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Moderator: Ms Lyall and Mr Broeders

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Page 1 of 21

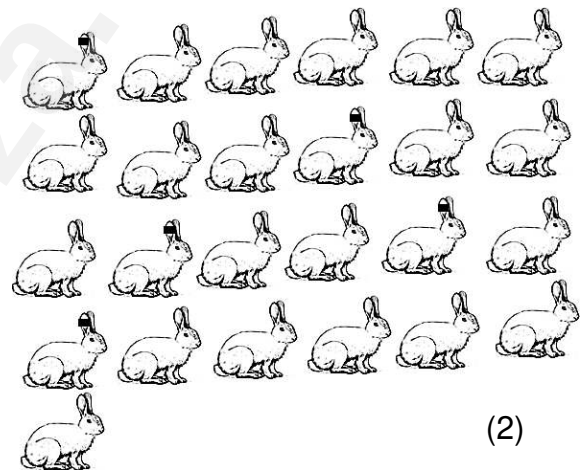
1.2 Five multiple-choice questions are given below. Choose the most correct option for each question and **write the letter** of your choice in the space provided in the table below.

QUESTION	1.2.1	1.2.2	1.2.3	1.2.4	1.2.5
ANSWER					

(8)

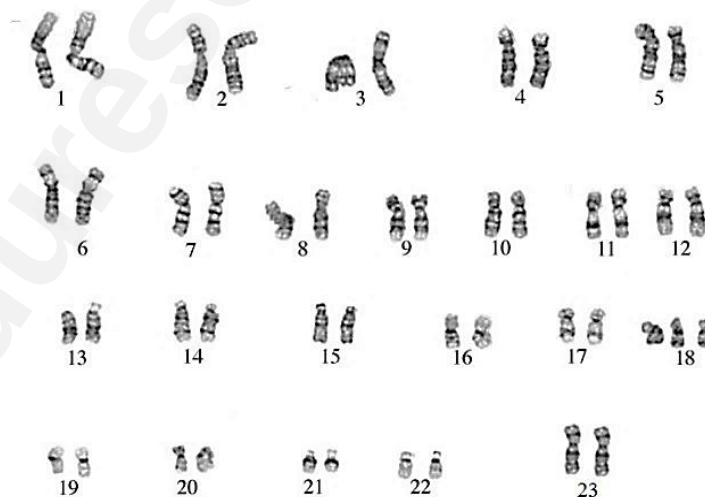
1.2.1 In an attempt to determine the size of a rabbit population, 15 rabbits were caught, and tags were attached to their ears. Two weeks later, a sample of 25 rabbits were re-captured from the same area. The diagram alongside shows the rabbits that were re-captured. The estimated population size can be calculated to be...

- A 75
- B 3
- C 8
- D 25



(2)

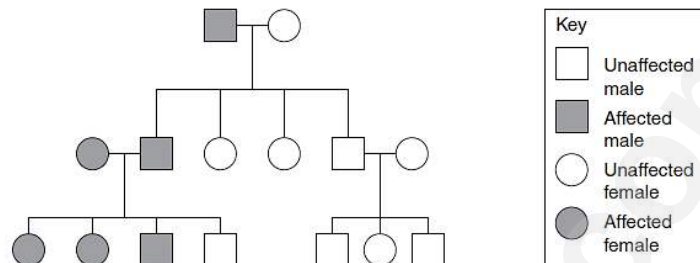
1.2.2 The karyotype shown below is from a ...



- A female with trisomy 21
- B female with trisomy 18
- C male with trisomy 21
- D male with trisomy 18

(1)

1.2.3 A pedigree is shown below

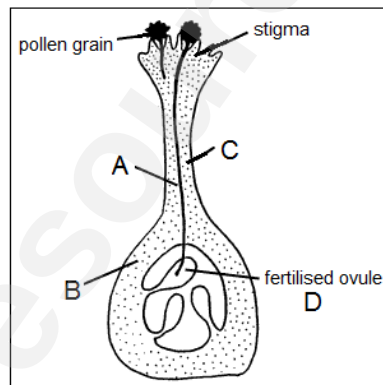


What type of inheritance is shown by the gene for the condition in this pedigree?

- A Sex-linked recessive
- B Sex-linked dominant
- C Non sex-linked recessive
- D Non sex-linked dominant

(1)

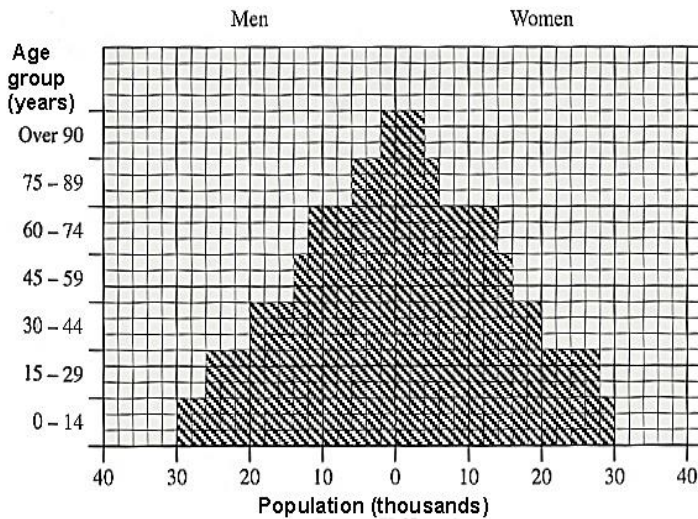
1.2.4 Which of the following statements regarding the diagram below is not true:



- A The pollen grain contains the male gamete
- B B is the ovary which will develop into the fruit
- C The fertilized ovule is haploid
- D C represents the style

(2)

1.2.5 The diagram below shows a population pyramid for a small country.



How many of the population are women aged 75 years or older? (2)

- A 9 000
- B 5 000
- C 3 000
- D 10 000

1.3 Read the text below about the Sand Scorpion found in the Mojave Desert of California.

The Sand Scorpion, which spends its days in a burrow underground, emerges to capture prey at night. If it's the right time of year, scorpions might also be seen dancing the night away. Males grasp the females by their pincers and move them around in circles. After dancing for a while, the male deposits a packet of sperm on a stick or other surface. Then he moves the female until she is on top of the sperm. She takes in the sperm, which fertilise her eggs. The dance ends here, and the male usually skitters off to find more mates.

