



Smith's Hill High School

Promoting excellence in a spirit of trust and co-operation

STUDENT NAME / BOS NUMBER: _____

TEACHER: _____

Year 2022
HSC
Assessment Task 4

Biology

General Instructions

- Reading time – 5 Minutes
- Working time – 3 hours
- Write using black pen
- Write your name and / or student number at the top of every page
- Show all relevant working
- NESA approved calculators may be used

Total Marks - 100

Section I

20 Marks

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

Section II

80 Marks

- Attempt Questions 21-35
- Allow about 2 hours 25 mins for this section

This paper MUST NOT be removed from the exam room

Student Number/Name:

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Section I – 20 marks

Attempt Questions 1-20

Allow about 35 minutes for this part

Use the multiple-choice answer sheet provided for Questions 1-20

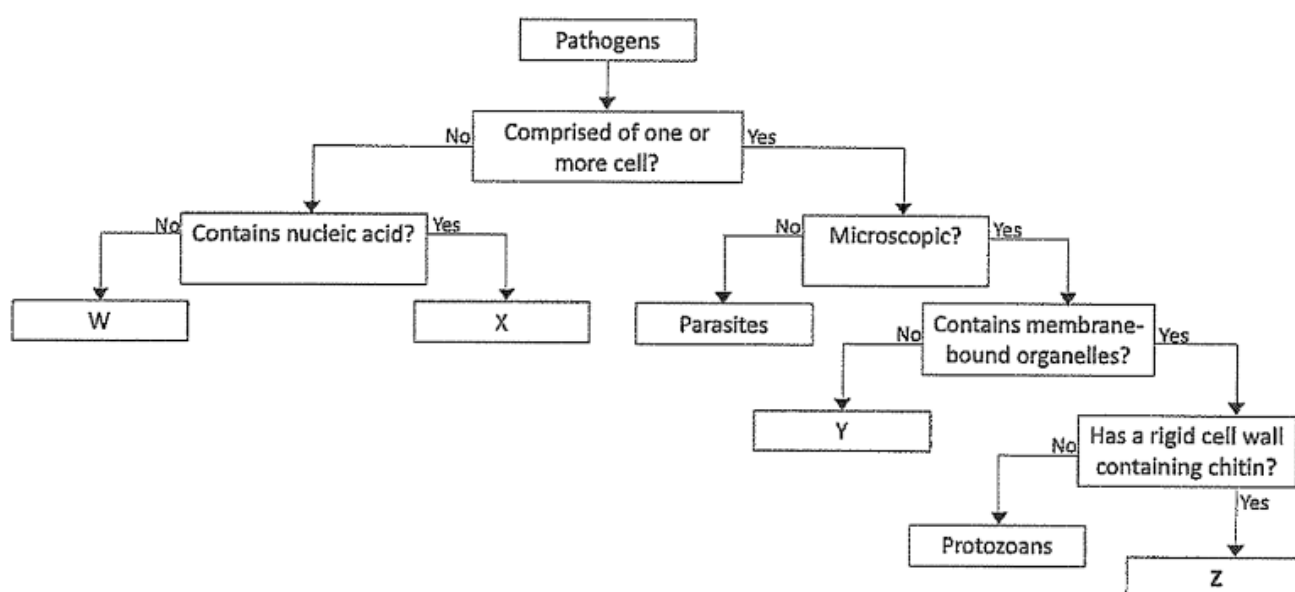
1. A certain cell is known to be eukaryotic, heterotrophic and capable of causing disease. Which of the following is it likely to be?
 - (A) a macrophage
 - (B) a bacterium
 - (C) a fungus
 - (D) a virus

2. One difference between T-lymphocytes and B-lymphocytes is:
 - (A) Only B-lymphocytes can produce memory cells.
 - (B) B-lymphocytes produce antibodies and T-lymphocytes attack infected cells.
 - (C) Only B-lymphocytes can produce antigens.
 - (D) B-lymphocytes attack pathogens and T-lymphocytes attack tumour cells.

3. The woolly mammoth was a large mammal that became extinct approximately 4000 years ago. Reduced genetic diversity associated with a small population size contributed to the extinction of this species and was probably due to:
 - (A) artificial selection.
 - (B) gene flow.
 - (C) mutation.
 - (D) genetic drift.

