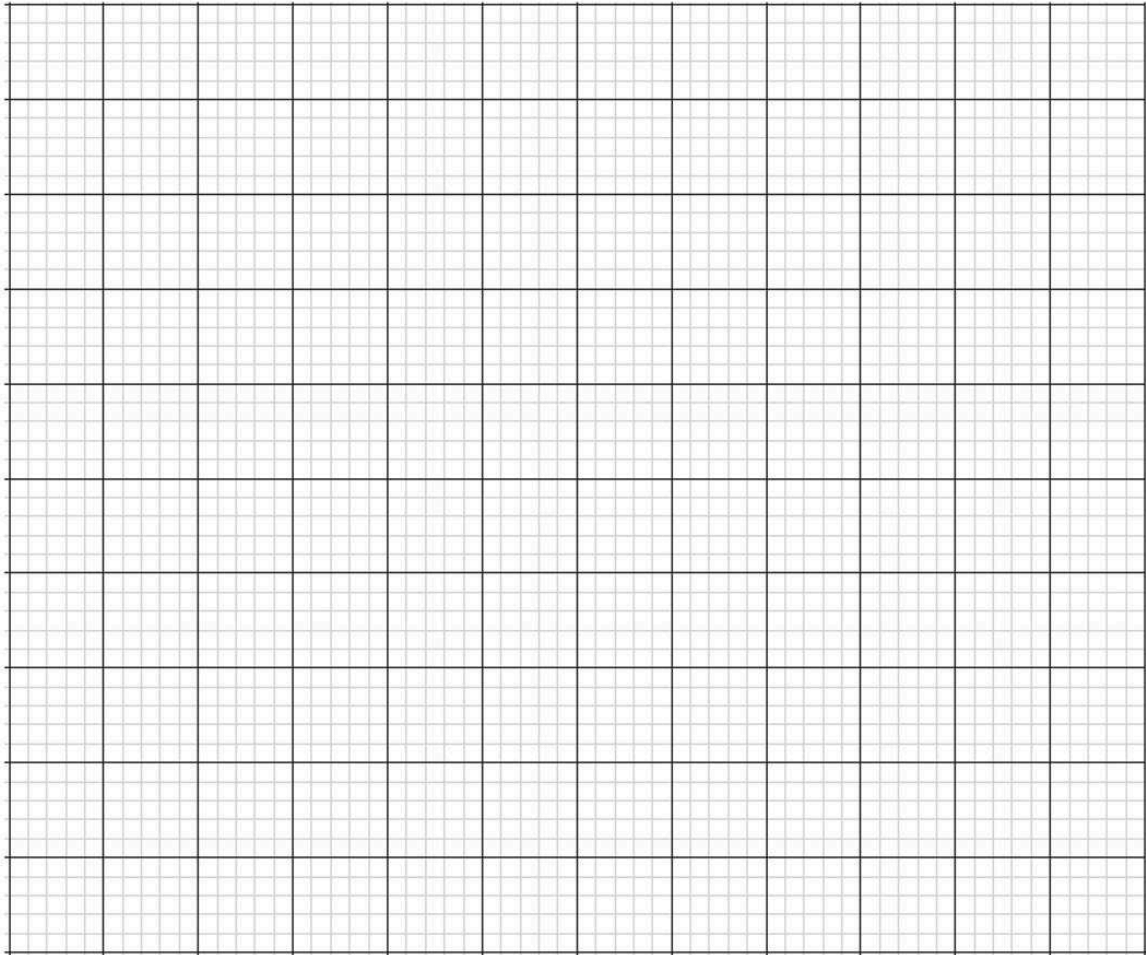
- Maternal age group between 25–29 years had an incidence rate of 0,4 (per 1 000 pregnancies)
- Maternal age group between 30–34 years and 35–39 years both had an incidence rate of 1,8 (per 1 000 pregnancies)
- Maternal age group between 40–44 years had an incidence rate of 5,4 (per 1 000 pregnancies)
- Maternal age group between 45–49 years had an incidence rate of 37 (per 1 000 pregnancies)
- There was no data on the incidence rate for the maternal age group for 50 years and older

[Adapted: Kim Y.J *et al.* 2013. Maternal age-specific rates of fetal chromosomal abnormalities in Korean pregnant women of advanced maternal age. *Obstet Gynecol Sci.* 56(3):160-166. <<https://pmc.ncbi.nlm.nih.gov>>; <<https://my.clevelandclinic.org/health/diseases/22172-edwards-syndrome>>]

- 3.2.1 Identify the organ where a sex cell is produced when meiosis takes place in **females**.

