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St Catherine's Convent

GRADE 12 PRELIMINARY EXAMINATIONS 2023

LIFE SCIENCES: PAPER I

Time: 3 hours

200 marks

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Moderators: J. Steyn, D. Kirsten & Mrs M. Rudman

NAME & SURNAME: _____

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 37 pages. Please check that your paper is complete.
2. This paper consists of four questions.
3. **Answer the ALL the questions on the question paper and hand it in at the end of the examination. Remember to write your name in the space provided.**
4. Read the questions carefully.
5. It is in your own interest to write legibly and to present your work neatly.
6. ONE additional (page 37) is included at the end of the paper. If you run out of space for an answer use se this page. Cleary indicate the number of your answer should you use this extra space.

FOR EXAMINER'S USE ONLY:

Q1	Q2	Q3	Q4	TOTAL
80	40	40	40	200

QUESTION 1

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

Column A	Column B
1.1.1 [] A type of reproduction in humans where the foetus develops inside the uterus.	A Chorion
1.1.2 [] The amount of carbon dioxide produced by an individual per unit time because of his/her activities.	B Dominant
1.1.3 [] The structure that provides oxygen and nutrients to a baby through the umbilical cord	C Polymerase chain reaction
1.1.4 [] The inner lining of the uterus where implantation of the embryo occurs.	D Endometrium
1.1.5 [] The type of variation in a population with no intermediate phenotypes.	E Discontinuous
1.1.6 [] A gene that is expressed in the phenotype whether an individual is heterozygous or homozygous for the trait.	F Karyotype
1.1.7 [] Used to identify chromosomal abnormalities.	G Viviparous
1.1.8 [] Makes many copies of a small section of DNA.	H Carbon Footprint
	I Placenta
	J Electrophoresis

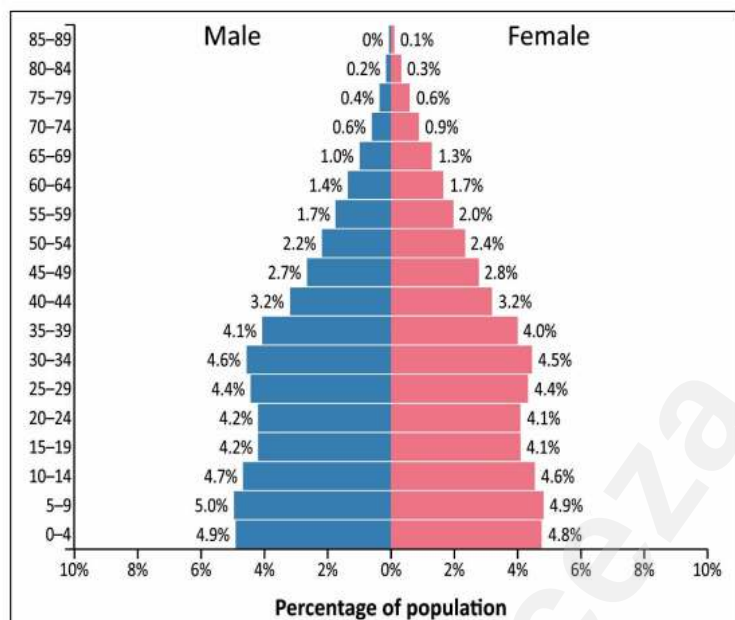
[Source: Unknown]

[8]

- 1.2 Six multiple choice questions are given below. Choose the most correct option in each question and write only the LETTER (A – D) in the space provided in the table.**

Question	1.2.1 (1)	1.2.2 (1)	1.2.3 (2)	1.2.4 (1)	1.2.5 (2)	1.2.6 (2)	TOTAL [9]
Answer							

The population pyramid of South Africa in 2020 is shown below. It shows the current percentage of people by age and gender. Questions 1.2.1 and 1.2.2 are based on the diagram below.



[Source: <<https://www.populationpyramid.net>>]

[Adapted: IEB NSC May 2021]

1.2.1 What percentage of the male population is under 10 years old?

- A 19,6
- B 14,6
- C 9,9
- D 9,7

(1)

1.2.2 South Africa is classified as a growing population. Which statement would suggest that it is becoming a stable population as seen in the pyramid?

- A The population is growing rapidly as seen by the large base of the pyramid.
- B The growth of the population is decreasing as seen by a more uniform population size.
- C A larger percentage of the population are in their reproductive years so there is much potential for growth.
- D Life expectancy in South Africa has increased to ages 85 to 89.

(1)

1.2.3 Which of the following statements are true regarding the importance of meiosis?

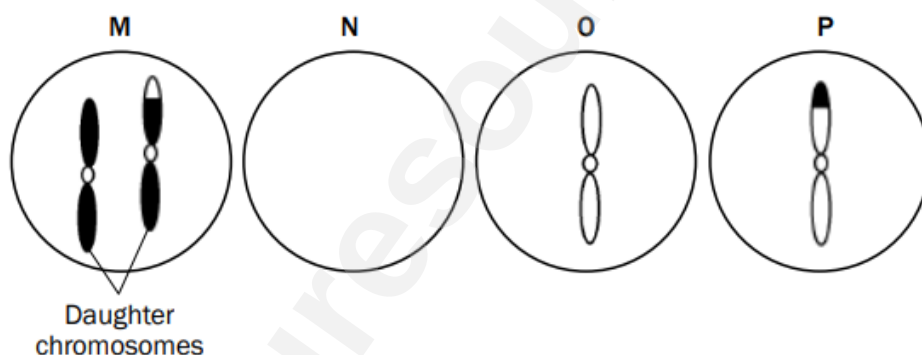
- (i) Gametes are produced.
- (ii) The number of chromosomes are doubled.
- (iii) It results in genetic variation.
- (iv) Identical haploid cells are produced.
- (v) It ensures that organisms produced by sexual reproduction have the correct number of chromosomes.

- A All statements are correct.
- B (i), (iii) and (iv) are correct.
- C (i), (ii) and (v) are correct.
- D (i), (iii) and (v) are correct.

(2)

[source: Adapted from IEB NSC Nov 2020 May/June]

1.2.4 The diagram below shows the nuclei of the four cells that resulted from meiosis of **chromosome pair 21** in a woman.



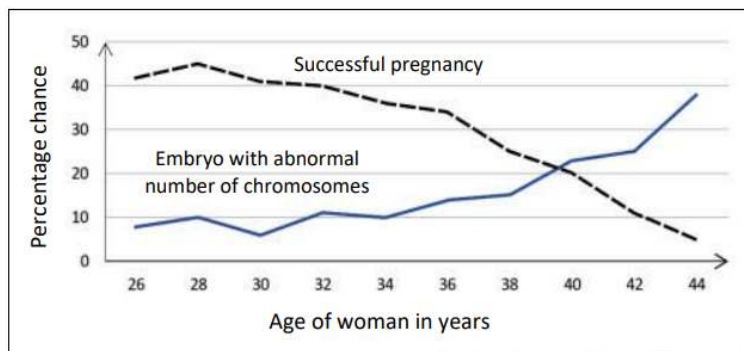
[Source: Adapted from Mind the Gap CAPS Grade 12 Life Sciences]

The disorder that will result if diagram **M** represents an egg cell that fuses with a normal sperm cell.

- A Turner Syndrome
- B Down syndrome
- C An X-linked genetic disorder
- D Monosomy 21

(1)

1.2.5 The graph below shows the chance of women of different ages having an embryo with an abnormal number of chromosomes, as well as the chances of having a successful pregnancy.



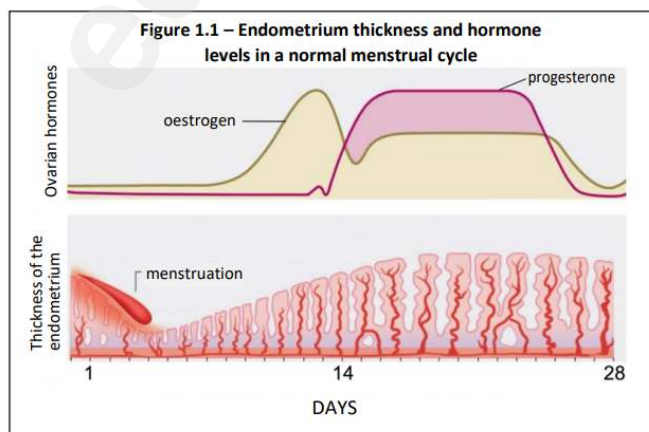
[Adapted: <<https://www.sbvif.com>>]

[Adapted from: IEB NSC Nov 2020 May/June]

Which one of the following statements correctly describes the information shown in the graph?