Young Sand Scorpions spend about 12 months developing inside eggs in their mother before they are born live. After they're born, they quickly crawl onto their mother's back where they stay until they're big enough to leave the burrow. On average, a Sand Scorpion mother has about 33 new-borns hitching rides on her back.

Male sand Scorpion



Female Sand Scorpion with young on her back



(5)

1.3.1 Study the following table, which consists of two items (numbered A and B).
Decide which item(s) describes the Sand Scorpion.
WRITE A ONLY, B ONLY, BOTH A AND B OR NONE.

Answer	Item
--------	------

1.3.2 Identify two reproductive strategies described in the text above and discuss how these reproductive strategies are advantageous for the Sand Scorpion.

(4)

(9)

1.4 The giant quiver tree, *Aloe pillansii*, shown alongside, is an endangered species. These long-lived trees grow in harsh environments.

Some populations of *A.pillansii* are found within the Richtersveld National Park (in the Northern Cape) , but one population is found just outside on a mountain called Cornell's Kop in Southern Africa.



1.4.1 State the genus of the giant quiver tree. _____ (1)

1.4.2 Explain why the *A.pillansii* trees on Cornell's Kop represent a population. _____

_____ (3)

1.4.3 Suggest three reasons why the giant quiver tree is an endangered species.

_____ (3)

It was estimated in 2005 that the total number of giant quiver trees in the wild was less than 3000, which is considered to be very low compared with other tree species.

1.4.4 Explain the risks to a plant species of having very small numbers.

_____ (3)

The population of *A. pillansii* trees on Cornell's Kop was surveyed and photographed at four sites, **A** to **D**, from the year 1937 onwards. Researchers took photographs at all four sites in 2004 and compared them with the original photographs. Their data analysis is shown in the table below.

site	date of the original photograph	number of living trees in the original photograph	number of living trees in 2004	number of dead tree stumps	average annual mortality rate /percentage of deaths per year
A	1937	12	4	8	1.0
B	1953	9	5	4	0.9
C	1985	5	3	2	2.1
D	2001	6	5	1	5.6

1.4.5 Calculate the percentage decrease in the number of living trees at site **B** from 1953 to 2004. Show your working and give your answer to the nearest whole number.

(3)

1.4.6 Describe what the analysis of the photographs (table above) shows about the population of *A. pillansii* on Cornell's Kop.

(3)

(16)

1.5 Experts Warn Air Fresheners 'Make Cats Nervous and Lose Weight'

A new study has now found a link between hyperthyroidism in cats and household goods, such as air fresheners, which contain flame retardants. Over time, chemicals known as 'endocrine disruptors' seep out of the furniture into the air,



Pet tag

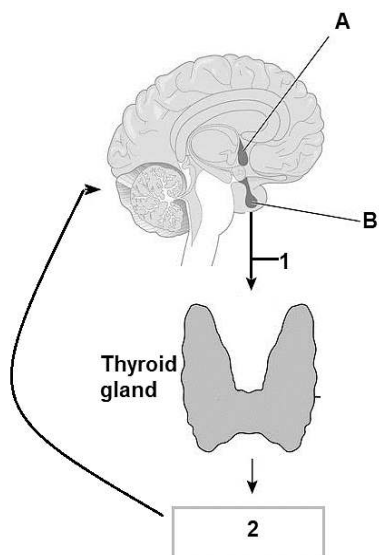


Diagram illustrating the interaction between two endocrine glands and their secretions.

settling on the bodies of household cats. After humans, this condition is most common in cats. Professor Kim Anderson of Oregon State University recruited 78 cats that were aged seven and older – half healthy and normal, half with hyperthyroidism. His team attached silicone pet tags to the cats for a week; these tags could pick up volatile and semi-volatile organic compounds such as tris(1,3-dichloroisopropyl) phosphate (TDCIPP).

By the experiment's end, they found that the cats with hyperthyroidism were exposed to higher levels of TDCIPP on average. Cats without hyperthyroidism, but who had higher levels of a hormone linked to the condition, were also seemingly exposed to more TDCIPP than cats with normal hormone levels.

