CSSA

2021

TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

DO NOT REMOVE PAPER FROM EXAMINATION ROOM

Centre Number

Student Number

Biology

Morning Session

Saturday, 31st of February 2021

General Instructions:

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Use the Multiple-Choice Answer Sheet provided
- Draw diagrams using pencil
- NESA-approved calculators may be used
- Write your Centre Number and Student Number on the top of this page

Total marks: 100

Section I – 20 marks (pages 2 – 12)

- Attempt Questions 1-20
- Allow about 35 minutes for this section

Section II – 80 marks (pages 13 – 31)

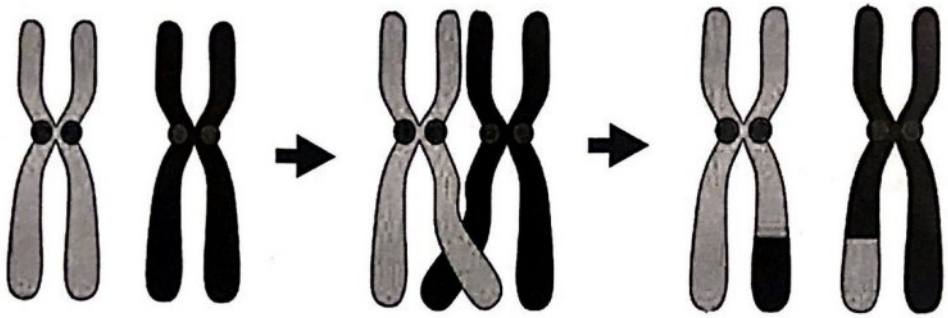
- Attempt Questions 21 – 33
- Allow about 2 hours and 25 minutes for this section

Section I
20 marks

Attempt Questions 1–20
Allow about 35 minutes for this section

Use the Multiple-Choice Answer Sheet for Questions 1–20.

1 The diagram depicts the process of crossing over, which occurs between homologous chromosomes during meiosis.



What is the result of this process?

A. An increase in offspring variation

B. The deletion of amino acids in proteins

C. An increase in mutations in genetic material

D. The production of gametes that are genetically identical

2 Antiviral medications affect viruses by

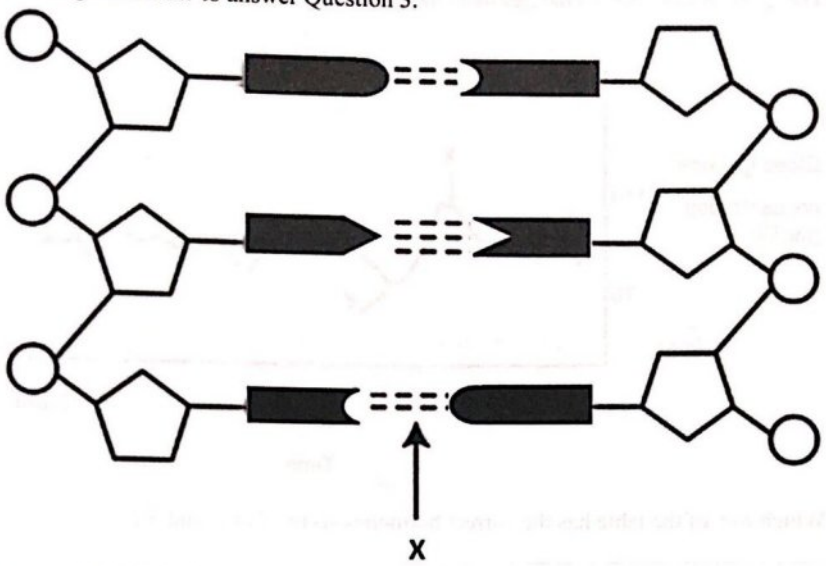
A. killing them.

B. disrupting their reproduction.

C. destroying viral cell membranes.

D. destroying toxins produced by viruses.

3 Use the diagram below to answer Question 3.



The arrow labelled X is pointing to a

A. nucleotide.

B. peptide bond.

C. covalent bond.

D. hydrogen bond.

4 Which of the following outlines a physiological adaptation that assists the red kangaroo to maintain a constant body temperature?

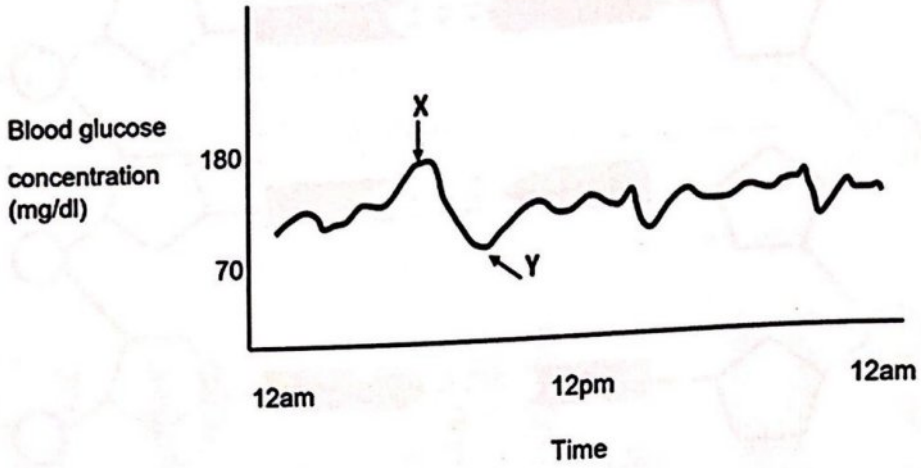
A. It has a dense network of capillaries in its forearms

B. On hot days it is often observed to lick its forearms

C. In summer it spends the hottest part of the day lying in the shade

D. Blood flow to the capillaries of its forearms increases in hot weather

5 The graph below shows changes in an individual's blood glucose concentration over time.



Which row of the table has the correct hormones secreted at X and Y?