- A Only older women are likely to have embryos with an abnormal number of chromosomes.
- B A decrease in pregnancy rates with maternal age may be caused by a corresponding increase in embryos with an abnormal number of chromosomes.
- C The chances of an embryo with an abnormal number of chromosomes and a successful pregnancy increase with maternal age.
- D There is no relationship between maternal age, an embryo with an abnormal number of chromosomes and a successful pregnancy. (2)

1.2.6 Figure 1.1 shows the ovarian hormones levels and the corresponding endometrium thickness during a normal menstrual cycle. Studies have shown that increased stress levels decrease the production and the release of progesterone.

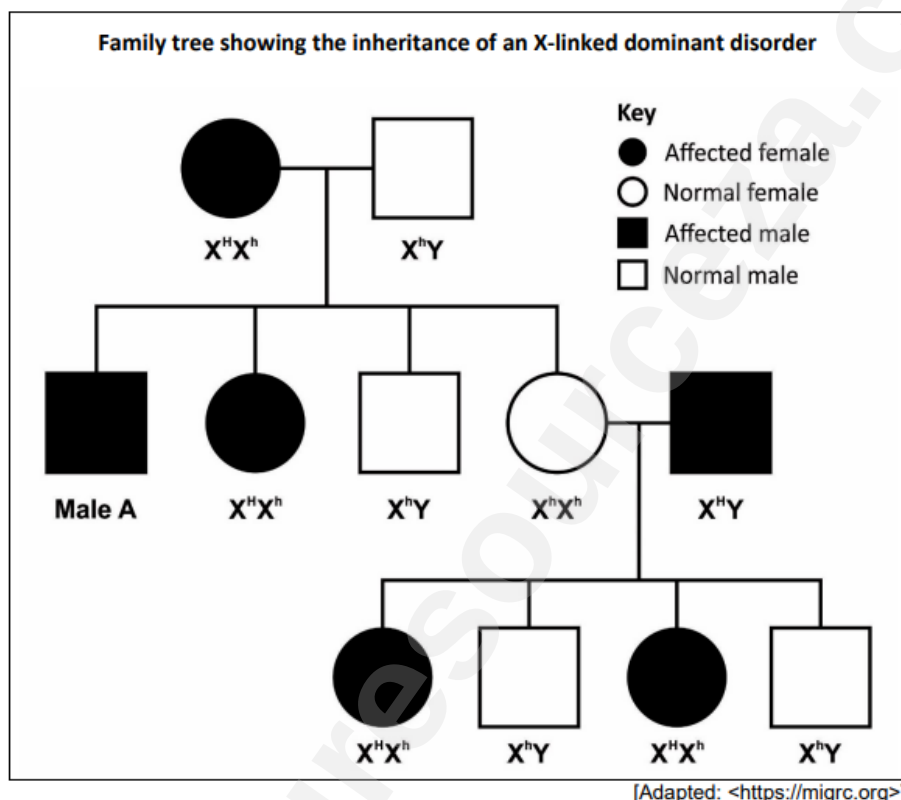


[Adapted: <<https://img.brainkart.com>>]

A logical deduction on the effect of high stress levels on a woman's menstrual cycle is that ...

- A ovulation will occur earlier than normal.
 - B menstruation will start in a shorter time after ovulation.
 - C the endometrium will have a greater thickness.
 - D the menstrual cycle will not be affected.
- (2)

1.3 Study the pedigree tree showing the inheritance of a dominant X-linked genetic disorder.



[Source: adapted from: IEB NSC May 2021]

Use the information depicted in the pedigree shown above and your own knowledge to determine whether the following statements are TRUE or FALSE.

Only write **True or false**.

- (a) Females who are heterozygous will not have the genetic condition.
_____ (1)
- (b) All daughters of a male who has the trait will also have the trait.
_____ (1)
- (c) There is no father to son transmission; the trait follows the inheritance of the X-chromosome.
_____ (1)

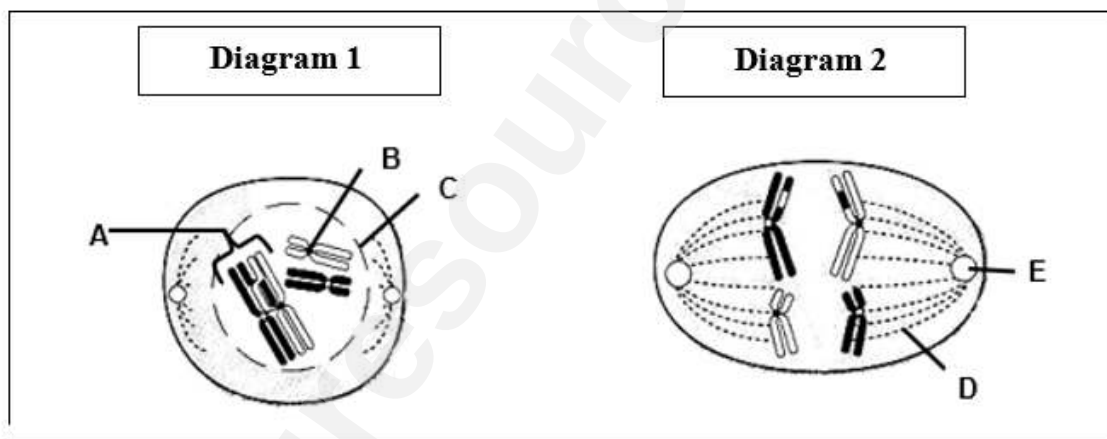
- (d) Sons can have the trait only if their father also has the trait.
 _____ (1)
- (e) Males can be carriers of the allele that causes the genetic condition.
 _____ (1)
- (f) The chance of an unaffected father and unaffected mother producing a child with the genetic condition is 0%.
 _____ (1)

1.3.2 Determine the genotype of Male A indicated in the diagram on the previous page.
 _____ (1)

1.3.3 Name ONE example of a recessive sex-linked disease/disorder.
 _____ (1)

[8]

1.4 Study the diagrams on meiosis below and answer the questions that follow



[Source: adapted from: Torah Academy Cycle test Feb 2023]

The table below has statements in Column I and two terms (A and B) in Column II. Match the terms to the statements by using the following codes:

- A** only term A relates to the statement
- B** only term B relates to the statement
- C** both terms A and B relate to the statement
- D** neither term A nor B relates to the statement

Write only the letter of the correct code next to the question number in the table below.

	Column I		Column II	Answer
1.4.1	Structure B is split during...	A B	Anaphase I Anaphase II	
1.4.2	By the end of meiosis I for Diagram 1	A B	two haploid cells will be formed two diploid cells will be formed	
1.4.3	If diagram 2 was shown in the same phase, but in meiosis II then...	A B	four chromosomes would be present in the cell structure E and D would be present in the cell	
1.4.4	The process shown by the bracket A...	A B	results in a recombination of genetic information only occurs in the phase shown in Diagram 1	
1.4.5	The number of chromosomes that would be present once the cell has completed meiosis is...	A B	4 23	

[5]

1.5 Read the following text/source and use the information and your own knowledge to answer the questions that follow.

A scientist wanted to determine the population size of the Angulate tortoise on Robben Island, located 10 km off the coast of Cape Town. The tortoise population on Robben Island is considered a closed population. The mark-recapture method was considered suitable to determine an estimate for the population size.

The image below shows how the tortoises were marked during the study.



[Image: <www.researchgate.net>]

[Source: adapted from: IEB NSC May 2021]

1.5.1 Identify ONE population parameter that will not apply to the Angulate tortoise.

(1)

1.5.2 Name a precaution that should be taken when marking the tortoise to ensure reliable results.

(1)

1.5.3 Name TWO density-dependent factors that could affect the growth of the tortoise population.

(2)

1.5.4 The table below shows the data that the scientist collected during the study:

	Number of tortoises
First sampling session	
Number of tortoises captured and marked	37
Second sampling session	
Total number of tortoises captured	24
Number of tortoises originally marked	11

Using the scientist's data in the table above, calculate in the given space below the size of the Angulate tortoise population on Robben Island. Show all working and express your answer as a whole number.