Adapted from: Carolyn M. Poutasse, Julie B. Herbstman, Mark E. Peterson, Jana Gordon, Peter H. Soboroff, Darrell Holmes, Dezere Gonzalez, Lane G. Tidwell, Kim A. Anderson. **Silicone Pet Tags Associate Tris(1,3-dichloro-2-isopropyl) Phosphate Exposures with Feline Hyperthyroidism.** *Environmental Science & Technology*, 2019; DOI: 10.1021/acs.est.9b02226

1.5.1 What are 'endocrine disruptors'? _____ (1)

1.5.2 List one precaution the scientists needed to take when applying the pet tags.

_____ (1)

1.5.3 Is this experiment credible? Provide a reason for your answer. _____

_____ (2)

1.5.4 Where exactly in the human body is the thyroid gland located?

_____ (2)

1.5.5 Suggest why over secretion of thyroid hormone would cause cats to lose weight.

(2)

1.5.6 How can this disorder be treated? _____

(1)

1.5.7 What process is depicted by the diagram above? _____

1.5.8 Identify the hormone numbered 1 and 2 that are involved in this interaction.

1: _____

2: _____

1.5.9 Identify the gland labelled B. This gland is sometimes dubbed the 'master gland'.

Suggest a reason for this. _____

(2)

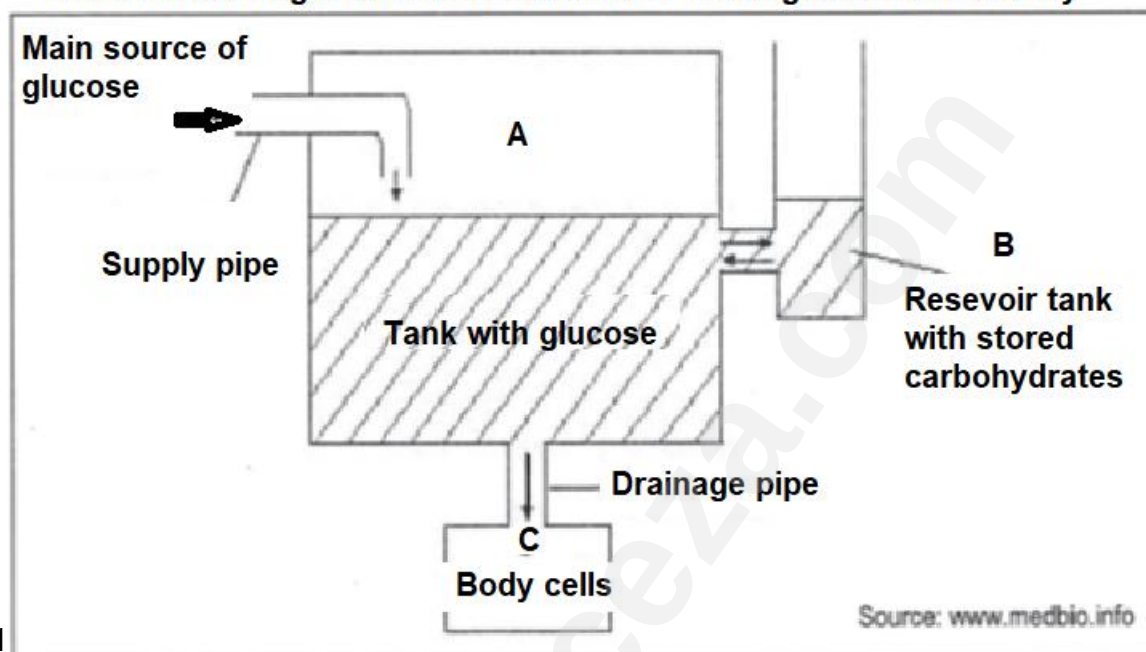
1.5.10 Describe briefly the interaction between the thyroid gland and gland labelled B.

(4)

(18)

1.6 The following diagram represents a model of the origin and the destination of blood glucose in the body. In this diagram blood glucose are depicted as a tank of fluid.

Model of the origin and the destination of blood glucose in the body



1.6.1 (1)

1.6.2 Which organ in the human body is represented by the reservoir tank B? (1)

1.6.3 Name a carbohydrate stored in tank B. (1)

1.6.4 The following statements describe the effects of two hormones. **Choose in each statement if it is applicable to the effect of insulin OR glucagon.** (3)

1.6.4.1 Decrease the amount of stored carbohydrates in the reservoir tank B. _____

1.6.4.2 Decrease the amount of glucose in tank A _____

1.6.4.3 Increase the intake of glucose by the body cells (C) _____

1.6.5 Name the chronic, metabolic disease that is characterised by high glucose levels in tank A and provide two symptoms an individual with this disease will experience.

(3)

(9)

1.7 Epinephrine or adrenalin are hormones responsible for the fight or flight response of the body to certain situations that require the body to run or face the situation. Scientists are investigating the fact that one of the signals to initiate the birth process in sheep is the increased level of foetal adrenalin just before birth. The effect of adrenalin is the same in sheep as well as humans.

1.7.1 State exactly from where adrenalin is secreted. _____ (2)

1.7.2 Explain why adrenalin will be beneficial to the mother of a sheep giving birth in the wild. _____

_____ (2)

1.7.3 Describe two physical effects of adrenalin on the mother's body and explain how this will aid a successful birthing process in sheep.

_____ (4)

(8)

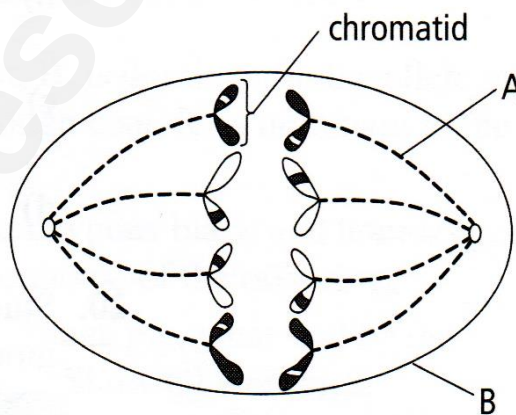
Section A:
Total Marks: [78]

SECTION B

Answer this section on folio paper. Remember to write your examination number.