(1)

- 3.2.2 Plot a suitable graph on the graph grid provided below of the results from the study on the incidence of trisomy 18 pregnancies.



(8)

- 3.2.3 Suggest a hypothesis that could explain the observed trend shown by the data for the study on page 28.

(3)

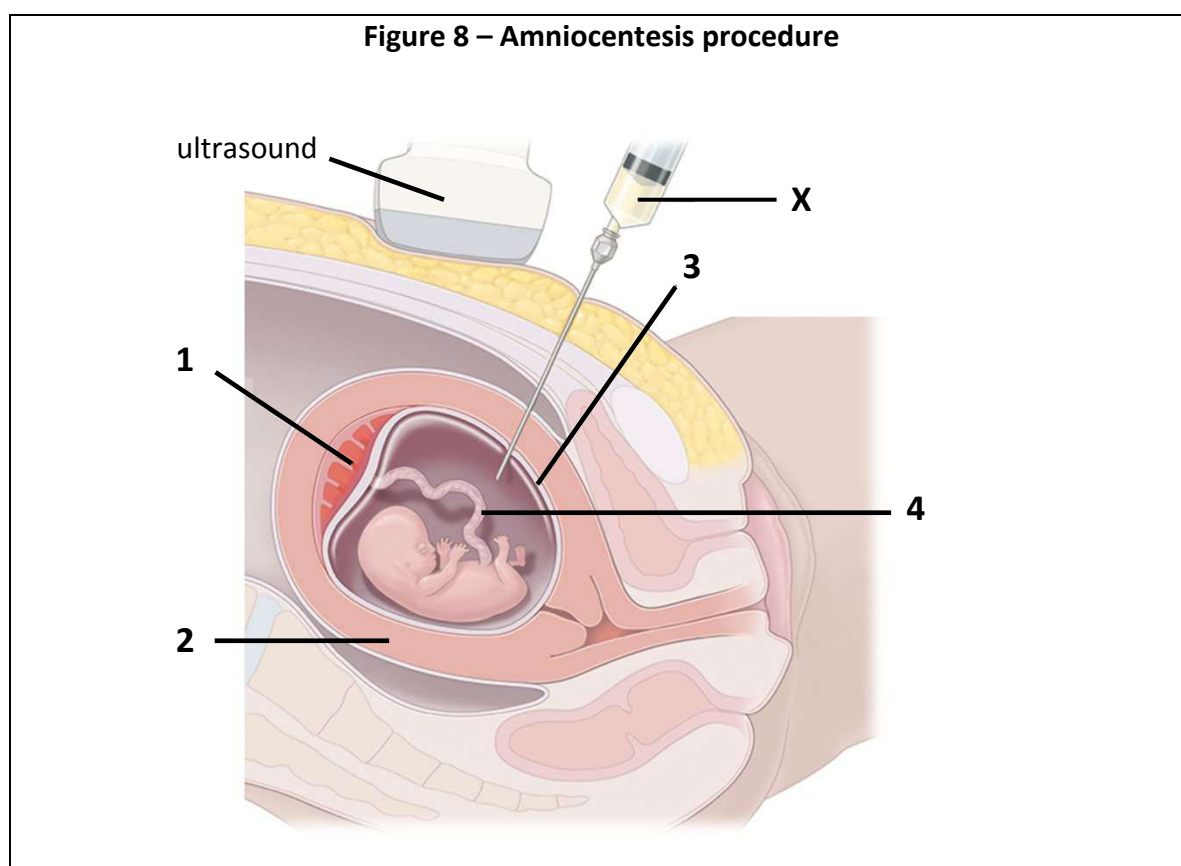
3.2.4 Suggest why there is no data for the incidence rate of trisomy 18 for women over 50 years of age.