(2)

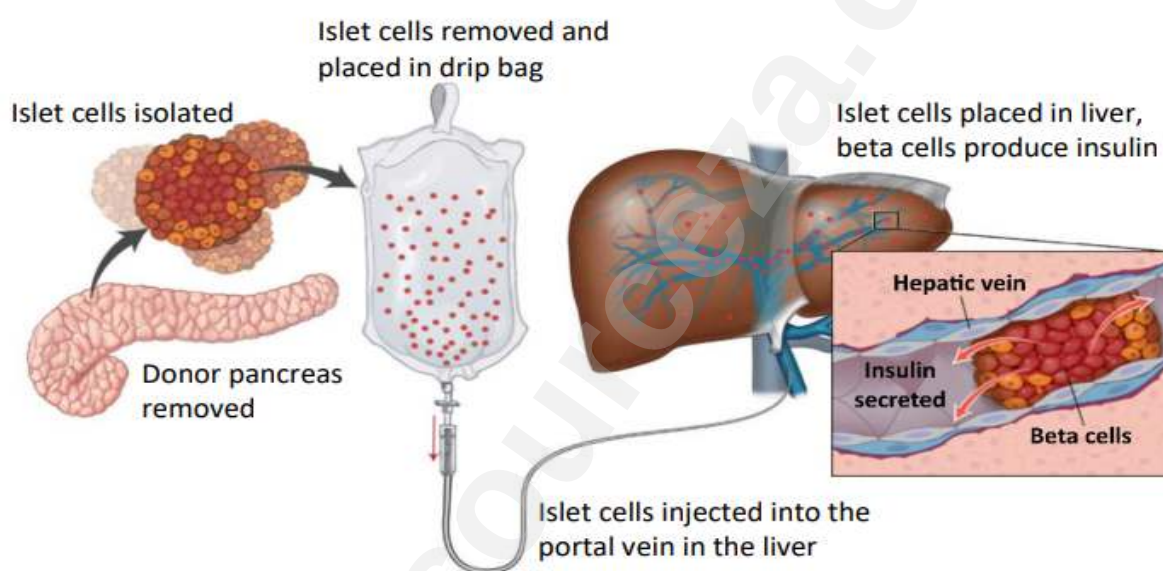
[6]

1.6 Study the information and Figure 1.6 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 1.6 – Transplantation process of islet cells into the liver of a diabetic Patient



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

[Source: adapted from: IEB NSC May 2022]

1.6.1 Outline your understanding of type 1 diabetes.

(2)

1.6.2 Explain why the islet cell transplantation procedure would be a more suitable treatment for diabetes than insulin injections.

(3)

1.6.3 Explain why islet cell transplantation is not effective in treating type 2 diabetes.

(3)

1.6.4 Could islet cell transplantation be considered a form of gene therapy? Provide a well explained reason for your answer.

(2)

[10]

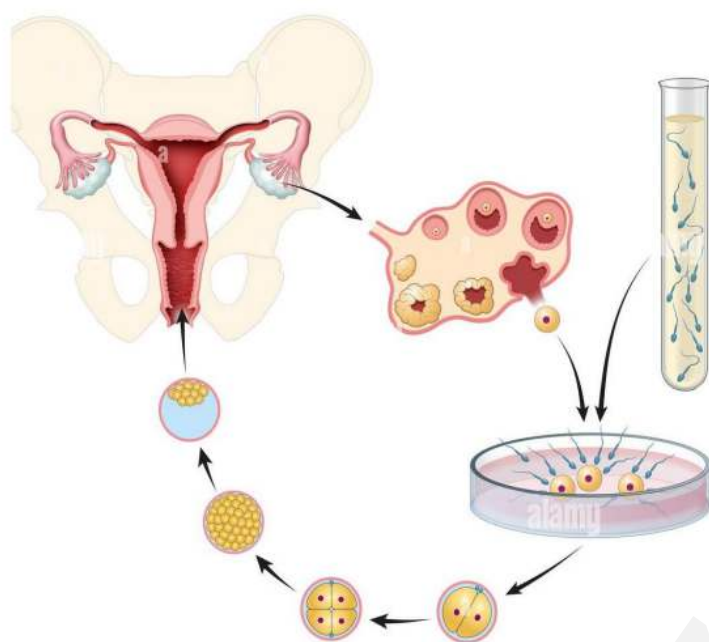
1.7 Read the extract and study the diagram below and answer the questions that follow.

Sophia found out that she had scar tissue blocking both her Fallopian tubes and therefore could not have a baby. She decided to try in vitro fertilisation (IVF).

The IVF procedure was performed as follows:

- (i) Sophia was given hormone supplements to stimulate the production of ova in the ovaries.
- (ii) The mature ova were then collected and placed in a petri dish.
- (iii) Her partner was then asked to release his semen into a special container.
- (iv) The ova and the semen were then mixed in a petri dish.
- (v) The diploid multi-cellular structure that developed after a few days were then inserted into Sophia's uterus.

The diagram below is a representation of how the procedure was done.



[Adapted from: Crawford College Sandton LSC Exam – June 2022]

1.7.1 Explain why Sophia's condition had prevented her from falling pregnant.

(2)

1.7.2 Describe the events and mention the stages that take place in the petri dish after fertilisation, until implantation takes place in point form.

(5)

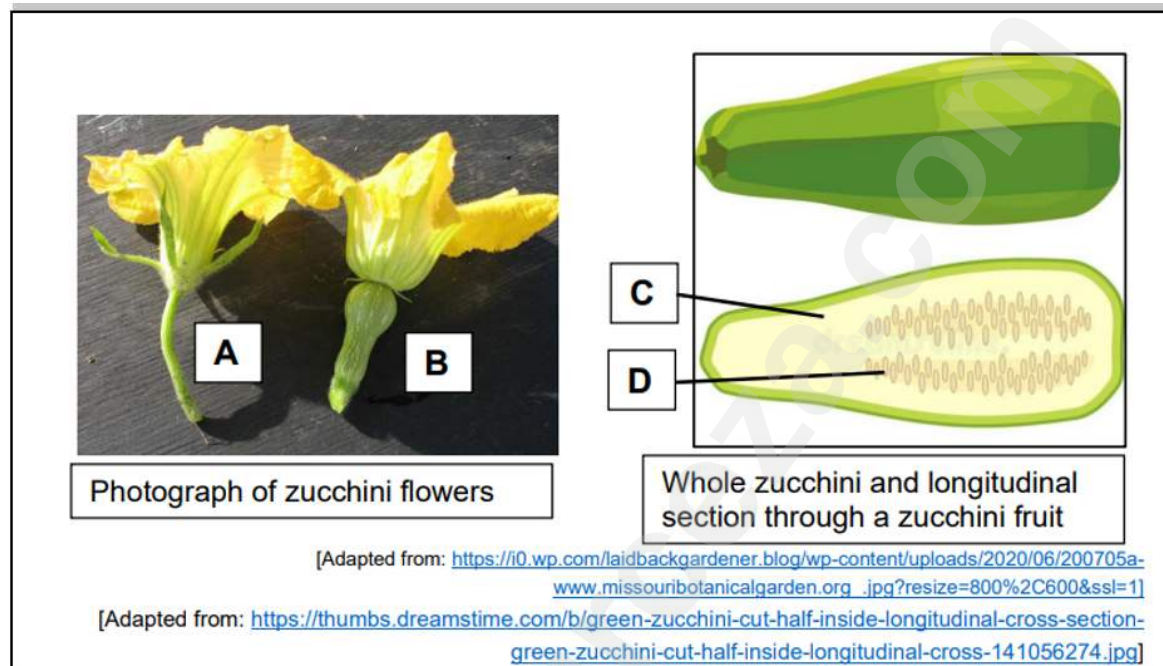
1.7.3 Explain ONE possible consequence for the developing embryo if the corpus luteum disintegrates immediately after implantation.