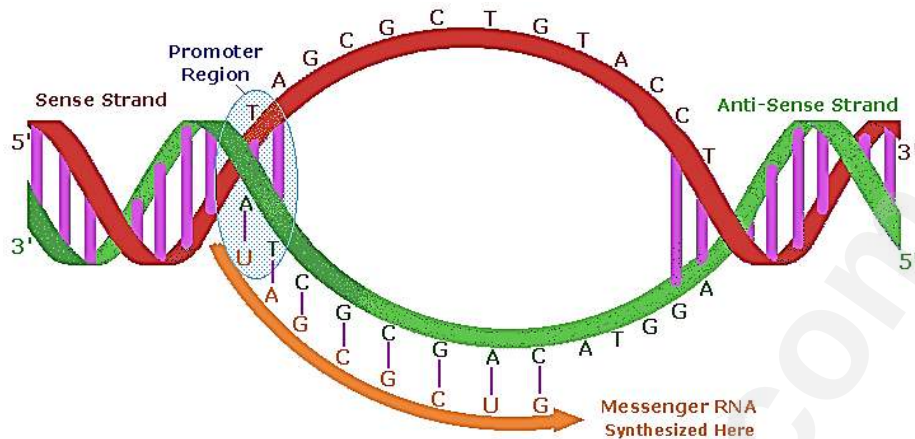
Question 2

2.1 Study the diagram representing a phase of meiosis in an animal below and answer the questions that follow.



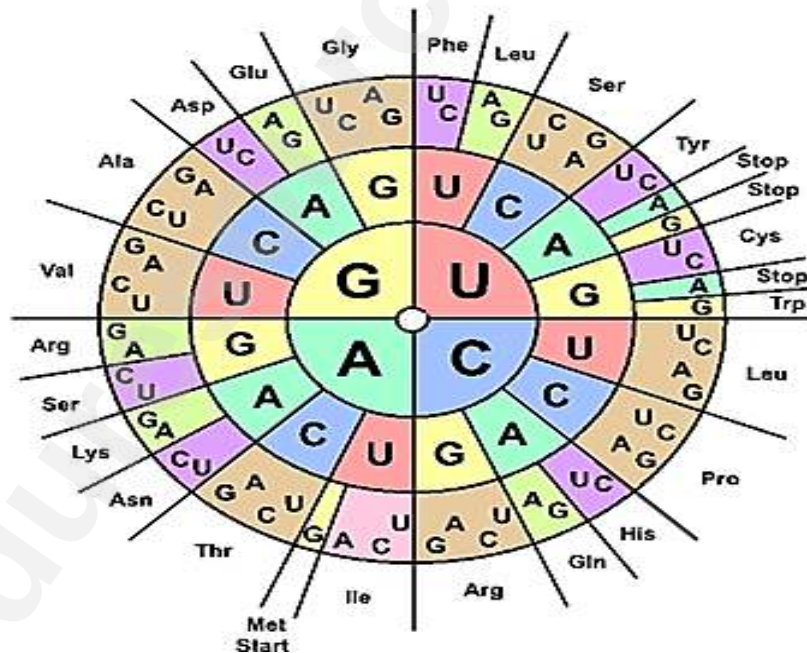
- 2.1.1 Which phase of meiosis is represented in the above diagram? Give a reason for your answer. (2)
- 2.1.2 Provide labels for parts A and B. (2)
- 2.1.3 How many chromosomes does this animal have in the diploid condition? (1)
- 2.1.4 How do we know that the cell in the diagram does not represent a human cell? (1)
- 2.1.5 Give two reasons why meiosis is biologically important. (2)

The diagram below is showing a common process found in all living cells. Study the diagram and then answer the questions that follow.



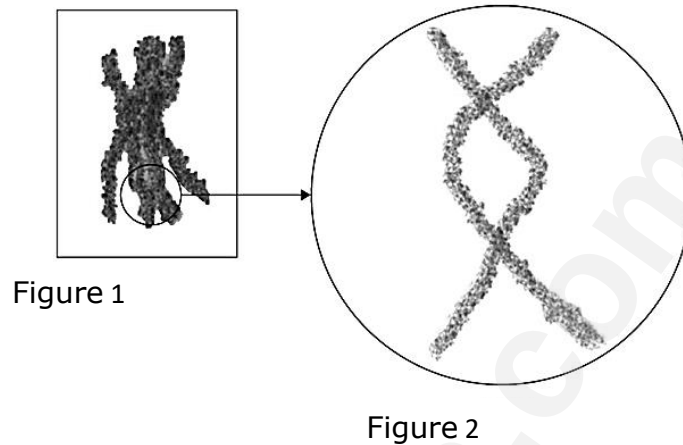
Source of diagram: <https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/nucacids.htm>

- 2.1.6 Name the exact phase of the process taking place in the diagram. (1)
- 2.1.7 Where in the cell is this process taking place? (1)
- 2.1.8 Starting at the left-hand side of the mRNA strand, use the codon table below to list the first four amino acids in the correct order. Use the abbreviations for the amino acids. (4)

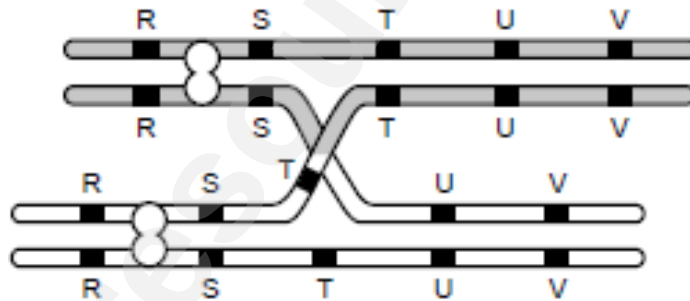


- 2.1.9 What is the final product of the entire process depicted above? (1)

2.2 Figures 1 and 2 below show a pair of chromosomes during a particular stage of cell division. Figure 1 shows the whole chromosomes and Figure 2 is an enlarged view of the section circled in Figure 1.