(2)

3.2.5 Name another example of a trisomy disorder that you have studied.

(1)

3.3 Genetic testing is used to diagnose a trisomy pregnancy. Foetal cells are collected using a procedure called amniocentesis, which is shown in Figure 8. A syringe needle is inserted to extract some of the fluid around the foetus. A karyotype for the foetus is produced from the foetal cells found in the fluid and analysed to determine if there is a chromosomal abnormality. Amniocentesis is usually done between weeks 14 and 20 of pregnancy. Amniocentesis done before week 14 of pregnancy has a higher risk of complications, such as a miscarriage.



[Adapted: <https://www.babycenter.com/pregnancy/health-and-safety/amniocentesis_327>]

3.3.1 On Figure 8, label the part of the female reproductive system that is also known as the birth canal. (2)

3.3.2 A liquid (labelled X in Figure 8) is drawn up into the syringe during the amniocentesis procedure.

(a) State the name of this liquid X.

_____ (1)

(b) Explain ONE way how liquid X protects the foetus during pregnancy.

_____ (2)

3.3.3 Suggest why the process of amniocentesis in an early pregnancy, before week 14, may carry a high risk of miscarriage. In your answer refer to specific names and numbered parts in Figure 8 to help you answer the question.

_____ (4)

3.3.4 Structure 4, in Figure 8, contains blood vessels. Complete the table below.

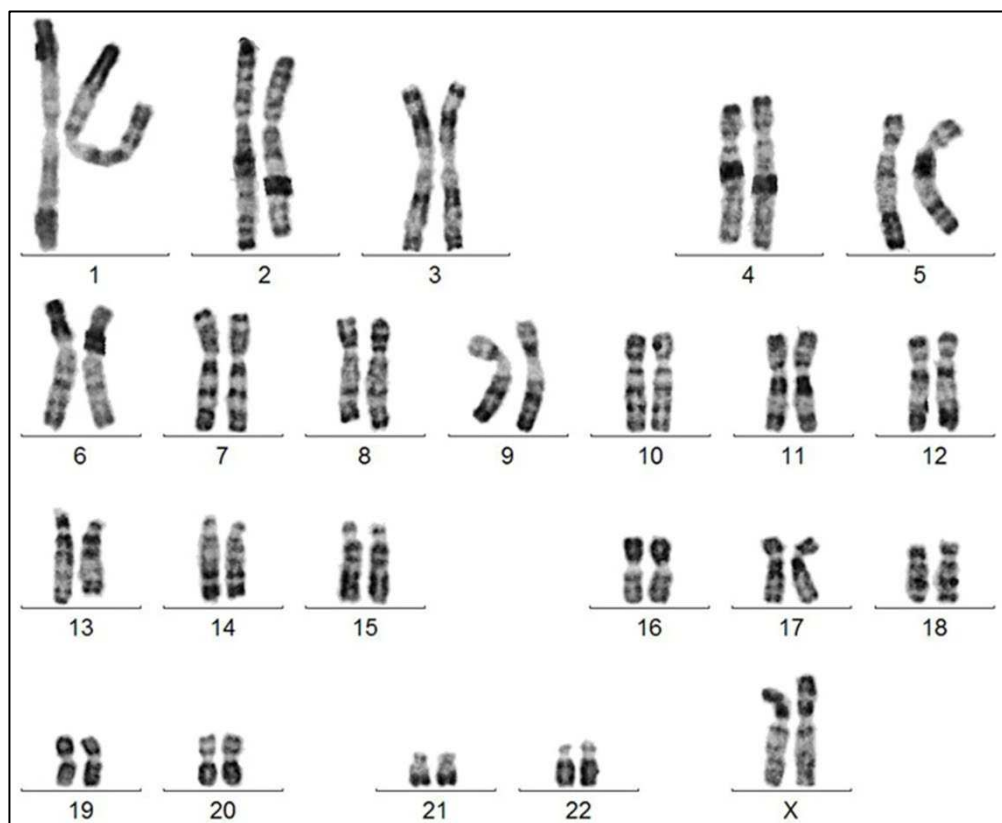
- Provide a heading that identifies structure 4.
- Name the type of blood vessels found in structure 4.
- State a function of each blood vessel found in structure 4.