(3)

[10]

1.8 Read the information and study the diagrams below then answer the questions that follow.

Zucchini squash (baby marrow), produce large, yellow, male and female flowers. Zucchini have been genetically modified to resist certain plant viruses to prevent food waste from crop destruction that would result from a viral infestation.



[Source: adapted from: Crawford College Sandton LSC Exam – June 2022]

1.8.1 Which of the flowers, A or B is the female flower? Give a visible reason for your answer.

(2)

1.8.2 What other difference (not visible in the photograph) would you expect to find between the two flowers?

(2)

1.8.3 Differentiate between pollination and fertilisation.

(2)

1.8.4 What characteristics do these flowers possess informing us that they are pollinated by insects?

(1)

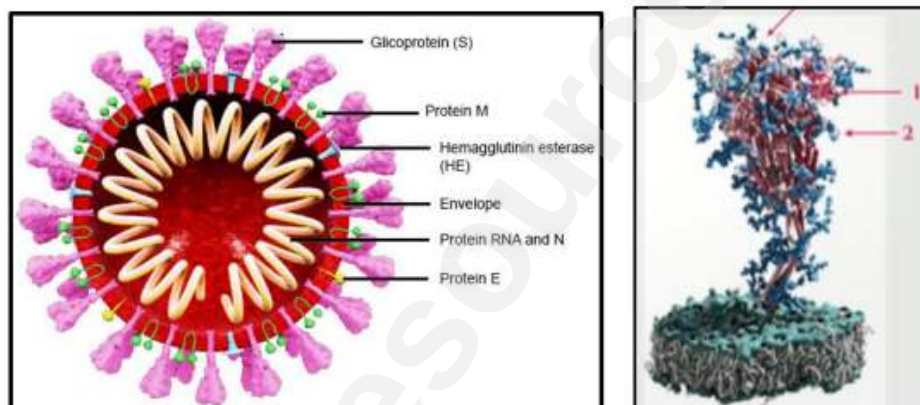
1.8.5 Name the respective parts of the flower that will produce parts **C** and **D** in the fruit.

(2)

[9]

1.9 Study the information concerning the genetic make-up and structure of the SARS-CoV-2 (Coronavirus) below and then answer the questions that follow.

An analysis of the genetic material of the SARS-Coronavirus showed that it contains 1996 adenine bases, 2131 guanine bases, 1642 uracil bases and 2365 cytosine bases. The diagrams below show the structure of the SARS-CoV-2 virus (left) and a molecular model diagram of its main spike protein (right).



[Adapted: <https://www.researchgate.net/profile/Veikko-Linko-2/publication/265115160/figure/fig1/AS:650765823668225@1532166071290/>]

[Adapted from an interview with Dr Richard M. Fleming PhD MD JD in May 2021]

All corona viruses have spike proteins radiating out from the virus and they are all very similar in their structure. The main spike protein uses the ACE -2 receptor found in the cell membranes in certain parts of the human body to gain access into the cells.

The SARS-CoV-2 virus has four added (inserted) amino acids found in this spike protein that are not found in any other corona virus. They are Proline – Arginine – Arginine – Alanine, collectively known as the PRRA insert.

1.9.1 Which one of the following describes the genetic material of the SARS - Coronavirus?

Underline only the correct answer below.

- A Single stranded DNA
- B Single stranded RNA
- C Double stranded DNA
- D Double stranded RNA

(1)

1.9.2 Explain how you determined your answer in question 1.9.1 by using the relative numbers of the different bases found in the virus. Give TWO different reasons.

_____ (2)

1.9.3 Excluding chromosomal aberrations, mutations usually occur one nucleotide at a time. How many extra nucleotides had to be inserted to code for the extra four amino acids?

_____ (1)

1.9.4 What is a mutation?

_____ (1)
[5]

1.10 Read the extract below and answer the questions that follow.

A proposed CRISPR-Engineered genetic framework for optimal physiological adaptation to Mars' gravitational conditions



Adapted from: CRISPR/CAS Editing of the Genome, Epigenome & Microbiome | A Proposed CRISPR-Engineered Genetic Framework for Optimal Physiological Adaptation to Mars' Gravitational Conditions | Facebook

As we venture beyond the bounds of our home planet, new environments pose significant challenges. Mars' surface gravity, approximately 38% of that on Earth, may lead to detrimental physiological changes, including muscle atrophy and bone density loss. Mitigating these risks is paramount in facilitating long-term habitation on the Red Planet. Recent advancements in CRISPR-Cas9 technology open a window to genetic engineering solutions for such challenges. This technique could be utilised to optimise our physiology for lower-gravity environments. Herein, we discuss potential genetic targets that may help humans to live sustainably on Mars.

1. Myostatin (MSTN): Myostatin is a protein that inhibits muscle growth. By knocking out the MSTN gene via CRISPR, we may potentially enhance muscle mass and strength, counteracting the effects of lower gravity.
2. Sclerostin (SOST): SOST regulates bone formation and remodelling. Knocking out the SOST gene could theoretically increase bone density, reducing the risk of osteoporosis induced by reduced gravitational stress.
3. Vascular Endothelial Growth Factor (VEGF): Hypo gravity may disrupt cardiovascular function. By up-regulating VEGF expression, we could potentially improve cardiovascular adaptations to Mars' lower gravity.

1.10. What are the functions of the following components/molecules when using CRISPR-Cas9 in genetic engineering?

1.10.1 Guide RNA

(2)

1.10.2 Cas9 enzyme

(2)

1.10.3 What are the possible benefits of genetically modifying the Myostatin protein?

(3)

1.10.4 Do you agree with the genetic modification of these proteins to facilitate long-term habitation on Mars? Provide a reason for your answer.

(3)

[10]

TOTAL OF QUESTION 1 [80]

QUESTION 2

2.1 For thousands of years, humans have used breeding methods to modify organisms. Read the extract below and answer the questions that follow.

Genetically Modified Organisms (GMOs) bring new hope for medical cures, promise to increase yields in agriculture and have the potential to help solve the world's pollution and resource crisis.

There are also many objections to GMOs, some stating that they are expensive to produce and are a threat to biodiversity.

[Adapted from: [https://www.education.gov.za/NSC 2012 Life Sciences P1 Nov 2012 Version 1](https://www.education.gov.za/NSC%202012%20Life%20Sciences%20P1%20Nov%202012%20Version%201)]

2.1.1 Suggest two other advantages of GMOs.

(2)

2.1.2 Suggest two other disadvantages of GMOs.

(2)

2.2 Read the extract below on the recently adopted DNA Bill.**Police Committee Adopts DNA Bill****DNA PROJECT****Fighting Crime with Science****The Portfolio Committee on Police has
Adopted the Criminal Law (Forensic
Procedures) Amendment Bill.**

Committee Chairperson, Ms. Annelize van Wyk, said she was aware that the Bill would not eradicate crime but it would contribute immensely to its crime-fighting efforts. The Bill seeks to, among others, provide for the taking of specified bodily samples for the purposes of forensic DNA analysis. It also provides for the use of forensic DNA profiles in the investigation of crime and the use of such profiles in proving the innocence or guilt of persons during a prosecution or the exoneration of convicted persons.

[Adapted from: Marist Brothers Linmeyer Prelim P1 2015; Adapted from The Answer Series: Life Sciences Gr. 12]

2.2.1 DNA samples may be used to generate DNA fingerprints. Give one use, other than for the solving of crimes, of these fingerprints.

(1)

2.2.2 Name one bodily sample that is usually collected at a crime scene for use in Forensic Investigations.

(1)

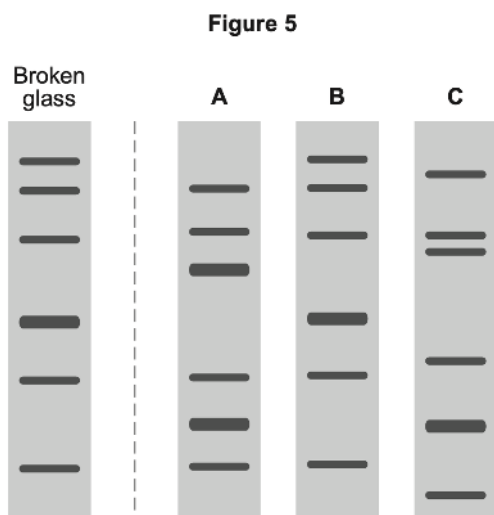
2.2.3 The DNA Bill took nine years to be accepted and passed in Parliament. Why do you think Parliament took so long in making a decision?