- 2.2.1 Name the stage of the cell division in which the chromosomes in this arrangement would be observed. (1)
- 2.2.2 What name is given to the process occurring in the circled area? (1)
- 2.2.3 What is the outcome of the process you named in answer to question 2.2.2 and what advantage does the result of this process give a species? (2)
- Sometimes mistakes occur in the process of this cell division. One such mistake is shown in the diagram below. The **letters** show the sequence of genes on the chromosomes.



Source: Victorian Certificate of Education, Biology, October 2015

- 2.2.4 Draw the resultant four daughter chromosomes as they would appear in the gametes on completion of the entire cell division. (4)
- 2.2.5 Give a detailed step-by-step account of DNA replication. (5)

2.3 Should we grow GM crops?

More than 25 years after genetically modified (GM) food first appeared, growing GM crops remains a hotly debated topic. Some people argue that GM crops are the only way to feed the growing world population and to minimise environmental harm. Other people express different views.

Bt cotton is a type of cotton that contains two genes from a soil bacterium, *Bacillus thuringiensis*, enabling it to produce insect-resistant proteins. Australian farmers of Bt cotton use only 15% of the quantity of the insecticide that was once needed to protect their cotton crops. However, Bt cotton is not as resistant to the main insect pest of cotton crops, *Helicoverpa*, as it has been in the past.

In Australia, Bt cotton is picked by machine, but in India, it is picked by hand. Workers in India have developed skin allergies, which have been attributed to Bt cotton proteins. Traditionally, farmers have saved money by keeping seed from one year's crop to plant the following year. However, it is illegal for farmers to keep Bt cotton seeds because these seeds have been declared the legal property of the company Monsanto. Every year, cotton farmers must buy more seeds from Monsanto.

Unlike Monsanto, the company that produces the GM food crop Golden Rice allows farmers to replant the rice they harvested the previous year. By inserting a gene from the bacteria *Erwinia uredovora* and another from a daffodil, *Narcissus pseudonarcissus*, into white rice, scientists produced Golden Rice – a rice variety containing higher levels of vitamin A. People who eat Golden Rice avoid vitamin A deficiency. Trials conducted in several countries have shown that Golden Rice is safe to eat.

Adapted from: CSIRO, 'Cotton pest management', case study, <www.csiro.au>; †JA Paine et al., 'Improving the nutritional value of Golden Rice through increased pro-vitamin A content', *Nature Biotechnology*, 23, 27 March 2005, pp. 482–487; A Coghlan, 'Golden Rice gets approval in the US', *NewScientist*, magazine issue 3180, 2 June 2018

2.3.1 Bt cotton and Golden Rice are genetically modified organisms but are they also transgenic organisms? Support your response with evidence from the article above. (3)

2.3.2 How can planting a Bt cotton crop lead to an increase in crop yield? (1)

2.3.3 Using information from the article, describe one social and one biological implication relevant to the use of Bt cotton and Golden Rice. The same implication should **not** be used twice. (4)

2.4 A newly approved crop is this apple from a Canadian biotech company that does not brown even after it's been sliced – these are called "Arctic Apples". It recently received FDA approval. The agency said it is safe to eat, which means they may appear on supermarket shelves.

Adapted from: <http://time.com/3840073/gmo-food-charts>



2.4.1 If you were a parent buying apples for your family, would you buy these GM apples? Justify your answer with two reasons. (2)



2.5 In some chickens, the heterozygous genotype leads to a phenotype known as erminette (checkered chickens), feathers which are speckled with **both** black and white. The allele for Black is B and the allele for white is W.

2.5.1 Predict the type of feathers the offspring will have if two erminette chickens are crossed. Include the following in your answer:

- ✓ Parental genotypes
- ✓ A punnet diagram
- ✓ The ratio of the possible genotypes and phenotypes of the offspring. (7)

2.5.2 This is an example of which inheritance pattern (incomplete dominance or codominance)? (1)

Question 3

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

Is wireless communication as safe as we're told it is?

A new study has found that exposure to Wifi connections lowers male fertility rates and reduces couples' chances of having children by killing sperm. The study was carried out on 51 men and showed that prolonged exposure to the waves from Wifi devices lowered male fertility. The men in the study, whose average age came to 38 years, were involved in in-vitro fertilisation (IVF) or artificial insemination procedures at the Yamashita Shonan Yume Clinic in Japan.

Sperm samples were taken from them and split into three groups - those whose samples were not exposed to electromagnetic waves from a Wifi router, those whose sperm were protected by a small shield that intercepted the waves, and those whose sperm were fully exposed to the waves. The sperm were exposed to electromagnetic waves from the Wifi router for lengths of 30 minutes, 60 minutes, two hours, and 24 hours. Sperm motion was then tested.