Heading: _____

Name of blood vessel in structure 4	Function of the blood vessel in structure 4

(4)

3.3.5 A karyotype of a normal healthy foetus is shown below.



[Source: <<https://www.ucsfbenioffchildrens.org>>]

- (a) Change the karyotype above to accurately represent a trisomy 18 karyotype by drawing in the extra chromosome(s) on the karyotype. (2)
- (b) Does the karyotype indicate a male or a female foetus? Give a reason for your answer.

(2)
[40]

QUESTION 4

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

Parus major, a bird commonly known as the great tit, has a black head and neck, white cheeks, olive upperparts and yellow underparts. The feather colour and pattern of the female is similar to that of the male except that the colours overall are duller. The colour of the male bird's breast has been shown to correlate with stronger sperm, and is one way that the male demonstrates his reproductive superiority to females.



Figure 9 – The great tit (*Parus major*).

Higher levels of *carotenoids increase the intensity of the yellow of the breast colour. Carotenoids cannot be synthesised by the bird and have to be obtained from food. The width of the male's ventral stripe, which varies with each individual, is selected by females. Females select males with brighter breasts and wider stripes.

Parus major are typically **monogamous breeders, although extra-pair copulations are frequent. One study in Germany found that 40% of nests contained some offspring fathered by parents other than the breeding male and that 8,5% of all chicks were the result of extra-pair copulations. During copulation, the male deposits sperm into the female's ***cloaca, during which the egg is fertilised inside the female.

Great tits usually nest in a hole in a tree. The female lays around 12 eggs and incubates them alone, although both parents raise the chicks. In most years the pair will raise two broods.

Glossary:

*carotenoids – a yellow pigment in fruit and vegetables

**monogamous – having only one mate at a time

***cloaca – a chamber into which the reproductive tract opens

[Adapted: <https://app.birda.org/species-guide/23406/Great_Tit>; <Strohbach, S *et al* (1998). 'Extrapair paternity in the great tit (*Parus major*): a test of the 'good genes' hypothesis'. *Behavioral Ecology*. 9 (4): 388–396. doi:10.1093/beheco/9.4.388>;

Image: <<https://pixabay.com/photos/great-tit-bird-forest-nature-4061902>>]

4.1.1 Explain why access to healthy food sources is important for the male *Parus major* birds to ensure reproductive success.

(3)

- 4.1.2 The table below shows two items (numbered 1 and 2) in the first column. Decide which item(s) describes the *Parus major* birds.

Write down your choice in the space provided in the 'answer' column, making use of the following codes:

- A** Only Item 1 is true of *Parus major* birds.
B Only Item 2 is true of *Parus major* birds.
C Both Items 1 and 2 are true of *Parus major* birds.
D Neither Item 1 nor 2 is true of *Parus major* birds.

	Item	Answer
(a)	1. <i>Parus major</i> is viviparous. 2. <i>Parus major</i> is ovoviviparous.	
(b)	1. Parental care present. 2. Parental care absent.	
(c)	1. Monogamous breeding pairs are common in <i>Parus major</i> . 2. Breeding outside of the <i>Parus major</i> monogamous pairs is evident.	

(3)

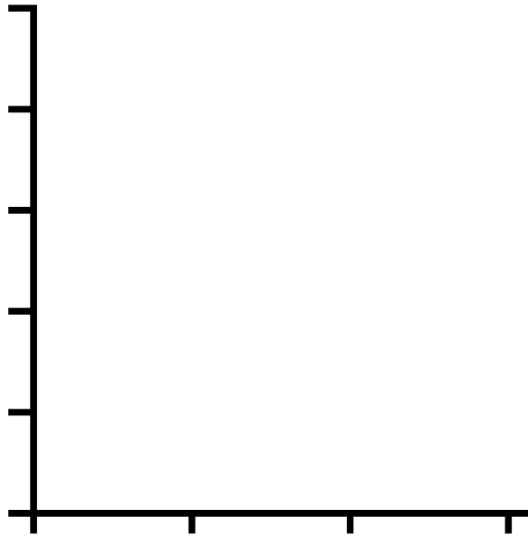
- 4.1.3 Identify a reproductive strategy of *Parus major* described in the text and explain how this reproductive strategy can increase its reproductive success.