(2)

[Adapted from: Marist Brothers Linmeyer Prelim P1 2015; Adapted from The Answer Series: Life Sciences Gr. 12]

- 2.3 A burglar broke into a house. The burglar cut his hand on some broken glass. Scientists extracted DNA from the blood on the broken glass. The scientists analysed the DNA from the glass and DNA from three suspects: A, B and C. The scientists used a method called DNA fingerprinting.**

The diagram below shows the scientists' results.



[Adapted from: AQA, June 2015; Biology B2]

- 2.3.1 Which suspect, **A**, **B** or **C**, is most likely to have been the burglar?**

(1)

In Australia, genetic screening is carried out on newborn babies.

- 2.3.2 Explain why it is important to have a genetic screening program for newborn babies.**

(2)

- 2.3.3 State **two** ethical implications of the genetic screening of newborn babies.**

(2)

[Adapted from: 2017 Biology Victorian certificate in Education]

2.4 Honey bees suffer from a range of viral diseases.

One of these viruses, the deformed wing virus (DWV), causes shrunken and abnormal wings in honeybees, as shown in the photograph below.



[Adapted from: https://en.wikipedia.org/wiki/Deformed_wing_virus]

- 2.4.1 The deformed wing virus is an RNA virus. Its genome is 10 140 nucleotides in length. One part of the genome, which is 450 nucleotides in length, codes for the VP1 protein.

Define the term Genome.

(2)

- 2.4.2 On this basis of the knowledge of the virus, how many amino acids are there in the VP1 protein? Justify your answer.

(3)

- 2.4.3 The diploid number of chromosomes in honey bees is 32. Queen bees are diploid and produce eggs by meiosis. Female worker bees hatch from fertilised eggs whereas male bees hatch from unfertilised eggs. How many chromosomes will occur in male bees?

Explain your answer below.

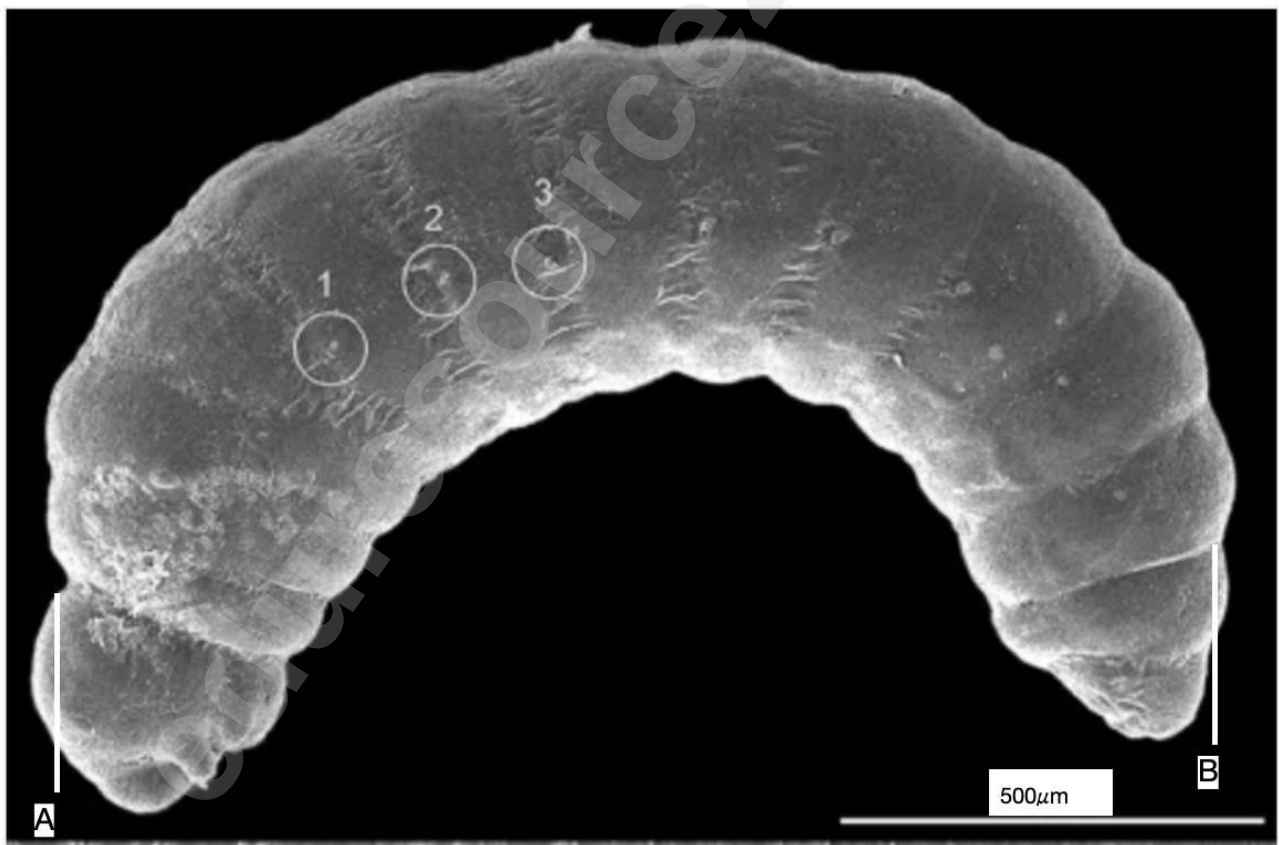
(3)

[Adapted from: Biology ATAR course examination, 2021]

2.4.4 Below is a micrograph of a larvae of a honey bee (*Apis mellifera*).

Calculate in the space provided below the actual size of the larvae between parts indicated A and B by using the scale bar information. Round up your answer.

(3)

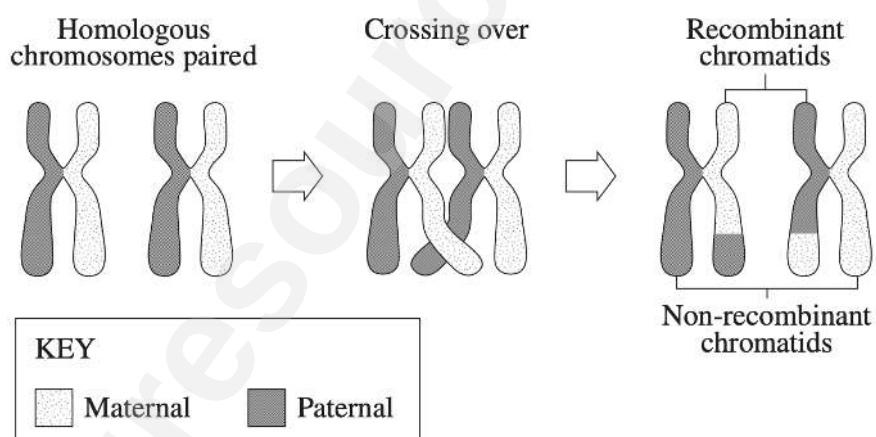


[<https://entomologytoday.org/2017/07/24/the-microscopic-spines-that-many-bee-species-use-to-hatch/>]

Space for calculation

2.5 A student drew a diagram to model part of the process of meiosis.

The diagram is shown below. Study and answer the questions that follow.



[Adapted from: 2020 NSW HSC Biology]

2.5.1 Explain the misunderstanding of meiosis shown in this model.

(2)

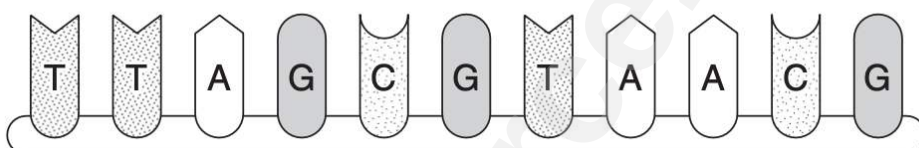
2.5.2 Explain the effect of meiosis on genetic variation.