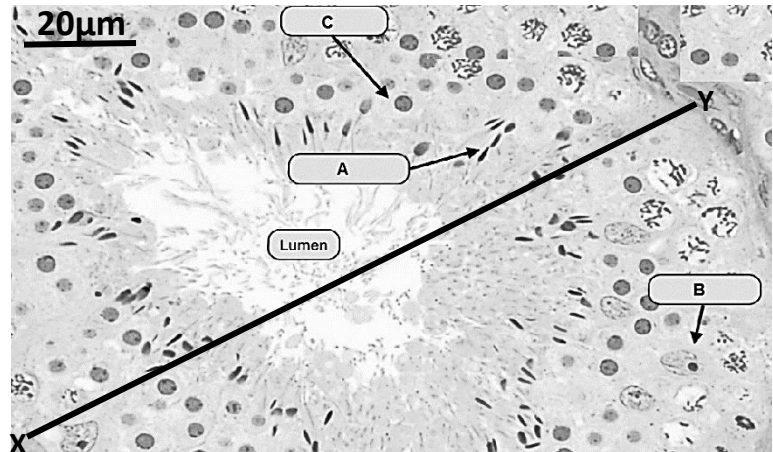
While there was little difference in sperm motility rates between the different groups after exposures of 30 minutes and 60 minutes, the study found that the longer the exposure, the lower the sperm motility rate and higher the death rate. After 24 hours, the dead sperm rate of the group that was not exposed to the waves was 8,4 percent, the Wifi shield group was 18,2 percent, and the exposed group was 23,3 percent.

The World Health Organisation predicts that infertility among males and females will be the third most serious condition after cancer and cardiovascular diseases in the 21st century.

Adapted from: <https://www.straitstimes.com>, May 2019 by Clair Huang.

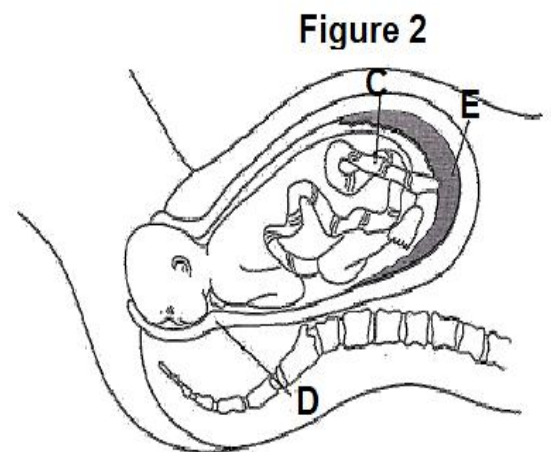
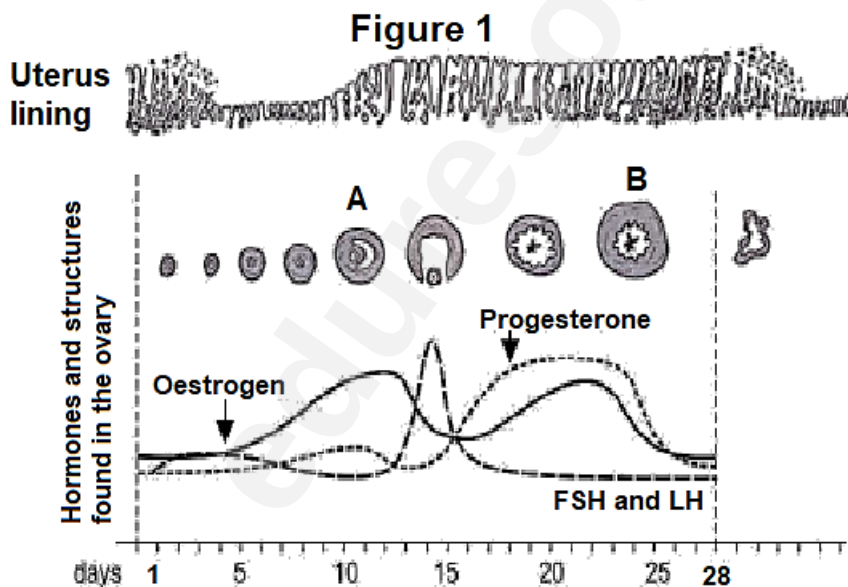
- 3.1.1 Write a suitable hypothesis for this investigation. (2)
- 3.1.2 Identify the following variables: (3)
 - 3.1.2.1 independent
 - 3.1.2.2 dependent
- 3.1.3 What was the control in this investigation and why was it necessary to use a control? (2)
- 3.1.4 Suggest one possible reason for the inactivity of the sperm. (1)
- 3.1.5 Provide one other possible reason for the sperm counts and mortality rates being low. (1)
- 3.1.6 Do you consider this research to be reliable? Explain your answer. (2)
- 3.1.7 Why do you think sperm motility would contribute to successful fertilisation? (2)

3.2 The micrograph alongside represents the seminiferous tubules.



- 3.2.1 Is the section of the seminiferous tubules in the transmission electron micrograph a transverse/cross or longitudinal section? (1)
- 3.2.2 Where exactly is the seminiferous tubule found in the male reproductive system? (1)
- 3.2.3 Of the cells found at A, B and C, which are haploid? (1)
- 3.2.4 Some cells collect at point A to receive nutrients. Why? (1)
- 3.2.5 Calculate the actual size of the seminiferous tubule above. Show all working. (4)

3.3 Study figure one and two below, then answer the following questions.



- 3.3.1 Define 'menstruation'. (2)
- 3.3.2 With reference to Figure 1, on which day(s) is progesterone at its highest level in the blood? (2)
- 3.3.3 Identify structures A and B in Figure 1. (2)
- 3.3.4 Identify structures C, D and E and give one function of structure E in Figure 2. (4)

- 3.3.5 Give a simple description of the human egg that is released during ovulation. (2)
- 3.3.6 Explain what initiates the process shown in Figure 2. (2)
- 3.3.7 An active healthy sperm cell is able to swim about 4mm per minute. If the distance from the cervix to the end of the fallopian tube is 20cm, how long will it take for the sperm to reach the ovum in the fallopian tube? Show your working. (2)
- 3.3.8 Tabulate two differences between the female condom and the contraceptive pill. (2)
- (39)

Question 4

- 4.1 Students investigated the abundance of plantain (*Plantago* species) and bugleweed (*Ajuga* species) in two fields (A and B). Field A measured 250 m² and field B measured 375 m².