	X	Y
A	Glucose	Glucagon
B.	Glucagon	Insulin
C.	Insulin	Glucose
D.	Insulin	Glucagon

6 The statements below relate to various types of proteins in living organisms. Which statement correctly outlines the function of a type of protein?

A. Some hormones play a role in growth and reproduction

B. Antibodies produced by T cells recognise a unique antigen

C. All enzymes are essential to the structure of the cell membrane

D. Antibodies transport materials into and out of the cell membrane

7 Which of the following reduces the genetic diversity within a population?

A. Mutation

B. Gene flow

C. Genetic drift

D. Sexual reproduction

8 Which of the following situations will increase the prevalence of a non-infectious disease in a population if all other factors remain constant?

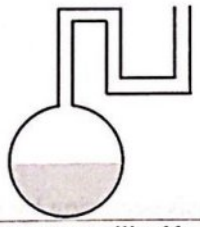
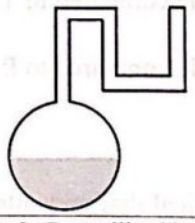
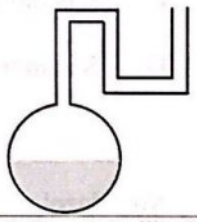
A. Incidence rate of the disease falls

B. Patients recover faster from the disease

C. Survival time with the disease increases

D. Population size in which the disease is measured increases

9 A class of Biology students wanted to recreate Pasteur's famous experiment. They filled four flasks with broth as shown in the labelled diagrams below.

			
Flask A: sterilised by boiling but not sealed	**Flask B**: sterilised by boiling but not sealed	**Flask C:** sterilised by boiling and then sealed	**Flask D**: not sterilised by boiling and not sealed

Which two flasks do students need to use to demonstrate that discoloured broth is caused by microbes in air?

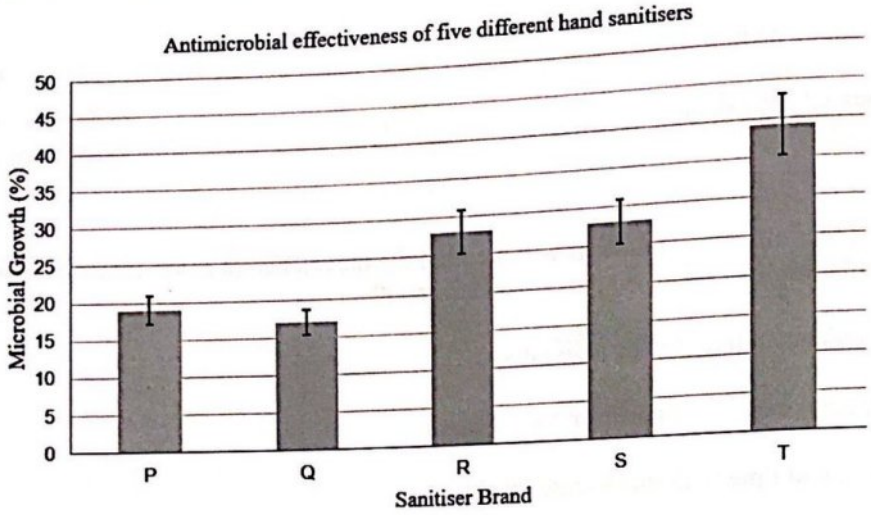
A. A and B

B. A and C

C. B and D

D. C and D

10 Students conducted a valid investigation to determine the antimicrobial effectiveness of five different brands of hand sanitisers. They graphed their results and showed the standard deviation of their data using error bars for each type of hand sanitiser. The higher the standard deviation of the data, the greater the spread of data.



Which statement about the data collected for each brand of hand sanitiser is correct based on the information presented in the students' graph?

A. Q is the least reliable overall

B. R is less reliable compared to T

C. P is more reliable compared to T

D. S is more reliable compared to P

11 Nocodazole is a chemical that prevents mitosis occurring by interfering with the production of microtubules which form the mitotic spindle fibres.

Which statement correctly identifies how this chemical might work?