(3)

- 4.1.4 The average life span of the *Parus major* bird is around 3 years. Mortality (death rate) is around 50% within the first month and declines at a relatively constant rate through its entire life.

Sketch the appropriate survivorship curve for the *Parus major* bird species on the axes provided below. Include the following on the axes:

- Suitable scale
- Labels for the axes



(4)

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

A new example of rapid evolution occurring is evident in *Parus major* bird species, found across Europe and the United Kingdom (see Figure 10).

The population of *Parus major* in England (Population A) have evolved longer beaks than the populations of *Parus major* found in the Netherlands in Europe (Populations B and C). Measuring museum specimens revealed the birds in England had slightly longer beaks – a difference of half a millimeter. Ecological data from living birds in Population A showed that over the past 26 years, their beaks have lengthened about a tenth of a millimeter.

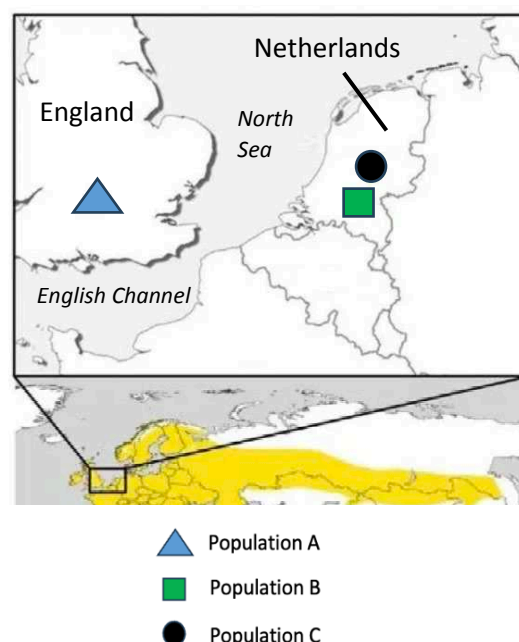


Figure 10 – Various populations and range of *Parus major*.



Figure 11 – Birds feeding at a bird feeder.

Scientists believe a possible reason for this difference is due to the widespread use of bird feeders in the gardens of England. A variety of different types of bird feeders are available for sale. A popular bird feeder used has the structure where the access points for the seed are quite deep. There is no significant difference in the birds' natural diet (which includes insects, berries and seeds) between the populations in England and across Europe.

[Adapted: <<https://www.forbes.com/sites/grrlscientist/2017/11/30/bird-feeders-drive-evolution-of-longer-beaks-in-british-tits>>;

Figure 11: <<https://www.ecocongregationscotland.org>>]

4.2.1 What is the meaning of the term species?

(3)

- 4.2.5 Biologists hypothesise that Population A of *Parus major* will become a separate species from the Populations B and C in the future. Explain why this hypothesis is valid.

(2)

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

Scientists analysed the genome of the *Parus major* birds. They determined that beak length is polygenic. But one particular gene affecting beak length was under strong selection. This gene has two alleles, **D** and **d**. The **d** allele is associated with longer beak lengths and is found at a much higher frequency in the English population than in mainland European populations.

[Adapted: <<https://evolution.berkeley.edu/evo-news/a-new-story-of-birds-and-beaks>>]

- 4.3.1 For each statement below, write the term that is used in the text box above that matches the statement.

	Statement	Term
(a)	A contrasting version of a gene.	
(b)	Controlled by many genes.	

(2)

- 4.3.2 The allele 'd' for longer beak length is recessive. What is meant by the term recessive?

(1)

- 4.3.3 Breeding experiments involving the same pair of *Parus major* birds repeatedly showed that their offspring consisted of 50% long beaked and 50% short beaked individuals.