4. The approximate number of amino acids that could be coded for by a fully processed mRNA molecule comprising 1500 nucleotides is:
 - (A) 150
 - (B) 300
 - (C) 500
 - (D) 700

5. Errors in the production of insulin by the pancreas can cause serious metabolic disorders in the body. Which of the following is NOT a consequence of increased insulin concentration in the blood?
- (A) increased synthesis of glucagon in the liver
 (B) increased production of glycogen by the liver
 (C) increased uptake of glucose by muscle and fat cells
 (D) increased conversion of glucose to fat in fat cells
6. The following is a flowchart which is used to identify unknown pathogens. Some of the labels are missing.



Which of the following rows correctly identifies the missing labels?

	<i>W</i>	<i>X</i>	<i>Y</i>	<i>Z</i>
(A)	Proteins	Viruses	Prokaryotes	Eukaryotes
(B)	Prions	Viruses	Bacteria	Fungi
(C)	Prions	Viruses	Fungi	Bacteria
(D)	Viruses	Proteins	Prokaryotes	Fungi

7. Myrtle rust (*Austropuccinia psidii*) is a fungal disease that attacks the soft, actively growing leaves, shoot tips and young stems of *Eucalyptus* and other *Myrtaceae* plants. The disease produces small purple spots which later develop masses of bright yellow spores.



Eucalypt sp. showing purple Myrtle Rust spots

Eucalypts have a number of mechanisms that help them resist or respond to infection by Myrtle rust. They have thick bark and cell walls reinforced with pectin and lignin. Their leaves produce eucalyptus oil, which has antifungal properties. When receptors on the Eucalypt's cell walls detect fungal markers, those cells produce more structural protein to reinforce their cell walls. Cells inside the plant showing fungal antigens are flooded with oxygen, increasing their rate of respiration and causing them to 'burn up'.

Which of the following is a general induced response of *Eucalyptus* to the Myrtle rust?

- (A) the thick bark and thick cell walls
- (B) the production of eucalyptus oil
- (C) the production of structural protein
- (D) the actively growing leaves, shoot tips and young stems

Questions 8 and 9 refer to the information below.

Beta-globin is a component of the haemoglobin protein found in red blood cells. The non-coding strand in the gene for beta-globin begins with the following DNA sequence:

C A C G T G G A C T G A G G A C T C

Sickle cell anemia is a genetic condition caused by the substitution mutation of the 17th nucleotide in this sequence (T) and the resulting change this has on the amino acid sequence. The amino acid glutamic acid (GLU) produced in 'normal' fully functional beta-globin is changed to a valine (VAL) in sickle cell anaemia.

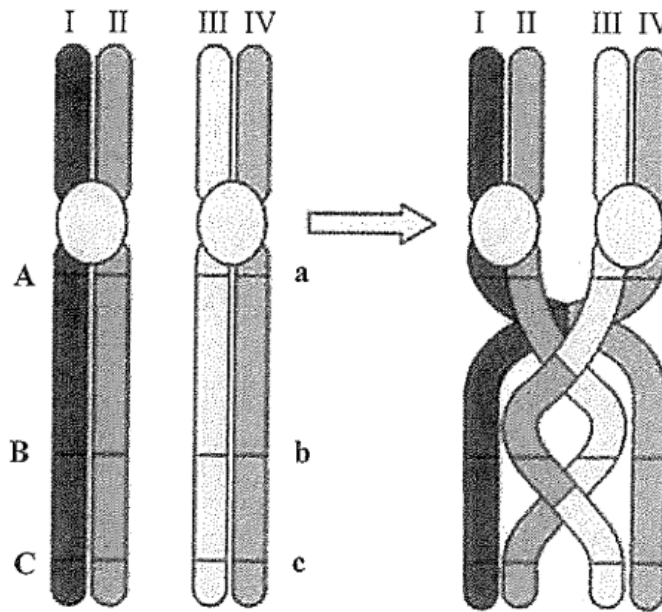
8. What kind of mutation has occurred to cause sickle cell anaemia?
- (A) a chromosomal mutation
 (B) a point mutation
 (C) a frameshift mutation
 (D) a somatic mutation
9. Using the codon table provided below, what nucleotide base was substituted for thymine to produce the sickle cell anaemia mutation?

UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA } Stop UAG }	UGU } Cys UGC } UGA } Stop UGG } Trp
CUU } CUC } Leu CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }
AUU } AUC } Ile AUA } AUG } Met	ACU } ACC } Thr ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }
GUU } GUC } Val GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } Gly GGA } GGG }

- (A) Adenine
 (B) Thymine
 (C) Guanine
 (D) Cytosine

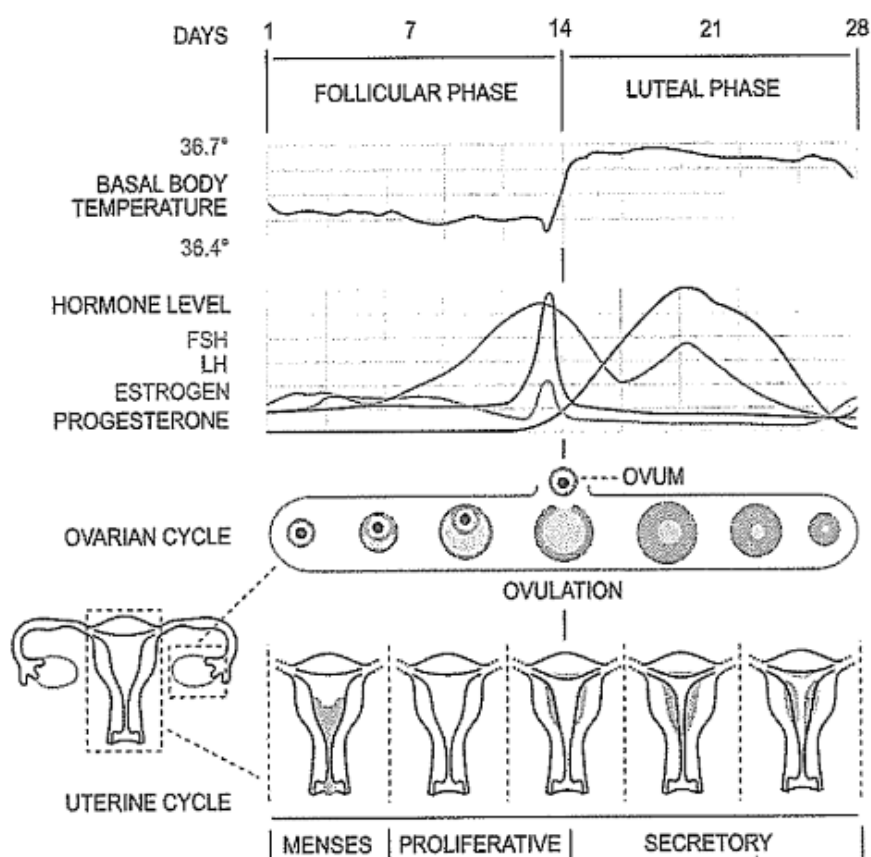
Questions 10 and 11 refer to the diagram below.

The following diagram shows homologous chromosomes as two pairs of sister chromatids labeled with alleles A and a, B and b, and C and c.



10. Which of the following statements is consistent with the process shown above?
- (A) The process is crossing over and increases genetic variation in a population.
 - (B) The process is crossing over and decreases genetic variation in a population.
 - (C) The process is independent assortment and increases genetic variation in a population.
 - (D) The process is independent assortment and decreases genetic variation in a population.
11. Which of the series of chromatids below would be the product of this process?
- (A) AbC, Abc, abC, aBc
 - (B) ABC, ABc, abC, abc
 - (C) ABc, ABc, abC, abC
 - (D) Abc, AbC, aBc, aBC

12. In watermelons, fruit bitterness is caused by two alleles of a gene, where an allele for bitter fruit is dominant over an allele for sweet fruit. A plant that is heterozygous for these two alleles is crossed with a plant with sweet fruit. The expected fruit phenotypes resulting from this cross would be
- (A) all bitter fruit
 (B) all sweet fruit
 (C) 50% bitter fruit and 50% sweet fruit
 (D) 75% bitter fruit and 25% sweet fruit
13. The menstrual cycle, like many bodily processes, is controlled by the action of hormones. The following diagram shows how the levels of some hormones change over the course of a typical menstrual cycle.



Not all ovulation occurs on day 14 —some cycles are longer or shorter.

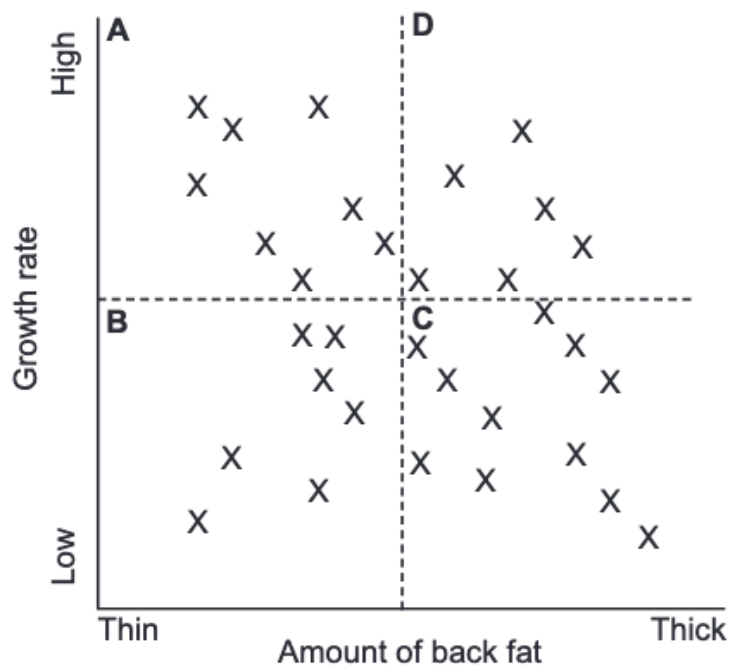
Using the information provided, how can a person determine that ovulation has occurred?