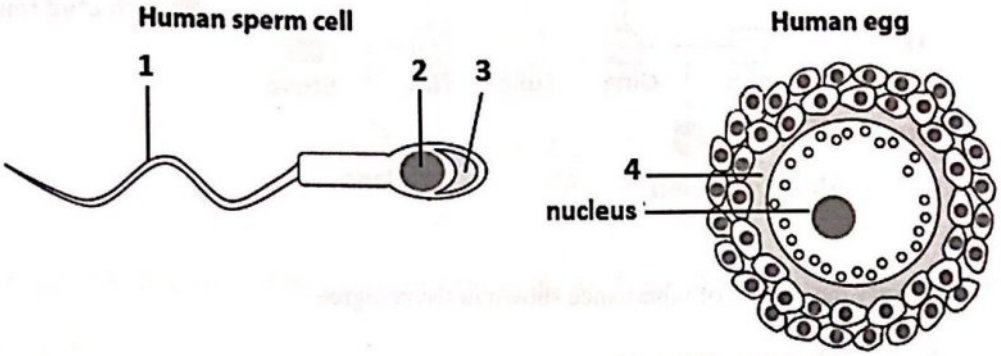
A. It prevents the formation of the centromeres

B. It prevents the disintegration of the nuclear membrane

C. It inhibits the condensation of chromatin into chromosomes

D. It prevents the migration of sister chromatids to opposite poles

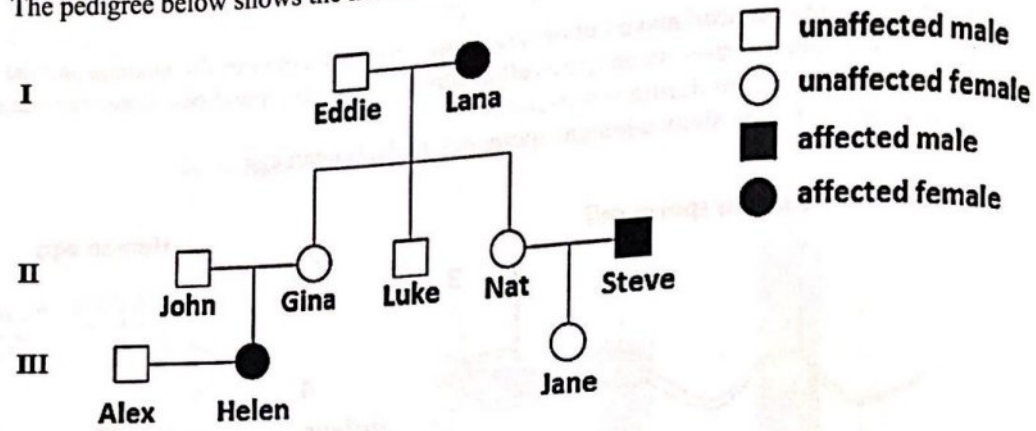
12 Human egg cells are large cells surrounded by an extracellular coat called the zona pellucida.
Sperm cells have a head and a tail or flagellum. The head contains the nucleus and the acrosome which releases an enzyme called acrosin that digests and penetrates the zona pellucida of the ovum during fertilisation.
The diagrams below show a human sperm cell and a human egg.



Choose the option that correctly links all three statements to the corresponding labels on the diagrams above.

	Site containing a haploid number of chromosomes	Site of acrosin release	Target site of acrosin
A.	3	2	4
B.	3	2	1
C.	2	3	4
D.	2	3	1

13 The pedigree below shows the inheritance of a genetic disorder in a family.



Identify the pattern of inheritance shown in the pedigree.

A. Autosomal, dominant

B. Autosomal, recessive

C. Sex linked, dominant

D. Sex linked, recessive

14 Some of the steps involved in gene cloning are given below.

1. Insertion of isolated gene into an appropriate cloning vector to create recombinant molecules
2. Introduction of recombinant vector to a suitable host for propagation
3. Isolation of target gene
4. Screening and selection of hosts that express the recombinant gene
5. Extraction of recombinant gene product

Which of the following is the correct sequence of steps involved?

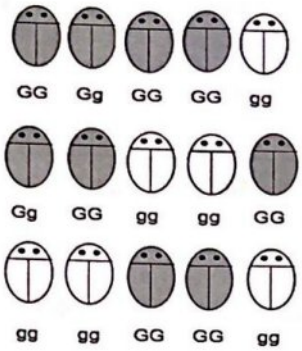
A. 1, 2, 3, 4, 5

B. 2, 1, 3, 4, 5

C. 3, 1, 2, 4, 5

D. 3, 1, 4, 2, 5

15 The frequency of an allele in a population refers to the proportion of the population that have that allele. In a population of beetles, grey colour (G) is dominant over white colour (g). The diagram below shows the phenotypes and genotypes of a population of beetles.



Calculate the frequency of the dominant allele in the beetle population shown in the diagram.

A. 0.60

B. 0.53

C. 0.46

D. 0.30

16 A pharmaceutical company has developed a new drug that increases the concentration of the High-Density Lipoprotein HDL (good cholesterol) in the blood.

To test this new drug scientists designed a trial as follows:
- 10,000 people were involved in the trial
- 50% of them (Group A) were given the new drug and a statin (a drug that reduces the level of bad cholesterol in the blood)
- The other half (Group B) were given the same statin without the new drug

The results showed the following:
- There was an increase in the concentration of HDL in the blood of the 10,000 people
- There were 70 deaths in Group A
- There were 30 deaths in Group B

In view of the results of the trial, what measure should the company take?

A. Discontinue the trial immediately

B. Increase the dose of the new drug

C. Advise people to stop taking statins

D. Increase the number of people taking part in the trial

17 Use the table below to answer Question 17.

Lung Cancer in some developed countries in 2012 per 100,000 people

	Australia	Canada	Denmark	Germany	Italy	New Zealand	USA
Incidence Rate	49.4	73.5	81.6	62	61.1	45.4	67.8
Mortality rate	35.9	58	68.1	53	55	37.2	53.1

What conclusion can be made from this data table?