(3)

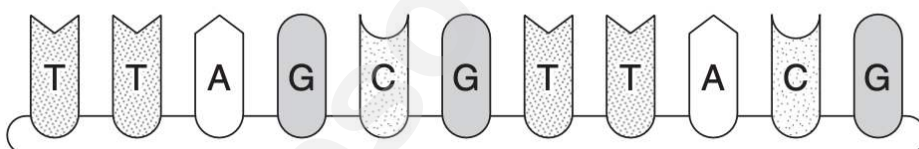
[Adapted from: 2020 NSW HSC Biology]

2.6 Visible mutations are often seen in drones. A recent eye colour mutation has occurred from light-yellow to dark-red. The diagram below shows the mutation.

Original DNA sequence



Mutated DNA sequence



[Adapted from: 2020 NSW HSC Biology]

2.6.1 What type of mutation is shown in the diagram?

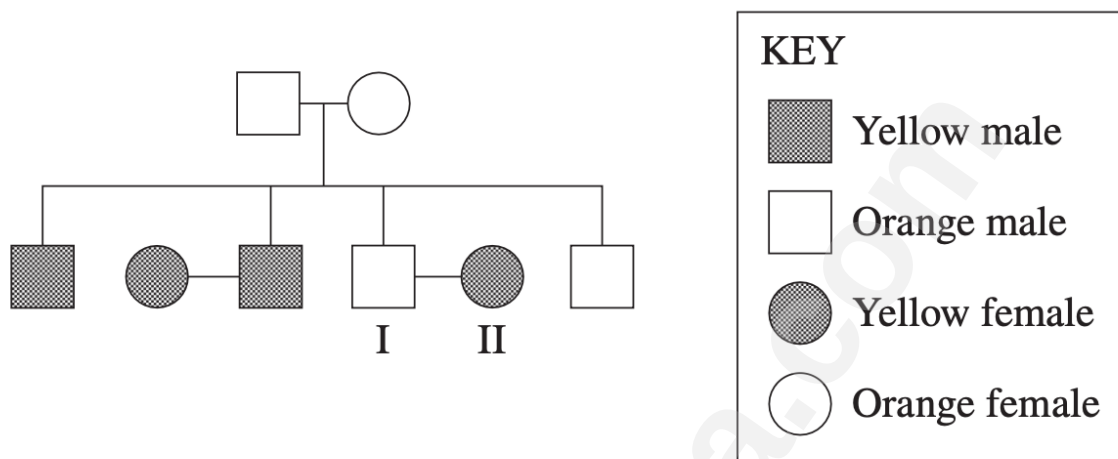
(1)

2.6.2 Use the Mutated DNA sequence and write down the mRNA that will form from the sequence.

(3)

- 2.7 One of the genes involved in determining the colour of a species of fish has two alleles: yellow and orange.**

The diagram shows a pedigree chart for the inheritance of colour in the fish.



[Adapted from: 2020 NSW HSC Biology]

- 2.7.1 Use the pedigree chart to explain why the yellow allele is recessive.**

(2)

- 2.7.2 Explain how a cross between individuals I and II could be used to determine whether the inheritance of colour in the fish is sex-linked or autosomal.**

(5)

TOTAL OF QUESTION 2 [40]

QUESTION 3

- 3.1. A group of students were asked to work out the population size of two similar moth species present in a nearby industrial area. Their results are shown in the Table below.**

Study the Table below and then answer the questions that follow.

	April 2022	May 2022	
Moths	Number Marked	Number Recaptured	Number marked in the Recaptured Sample
SPECIES A	25	106	10
SPECIES B	28	42	8

- 3.1.1. Justify why the students used this method to estimate the population size.**

(2)

- 3.1.2. Estimate the population size of Species B.**

(3)

- 3.1.3. The students discovered that the population size of Species A had decreased significantly from estimates conducted two years before. As the two species are similar, what kind of competition would you expect to find between the two species, then suggest two resources that they may be competing for.**

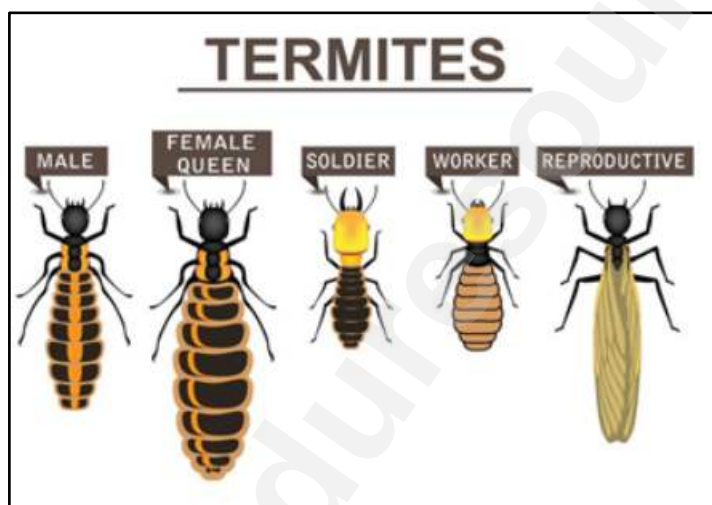
(3)

3.2. Read the passage below about a group of social insects then answer the questions.

Termites have been on Earth for over 50 million years. They have a highly developed social caste system that many believe contributed to the success of this group of organisms. The termite colony lives inside a protective mound. Some mounds can house up to five million termites. The diagram shows the three different castes: the reproductive (the queen and king), the workers and the soldiers. Each caste has a specific job in the colony. The queen lays about 30 000 eggs a day for up to fifteen years. The king provides the sperm to fertilise the eggs. The worker group is the biggest caste. The job of the workers is to feed and groom all of the dependent castes. They dig tunnels, locate food and water, and maintain, build and repair the mound. The soldiers protect the colony from ants and mammal predators such as aardvarks.

Termites eat dead plant materials, generally in the form of wood, leaf litter, soil or animal dung. About 10% of termite species are economically significant as pests that can cause serious damage to buildings, crops or plantation forests. However, termites also play an important ecological role, recycling nutrients from dead wood and improving soil fertility. They are also eaten by humans and provide a useful source of protein in certain African countries.

(Adapted from: Focus on Life Sciences Workbook Grade 12)



[Adapted from: <http://za.pinterest.com/pin/492299803009910728/>]

3.2.1. Some scientists refer to termite colonies as super organisms. A super organism is an organism consisting of many different organisms. Explain, referring to the different castes, why scientists may view a termite colony as one super organism.

(3)

3.2.2. What type of competition exists within the colony? How does the structure of the termite colony ensure that the queen is the only termite able to produce offspring?

(3)

3.2.3. State TWO ways that termites are beneficial to humans. Explain in your answer why these so-called benefits can also be detrimental to human activity.

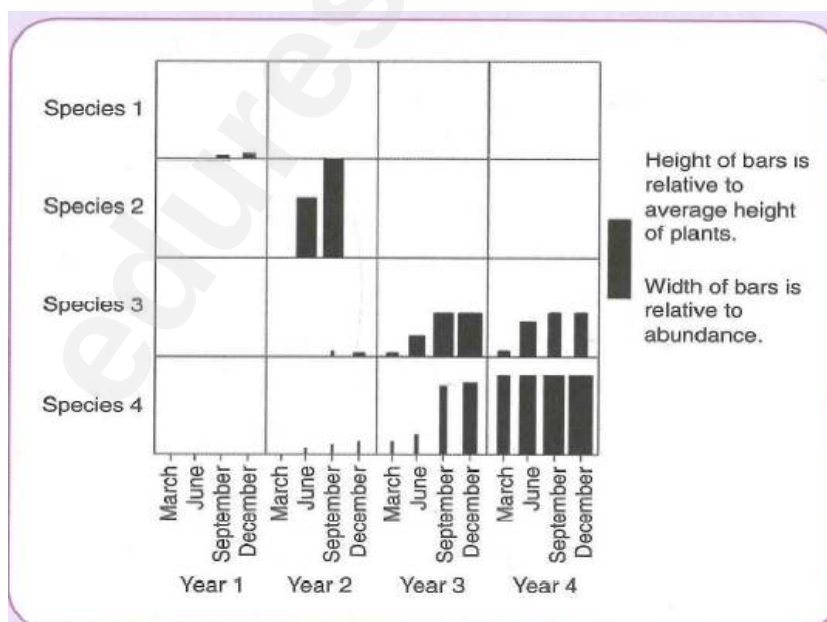
(3)