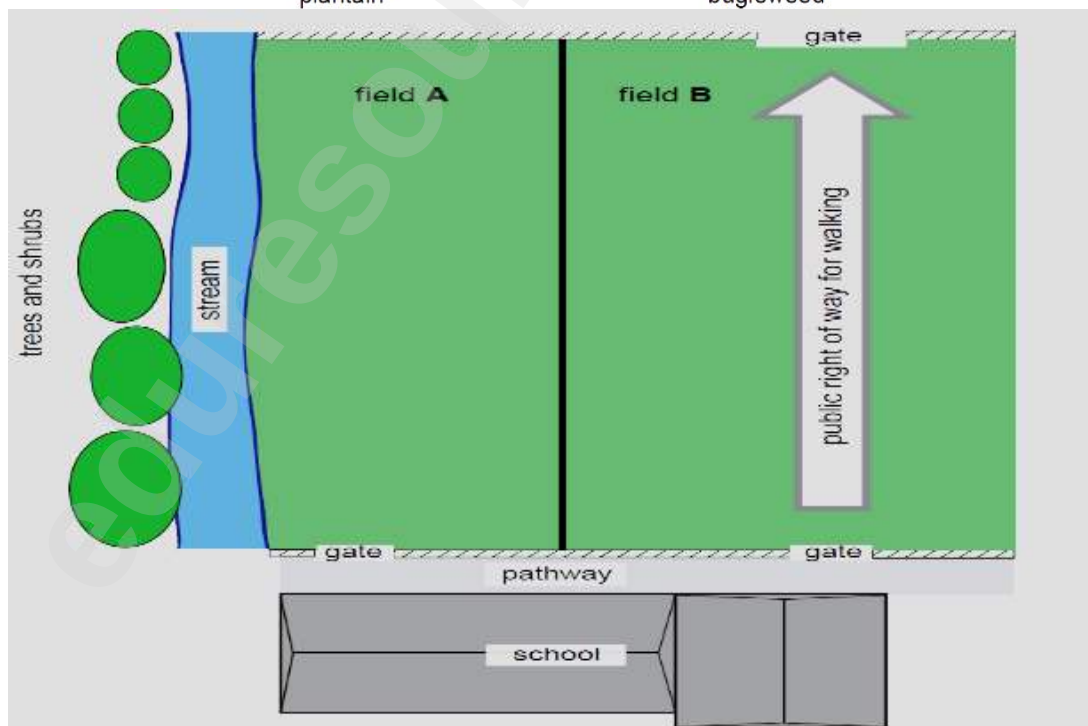
plantain



bugleweed

Trampling by

walkers



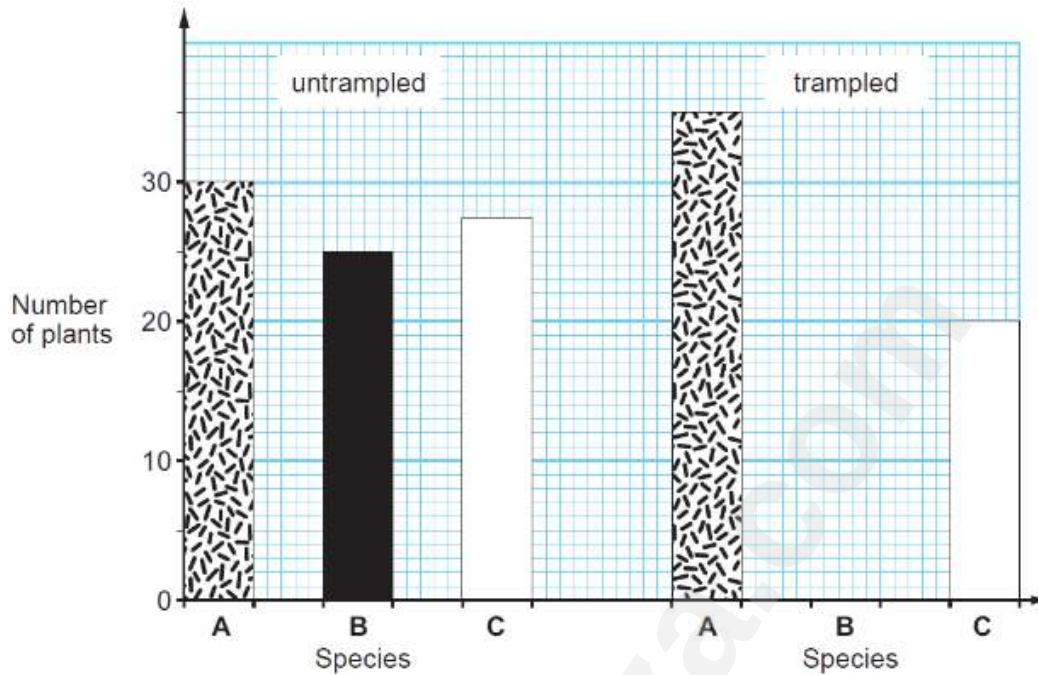
occurred in field B as a public right of way passed through, as shown below.