A. In 2012 there were more smokers in Denmark than in Australia

B. In 2012 more people were diagnosed with lung cancer in Canada than in USA

C. People diagnosed with lung cancer in 2012 had a greater risk of dying from the disease in Italy than in Australia

D. A higher percentage of the population was diagnosed with lung cancer in Australia than in New Zealand in 2012

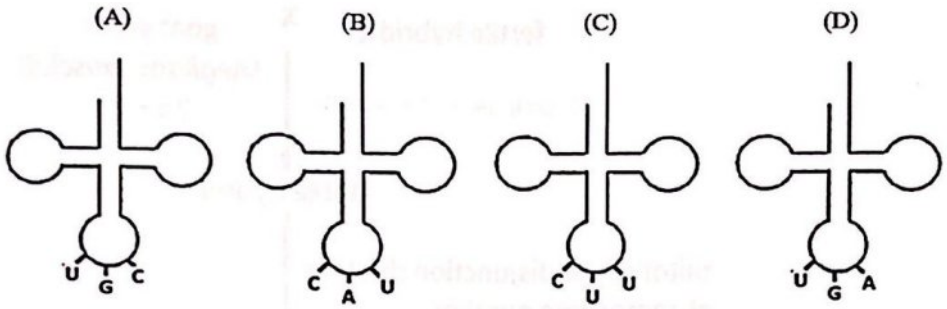
18 The same section of amino acid sequences in normal and sickle cell haemoglobin are shown below.

Normal haemoglobin	Sickle cell haemoglobin
thr-pro-glu-glu	thr-pro-val-glu

The possible mRNA codons for these amino acids are as follows:

threonine (thr) ACU ACC
proline (pro) CCU CCC
glutamine (glu) GAA GAG
valine (val) GUA GUG

Which tRNA molecule is NOT involved in the formation of this section of the sickle cell haemoglobin?



19 In the winter of 2009, the human swine flu (H1N1) pandemic occurred. The first person to be diagnosed in Australia was a woman who flew in from the USA. By the end of 2009, the Department of Health reported 37,537 cases of H1N1 across Australia.
In 2017 there was a measles outbreak in Western Sydney. It was determined that the outbreak was most likely caused by a person who became infected with the measles virus in Indonesia and spent some time in Western Sydney while infectious. 16 cases of measles were associated with the outbreak.

Which of the following statements is a reason the H1N1 virus spread more extensively than the measles virus throughout the Australian population?

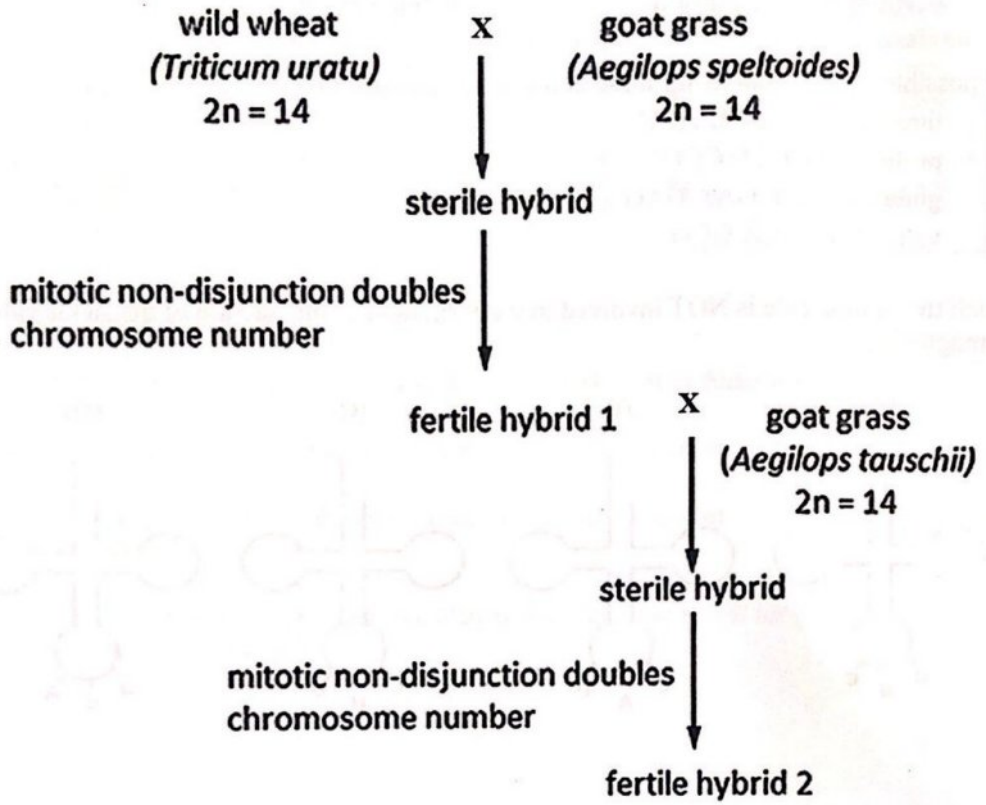
A. There was more international travel in 2009 than in 2017.