3.2.4. How many eggs will a queen termite be able to lay in her lifetime? Show your calculations.

(2)

3.3. Study the graph below and then answer the questions that follow.

Succession of four different species over a Period of Four Years



[Adapted from Life Sciences Solutions for All Grade 11]

3.3.1. Does this diagram show primary or secondary succession? Provide a reason for your answer.

_____(3)

3.3.2. Which species is the pioneer species?

_____(1)

3.3.3. Which two species are present in the climax community?

_____(2)

3.3.4. Suggest one possible reason why species two is not present in year 3.

_____(1)

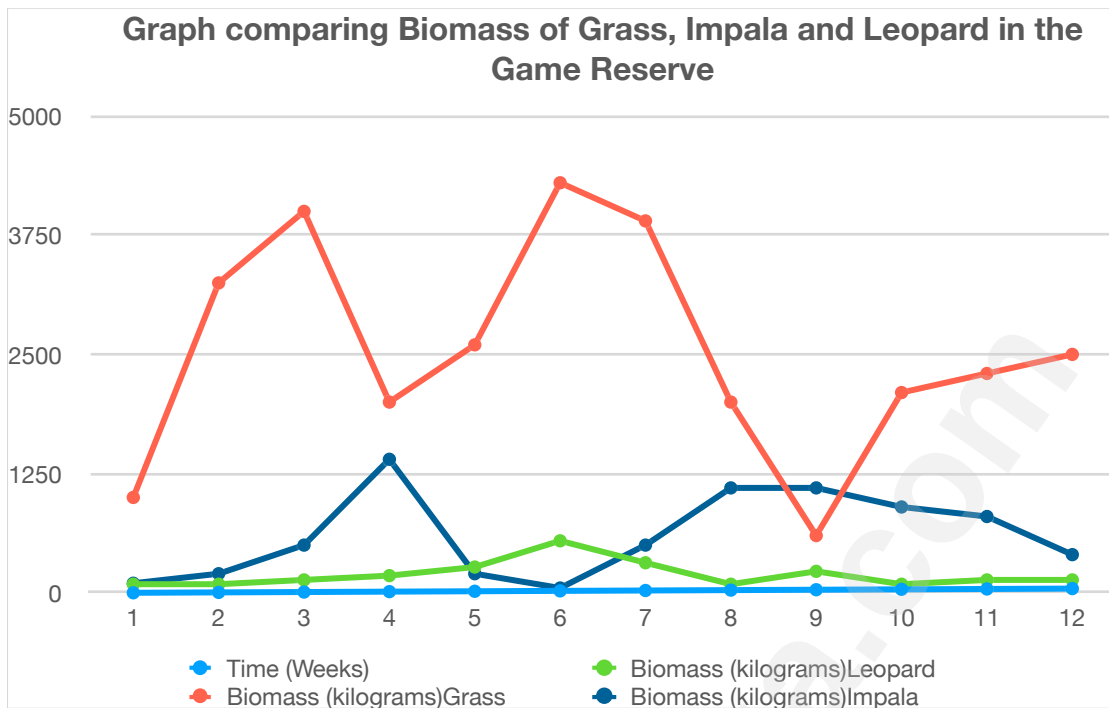
3.3.5. What is the defining characteristic that distinguishes primary succession from secondary succession?

_____(1)

3.4. Some years ago, a group of concerned farmers and landowners met together to establish a Game Reserve that included their properties, as the area supported an abundance of wildlife. A Reserve like this needs Conservation Management to ensure a balanced ecosystem within the fenced area. Read the following passage then answer the questions.

In 1993 a group of farmers fenced an area of grass and shrubs to make an impala reserve. Until then, the area had been used by local farmers for grazing sheep and cattle, and for 200 Impala. The Impala population was kept constant by cheetah and other predators such as leopard, that roamed freely in the area.

After the area was fenced in 1993, the sheep and cattle were moved to another area and the predators were hunted or trapped. An annual record was kept of the impala population. In 2010, the fenced area was increased but no more Impala were added. No predators were found in the newly fenced area. In 2012, a few cheetahs were introduced into the reserve. The carrying capacity of the original reserve was estimated to be 1 400 Impala. The graph below was drawn from data collected from the reserve.



(Adapted from Focus on Life Sciences, Grade 11 Exam Practice Book)

3.4.1. Provide a definition for the term: carrying capacity.

(2)

3.4.2. In Week 6, based on the graph, there was a veld fire in the Game Reserve.

Explain why a veld fire is classified as a density-independent factor and then describe the likely effect that it had on the Game Reserve.

(3)

3.4.3. What type of relationship exists between the leopard and the Impala?

(1)

3.4.4. Suggest a reason why it is useful to include the biomass of the grass on the graph.

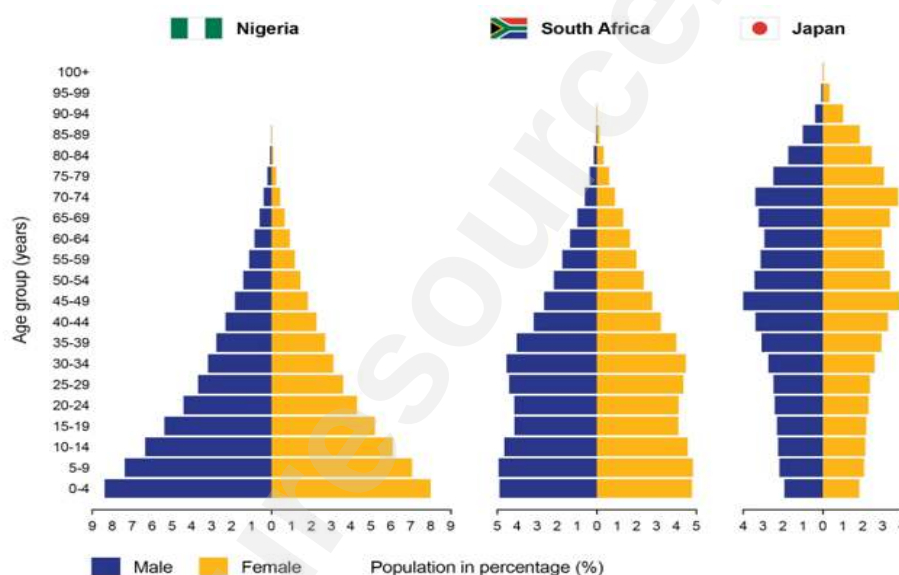
(2)

3.4.5. The average mass of a fully grown leopard is about 45 kilograms. Using the information from the graph, calculate the largest number of leopards that existed in a two-week period on the Game Reserve. Show all working out.

Space for calculation

(2)

3.5. Match the description in Column A with the type of Growth given in Column B for the Population Pyramid Graphs for South Africa, Nigeria and Japan. Write your answer in the Answer Column in the form: Country: A, B or C from Column A; either 1, 2 or 3 from Column B i.e. D7.



Column A	Column B	Answer
A. High birth rate; high mortality rate; lowest life expectancy	1. Negative growth	
B. Low birth rate; low mortality rate; highest life expectancy	2. Rapid growth	
C. Average birth rate; low mortality rate; intermediate life expectancy	3. Stable growth.	

(3)

TOTAL OF QUESTION 3 [40]

QUESTION 4**4.1 Read the following article. Use the information in the text and your own knowledge to answer the questions that follow****Mutation causes defective sperm flagella**

Male infertility impacts over 20 million men worldwide. Researchers say male infertility often comes down to the condition of the sperm. Now, a new study is shedding light on a key mutation which damages the sperm's flagellum, the tail which is crucial to movement. These tails become shorter, irregular, coiled, or even disappear altogether.

Researchers Dr Na Li and Dr Ling Sun at the Guangzhou Women and Children's Medical Center, China collected sperm samples from infertile men as part of their study. They identified one individual with multiple defects that were affecting his sperm flagella. After analysing these samples, the team discovered a specific gene mutation in a relatively unknown sperm protein, FSIP2. This protein is a component of sperm's fibrous sheath.