The students used six quadrats of 1 m^2 , which they placed randomly in the fields to investigate the abundance of plantain and bugleweed. The students tabulated their results as follows:

	Plantain		Bugleweed	
	Field A	Field B	Field A	Field B
Total number of plants counted in six quadrats	34	41	38	5
Mean number of plants per m^2 quadrat	A	B	6.3	0.8
Estimated total number of plants in field	C	D	1575	300

- 4.1.1 Complete the results table by calculating,
 (i) the mean numbers of plantain per m^2 for field **A** and **B**. (2)
 (ii) the estimated total numbers of plantain in the fields (**C** and **D**). (2)
- 4.1.2 From the results, state what can be concluded about the effects of trampling on the plant species. Explain your answer. (2)
- 4.1.3 From the information in the diagram, suggest two variables, apart from trampling, which could have affected the results, giving one reason for each variable. (4)
- 4.1.4 Describe a technique the students could have used to place their quadrats at random and obtain their data. (2)
- 4.1.5 State why the students should have increased the number of quadrats used. (1)

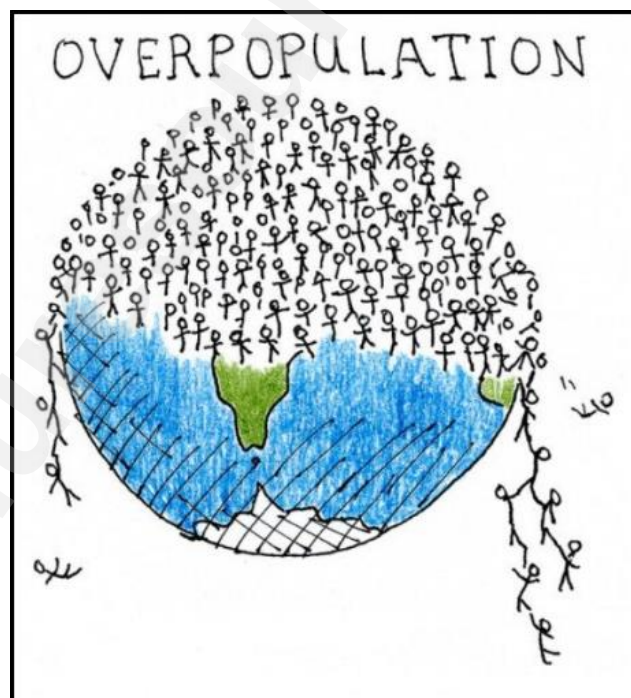
The bar chart below shows the results of an investigation on the effects of trampling carried out by conservation scientists in an area of grassland. They studied three species of plants, **A**, **B** and **C**.



4.1.6 From the information in the bar chart, state the evidence that biodiversity has been affected by trampling. (2)

4.1.7 State two reasons why it is important to protect the biodiversity of habitats. (2)

4.2 Study the image below and answer the questions that follow:



[Source: <<https://planetearth5.com>>]

4.2.1 Provide a definition for 'carrying capacity'. (2)

4.2.2 What does the image suggest about the earth's carrying capacity? (2)

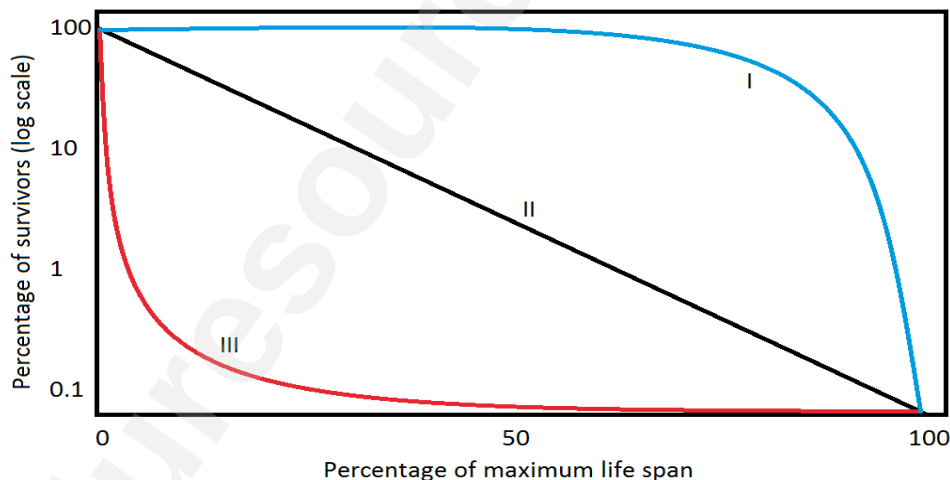
4.2.3 Humans have increased the carrying capacity of earth. Explain two ways they have been able to do this. (4)

4.3 Social organisation is one way in which a species can increase its chance of survival. Each member of the species has a specific role to play within the group. Beehives contain different castes (types) of bees each with a particular job to carry out in the hive.

The many hundreds of worker bees (infertile females) have different roles - some look after the larvae, others collect nectar and pollen, and others maintain the hive. Scout worker bees look for new nesting sites and sources of nectar and pollen, and some workers stand at the hive entrance and guard it against invaders such as wasps. The drones are fertile males and they mate with the queen on her nuptial flight. She then returns to the hive and lays about 2 500 eggs per day and dominates the hive. The drones die soon after mating with the queen. The queen receives several million sperm cells, which last her entire life span of nearly two years. The hive requires these jobs to be done in order to survive. The birth rate and death rate of bees is fairly constant at any time during their life span.

- 4.3.1 Use the information in the extract above and your own knowledge to describe two similarities between the social organization of bees and wild dogs, as well as two differences. Use the sub-headings 'similarities' and 'differences' in your answer. (6)
- 4.3.2 Explain briefly how wild dogs improve their survival rate through co-operative hunting. (3)

A survivorship curve is a graph that shows the number or proportion of individuals surviving to each age for a given species or group.



- 4.3.3 Does curve 'I' above represent survivorship in the wild dogs or in bees? Explain your answer. (3)
- (37)

Section B:
Total Marks: [122]