B. A large portion of the Australian population was vaccinated against measles.

C. By the time they reach adulthood most Australians have acquired immunity to the H1N1 virus.

D. H1N1 can only spread through the air whereas measles can spread via aerosol droplets.

20 The diagram shows cross breeding between wild wheat and two species of goat grass. **X** indicates the point where crossbreeding has occurred.



What is the chromosome number of the fertile hybrid 2?

A. 28

B. 42

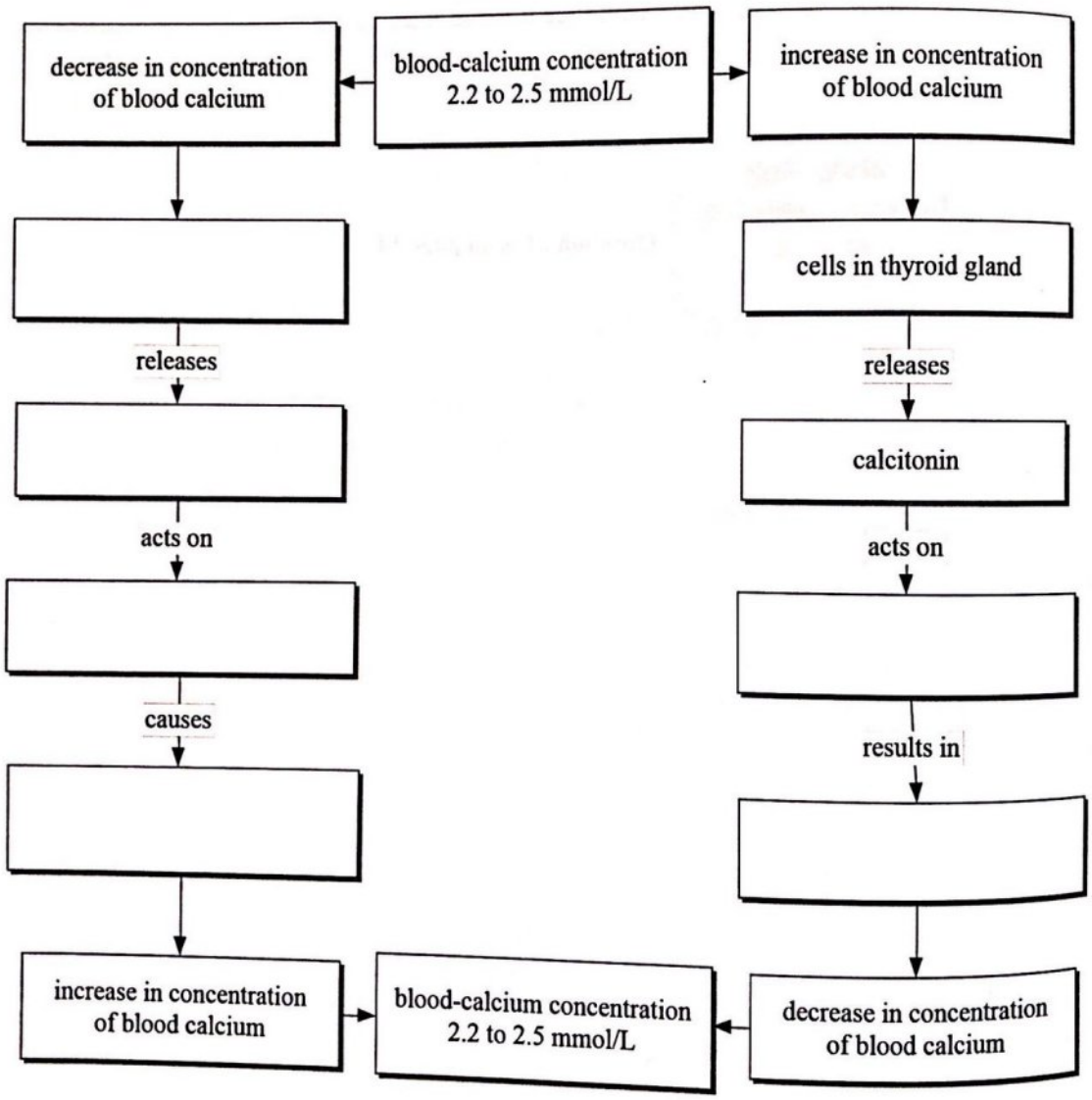
C. 56

D. 140

Question 21 (3 marks)

An example of homeostasis in humans involves the maintenance of a stable calcium concentration in blood. Parathyroid hormone is released by the parathyroid gland when the concentration of calcium in the blood is lowered. Parathyroid hormone causes bone cells, called osteoclasts, to break down bone tissue and release calcium into the blood. The hormone calcitonin is released by cells in the thyroid gland when calcium levels in the blood are raised. Calcitonin acts on bone tissue and increases the amount of calcium deposits in the bone.

Use the information given above to complete the flowchart by filling in the SIX empty boxes.



Question 22 (6 marks)

A class of Biology students were curious about the "use by date" labels on milk containers. They were interested to find out if milk that has passed its "use by date" contains more bacteria and is therefore not safe to consume.

Design a safe experiment to test whether the amount of bacteria in milk is related to the "use by date".

Hypothesis: .....

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Safe work practices: .....

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Method: .....