The fibrous sheath covers the tails of sperm found in humans and mice where fertilisation occurs within the animal's body. It offers the sperm tails flexibility and strength, which is necessary for sperm to swim in the dense and sticky medium of the human body. Interestingly, animals whose sperm swim through water, such as fish, do not have the FSIP2 protein. The diagram of a human sperm is represented by the schematic below.



Source: https://www.ecexams.co.za/2022_November_NSC_Examinations.htm

To study this particular mutation and the function of FSIP2, researchers examined two groups of mice. One group was engineered to have the same FSIP2 mutation as the one infertile man. The other group of mice was engineered to produce more than the normal amount of FSIP2 protein.

Results reveal that mice with the mutation also became infertile, just like the human patient. Their semen contained fewer live sperm and more than half could not swim properly.

On the other hand, mice overproducing the FSIP2 protein remained fertile.

The findings of the research appear in the journal Development.

4.1.1 Use the schematic diagram of a human sperm cell to answer the following questions.

(a) Identify part labelled **A**.

(1)

(b) Describe the role of structure **B** during fertilisation.

(1)

(c) Explain the role of the organelles found in large numbers in part **C**.

(2)

4.1.2 From the text, suggest why the researchers chose to use mice as test subjects to study the effects of this mutation.

(3)

4.1.3 Can this research be regarded as reliable? State TWO reasons in support of your answer.

(2)

4.1.4 State the independent variable of the mice study.

(1)

4.1.5 Explain why editing the DNA could correct this infertility problem.

(2)

- 4.1.6 Gene therapy can be used to edit DNA. In the space provided below, draw a flow diagram to show how this process could occur.

(5)

- 4.1.7 What conclusion can be drawn from the results of this study?

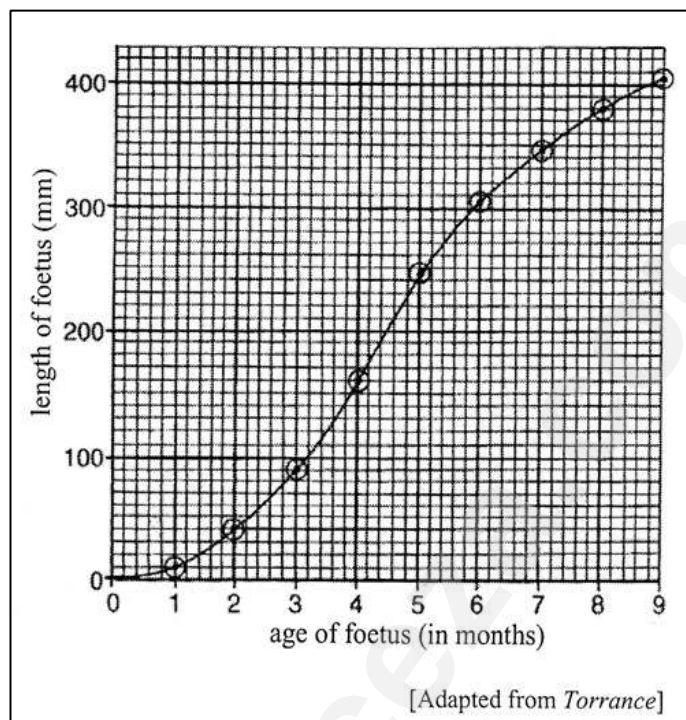
(2)

- 4.2 Use the words, **higher**, **lower**, **same**, as appropriate to complete the following table to compare the composition of the blood in the umbilical vein with that in the umbilical artery.

Content in umbilical vein	Level in umbilical vein compared to umbilical artery
Oxygen	
Urea	
Glucose	

(3)

- 4.3 The graph below shows the growth in length of a human foetus before birth. Study the graph and answer the questions that follow.



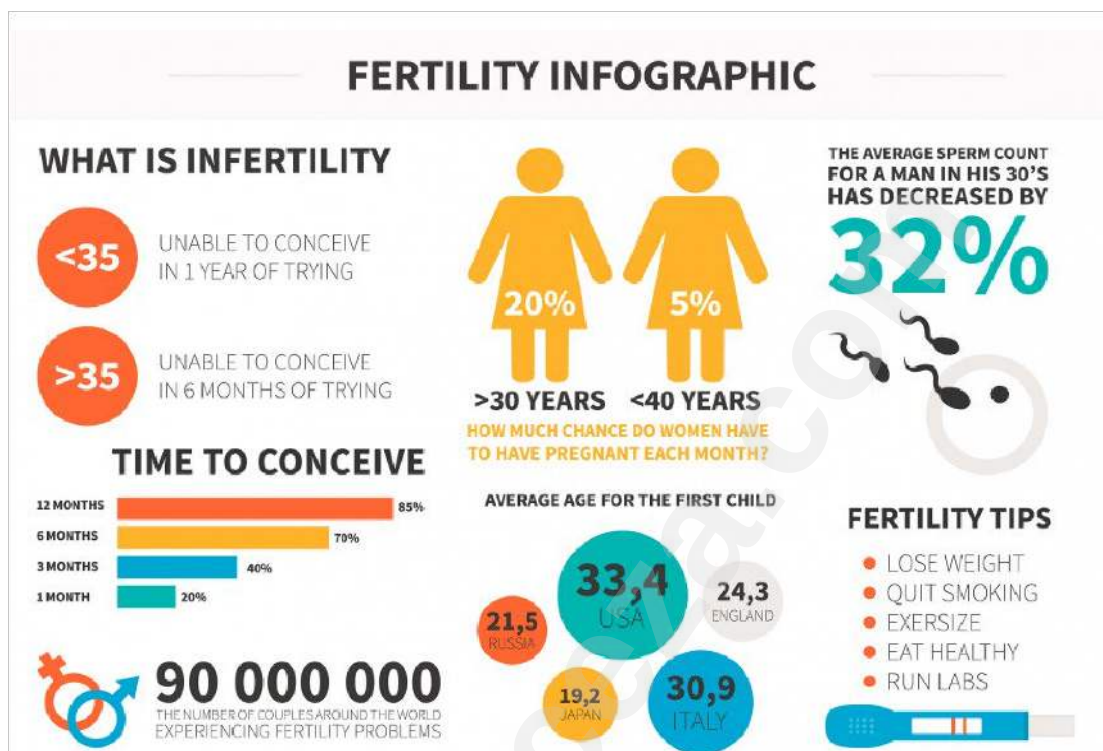
- 4.3.1 What was the length of the foetus at five months?

(1)

- 4.3.2 What was the average rate of growth of the foetus per month during the last trimester of pregnancy? Show your working.

(3)

- 4.4 Infertility is increasingly becoming a global issue. Use the Infographic below to answer the following questions.



[Adapted from: <https://www.vectorstock.com/royalty-free-vector/fertility-infographic-vector-3324703>]

- 4.4.1 Based on the data shown on the infographic, between Japan and USA, which country has a higher fertility rate?

(2)

- 4.4.2 List any three causes of infertility shown on the infographic.

(3)

- 4.5 Ultrasound scans can be used to measure the size of follicles in the human ovary. Once a follicle is located, the screen is frozen while a measurement is taken. The diameter of a follicle gives us an idea of the stage of development of the follicle.

In an investigation, the follicle size of 50 women was investigated over a period of 25 days, beginning when menstruation started in each woman. The changes in diameter of the follicles were measured and recorded. The average diameter on each day was recorded in the table below.

Table showing average follicle size during 25 days

Days of cycle when follicles were measured	Average follicle diameters of 50 women (mm)
5	6,9
10	13,3
13	18,8
14	22,0
20	3,4
25	2,6

4.5.1 Name the hormone responsible for the increase in follicle size from Day 5 to Day 14.

(1)

4.5.2 Explain the sudden drop in follicle size from Day 14 to Day 20.

(2)

4.5.3 A follicle not only responds to hormone messages, it also sends hormone messages.

(a) Name two hormones that are secreted by the follicles and indicate during which days they were secreted, based on the data in the table above.

(4)

(b) Explain one function of each of the hormones you have mentioned in Question 4.5.3 (a) above.

(2)

TOTAL OF QUESTION 4 [40]

[illegible]