Use a Punnett diagram to show the genetic cross between this pair of *Parus major* birds to produce the offspring that were observed in the breeding experiment.

Your answer must include the following:

- Parental genotypes
- Punnett diagram
- Possible genotypes of the offspring

Use the following key in your answer:

- Short beaked – **D** and Long beaked – **d**

Parental genotypes: _____ × _____

Punnett diagram:

Possible offspring genotypes:

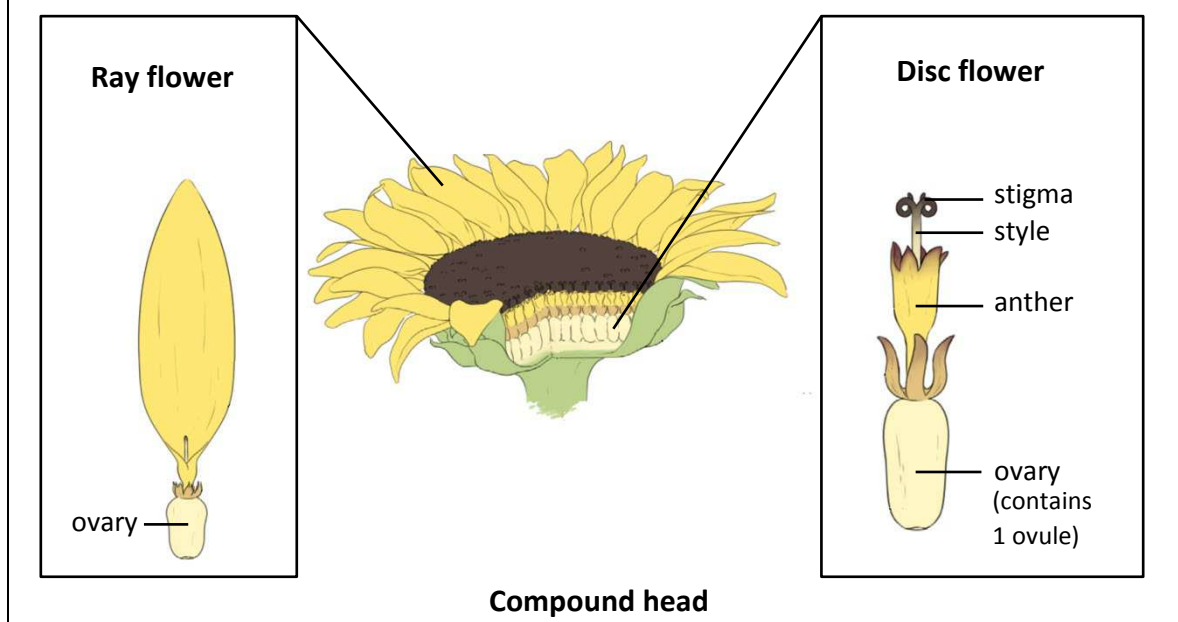
(5)

- 4.4 Sunflower seeds are a popular choice of seed that is included in the bird feed used in bird feeders. Read the following information on sunflowers and use it and your knowledge to answer the questions that follow.

The sunflower plant belongs to the Asteraceae family of flowering plant species. The defining characteristic of Asteraceae is its flower structure.

The sunflower is made up of two types of small flowers, and is known as a compound head. The two small flower types are ray flowers and disc flowers. The ray flowers are distributed around the head. The disc flowers form the centre of the disc and are complete (contain male and female parts) and there are many of these on one sunflower. If pollinated, the disc flowers go on to produce seeds.

Figure 12 – The sunflower structure



[Adapted: <<https://smmtc.org/plantofthemonth/images/AsterDrawing.png>>
<<https://www.grainsa.co.za>>
<<https://nuseed.com/eu/biology-of-sunflowers-uncovered>>]

- 4.4.1 The ray flowers are sterile and so do not produce gametes. Suggest a role that ray flowers play in sexual reproduction.

(1)

- 4.4.2 Name the male part of the flower that is labelled in Figure 12.

(1)

- 4.4.3 Construct a flow diagram to show the process of sexual reproduction from pollination until a seed is formed.