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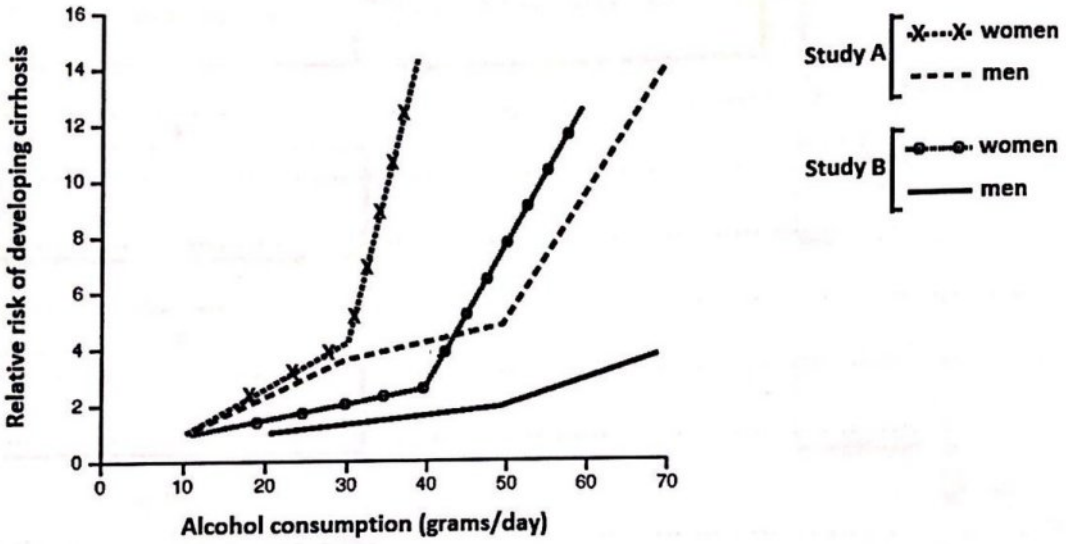
Question 23 (6 marks)

Cirrhosis is the most serious type of liver disease as it is the cause of many deaths and severe illnesses. In cirrhosis, scar tissue replaces normal liver tissue, disrupting blood flow through the liver, thus preventing it from functioning properly.
Epidemiological studies have evaluated factors that contribute to cirrhosis and have found that the main factor is the excessive consumption of alcohol.
In the 1980s, two studies of people from different backgrounds, Study A and Study B, were carried out to determine the relative risk of developing cirrhosis in relation to the amount of alcohol consumed each day by men and women. Both studies showed that the risk of cirrhosis was related to the amount of alcohol consumed.
The graph below shows the results of these two studies.



(a) Using the information in the graph, outline one similarity and one difference in the results for women in Studies A and B and suggest one reason for the difference. 3

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Question 23 continues on page 17

(b) Is the risk of developing cirrhosis linked to gender? Use data from the graph to justify your answer. **3**

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Question 24 (5 marks)

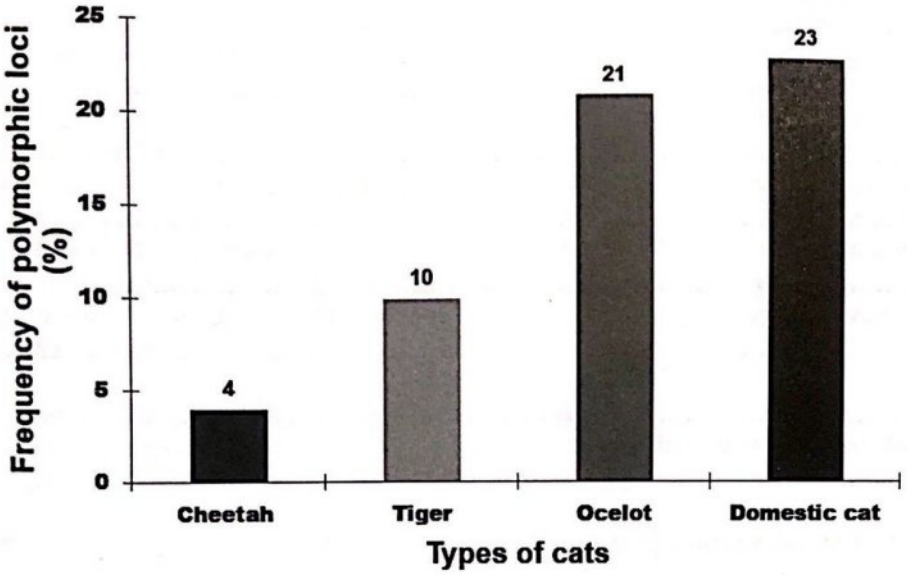
Kangaroo Grass (*Themeda triandra*), is a flowering plant that can reproduce both asexually and sexually.

Complete the table below to compare these two modes of reproduction in flowering plants.

Type of reproduction	Asexual	Sexual
Definition		
Description		
Advantages		

Question 25 (4 marks)

A gene is said to be polymorphic if more than one allele occupies that gene's locus (position on a chromosome) within a population.
One way to measure genetic diversity in a population is to find the percentage of genes that have different alleles, which is known as the frequency of polymorphic loci.
The graph below shows the frequency of polymorphic loci in four types of cats.



Use the information in the graph above and your own knowledge of genetic diversity to explain why the cheetah is at most risk of extinction if the environment changes.

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Question 26 (4 marks)

Scientific research has potential benefits for society.
Evaluate this statement using a named genetic technology.

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Question 29 (2 marks)

A conditional mutation is one that results in a change in phenotype only under certain conditions. The enzyme tyrosinase is involved in producing dark coloured fur in Siamese cats. A conditional mutation results in the production of a faulty version of tyrosinase. The faulty tyrosinase functions properly at low temperatures, but it becomes inactive at body temperature. A cat's extremities (ears, feet and tail) have a large surface area and so lose heat faster in cold conditions.

The diagram below shows three cats with different fur colour distributions.
The shaded areas represent dark coloured fur and non-shaded areas represent light coloured fur.

Cat A **Cat B** **Cat C**

Complete the following table to identify the cat that matches each of the following descriptions.

Description	Cat
Cat with functional tyrosinase	
Cat with defective tyrosinase living in a hot country	
Cat with defective tyrosinase living in a cold country	

Question 27 (4 marks)

In 2020 there was an international drive to develop an effective COVID-19 vaccine. Below is some information about the methodology of a study carried out by a pharmaceutical company to test the efficacy of their vaccine.

- The vaccine was administered to over 10,000 people worldwide. The study included people of diverse backgrounds, both male and female, and from various age groups. Most of the people in the study were given two full doses of the vaccine, but 2741 people were only given half a dose initially, then a full dose later. When the data was analysed later it was noticed that none of the people that were only given the half dose initially were over 55 years of age. There were people aged over 55 in the group that received two full doses of the vaccine.
- Another group of people was involved in the study. This group was given injections of saline water, instead of the vaccine.
- Both groups were monitored for symptoms of COVID-19 and had regular COVID-19 tests.
- Over time it was found that the people who received the vaccine had a lower chance of testing positive for COVID-19 than those who had received saline water only. The efficacy of the vaccine was determined to be 62% when two full doses were administered. The researchers were surprised to find that the efficacy was higher (90%) for the group that had been given half a dose initially.

Based on these results the pharmaceutical company announced:
"While the results appeared to indicate a higher efficacy in human trials with the lower dosage, a further study would be carried out to validate this."

Assess the methodology of the investigation described above and the announcement made by the pharmaceutical company.

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Question 28 (7 marks)

In Netherland Dwarf rabbits, agouti (dull brown) hair colour is dominant over black hair colour. A breeder places a heterozygous female rabbit in the same enclosure with an agouti male of unknown genotype.

(a) The female produces litters of rabbits. All the offspring are only ever agouti. Use a Punnett square to determine the genotype of the male rabbit. 3

(b) The breeder suspects that the neighbour's rabbit may have entered the enclosure and mated with the female. The neighbour's rabbit has the same genotype as the male rabbit in the cage. Describe a technology that could be used to determine which rabbit fathered the litter. 4

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Question 30 (17 marks)

(a) A woman is in the early stages of pregnancy. Identify ONE hormone involved in pregnancy and explain its importance. 3

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(b) The woman contracts a common cold. Describe TWO chemical changes that may occur in her body's cells and tissues. 4

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Question 30 continues on page 25

(c) The woman's obstetrician advised her to undergo a genetic test as she is over 35 years in age. The results indicate that the unborn child has Townes-Brocks Syndrome, an autosomal dominant genetic disorder caused by a point mutation. Some of the symptoms of Townes-Brocks Syndrome include abnormal ears associated with hearing impairment and abnormalities in the feet, heart and kidneys. Explain how a point mutation could cause these types of abnormalities. **4**

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Question 30 continues on page 26

(d) Further tests after birth reveal that the child has reduced kidney function and hearing loss. Evaluate the effectiveness of a technology that could assist with ONE of these conditions. **6**

Question 31 (8 marks)

The Spanish flu is a viral disease. The 1918 Spanish flu, before it was brought under control, is estimated to have killed between 17 - 50 million people.

(a) Antibiotics had not been developed in 1918. Would antibiotics have brought the pandemic under control sooner? Explain your answer. **2**

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(b) With reference to specific examples, assess the importance of understanding the mode of transmission of infectious diseases in order to achieve control of these diseases. **6**

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Question 32 (7 marks)

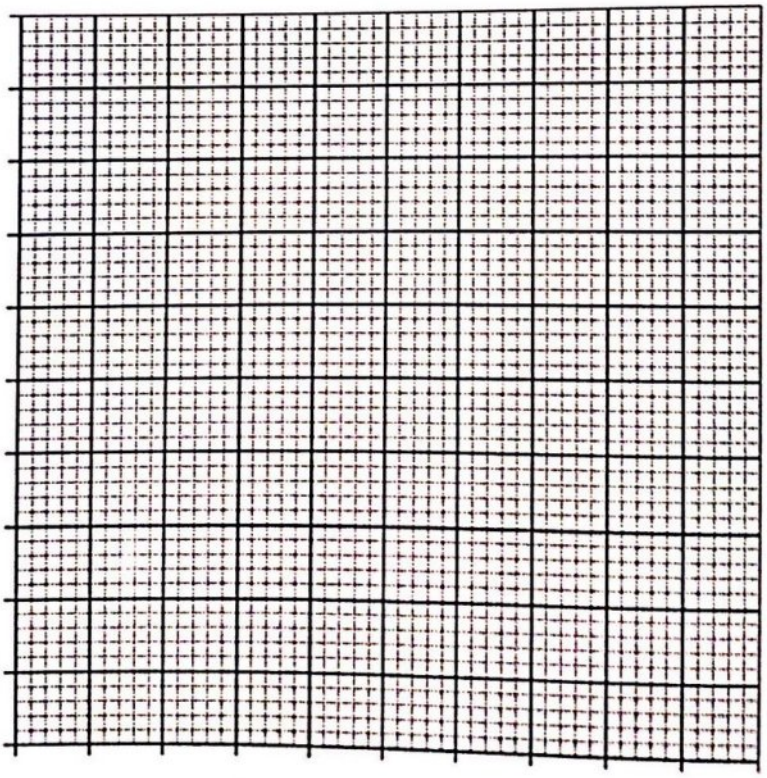
Since 1986, all newborns in Australia have been subject to a heel prick test which is a form of newborn screening. This test is used to screen for a few genetic conditions, such as cystic fibrosis (CF) and Phenylketonuria (PKU). In countries where newborn testing is not compulsory, genetic conditions such as CF and PKU may be identified later in life, in other ways.