(5)
[40]

Total: 200 marks

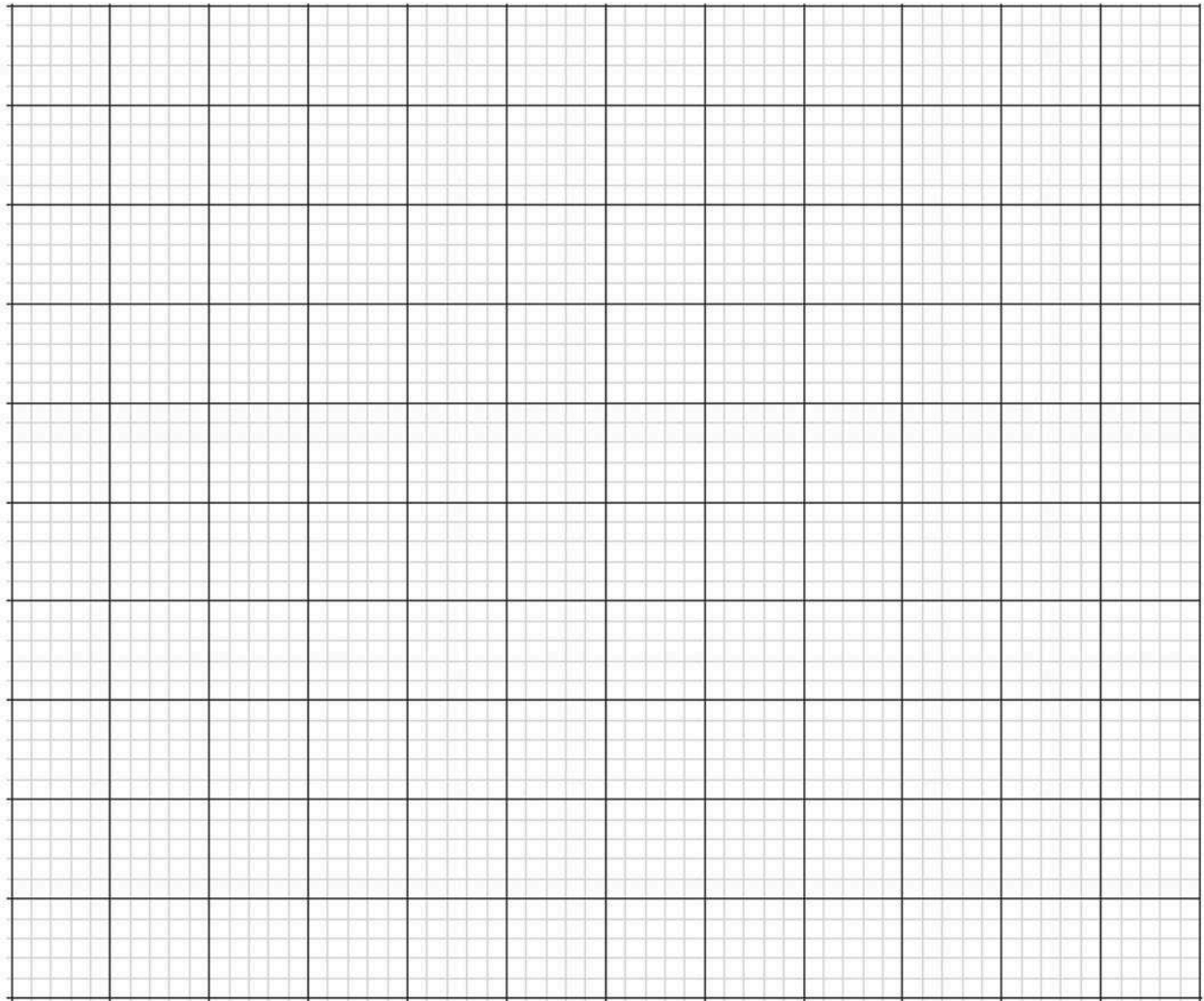
ADDITIONAL SPACE (ALL QUESTIONS)

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

[illegible]

[illegible]

QUESTION 3.2.2



(8)

QUESTION 4.1.4