The table below shows the medical status of children with a medical condition who were identified through newborn screening compared to other ways.

Medical status	Newborn screening (%)	Other ways (%)
Hospitalisation in first 6 months	28	55
Neurological complications	14	58
Additional support services	20	73

(a) Graph the data in the above table in the grid below. **3**

Medical status of children whose genetic condition was diagnosed through newborn screening versus other ways



Question 32 continues on page 29

(b) With reference to the data explain the social implications of newborn screening for genetic diseases. **4**

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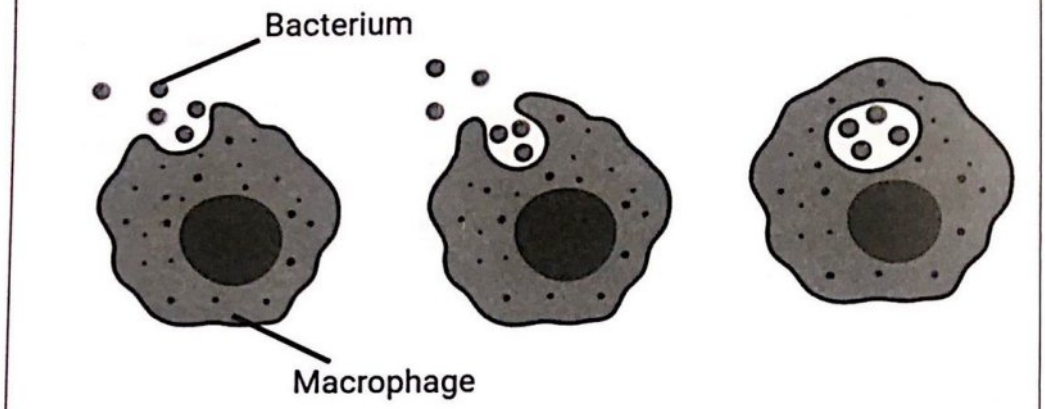
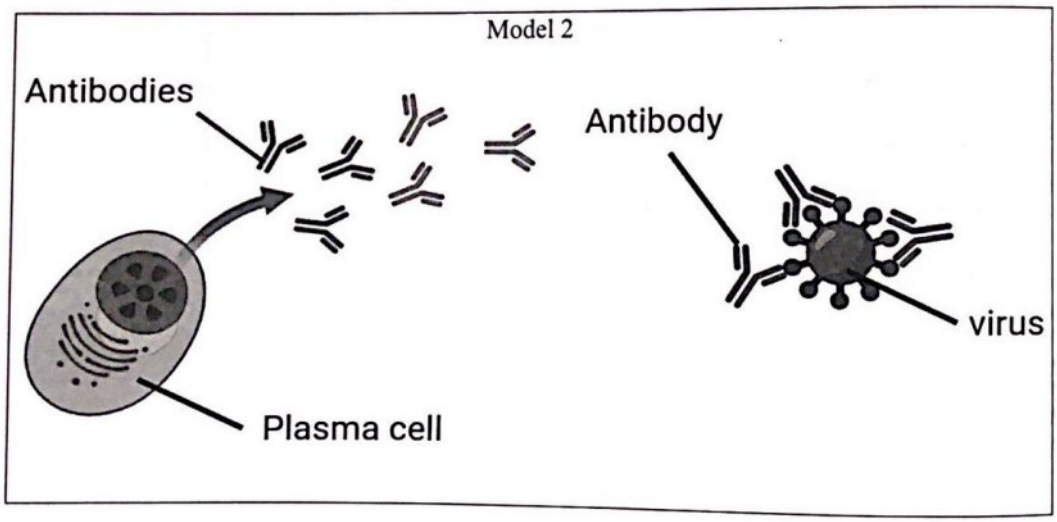
Question 33 (7 marks)

Below are two models that each represent a different aspect of the immune response in humans.

Model 1



Model 2



Construct a table to compare the processes represented in each model and assess the effectiveness of each model in representing these processes. The table must include the following:

- process that the models represent
- description of each process
- assessment of the effectiveness of each model in representing the processes.

Question 33 continues on page 31

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End of examination

Section II extra writing space
If you use this space, clearly indicate which question you are answering by writing the question number before beginning the response.