- (A) The uterine lining begins to shed (menses/menstruation).
 (B) Basal body temperature decreases.
 (C) Basal body temperature increases.
 (D) Menses/menstruation finishes.

14. Which of the following is the chemical composition of a chromosome?

- (A) carbohydrate and lipid
- (B) DNA and protein
- (C) lipid and DNA
- (D) protein and carbohydrate

15. A biologist measured the growth rate and the thickness of the back fat in a group of pigs raised in identical conditions. The results are shown in a diagram where each 'X' represents one pig. The biologist divided the pigs into four groups —A, B, C and D, according to their growth rate and thickness of back fat, as shown in the diagram.



What type of trait is growth rate in this group of pigs?

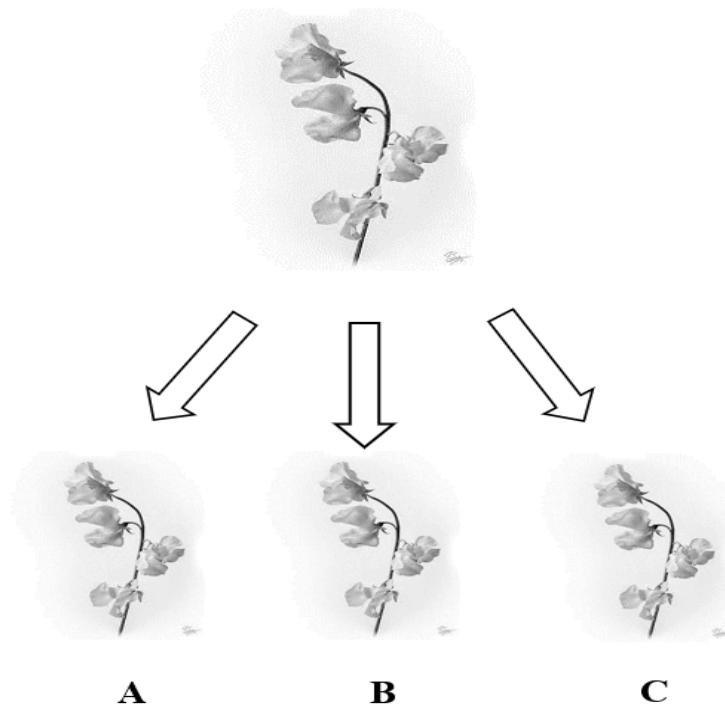
- (A) autosomal
- (B) recessive
- (C) dominant
- (D) polygenic

16. The Australian Budgerigar is a small Australian parrot which has 26 chromosomes in a general body cell. One easy way for the vet to determine a bird's sex is to analyse the bird's DNA using a PCR-based test. This test identifies a bird's sex based on its chromosome pair (ZW in females and ZZ in males).

What is the total number of autosomes which occur in a general body cell in a female budgerigar?

- (A) 13
 - (B) 24
 - (C) 26
 - (D) 52
17. Antibiotics are compounds capable of killing bacteria.
- Why are they considered a type of biotechnology?
- (A) Antibiotics are manufactured from viruses that have been deactivated but were once alive.
 - (B) Antibiotics are used to treat affected plants and animals which are living organisms.
 - (C) Antibiotics are used to kill bacteria, which are living.
 - (D) Antibiotics were first isolated from an organism —the fungus, *Penicillium notatum*.
18. What are the features of passive immunity?
- (A) antibodies produced, no memory cells and long-term effective period
 - (B) antibodies produced, memory cells and long-term effective period
 - (C) no antibodies produced, memory cells and short-term effective period
 - (D) no antibodies produced, no memory cells and short-term effective period

19. Many flowering plants can reproduce asexually as well as sexually. The plant below produces three groups of offspring by different means.



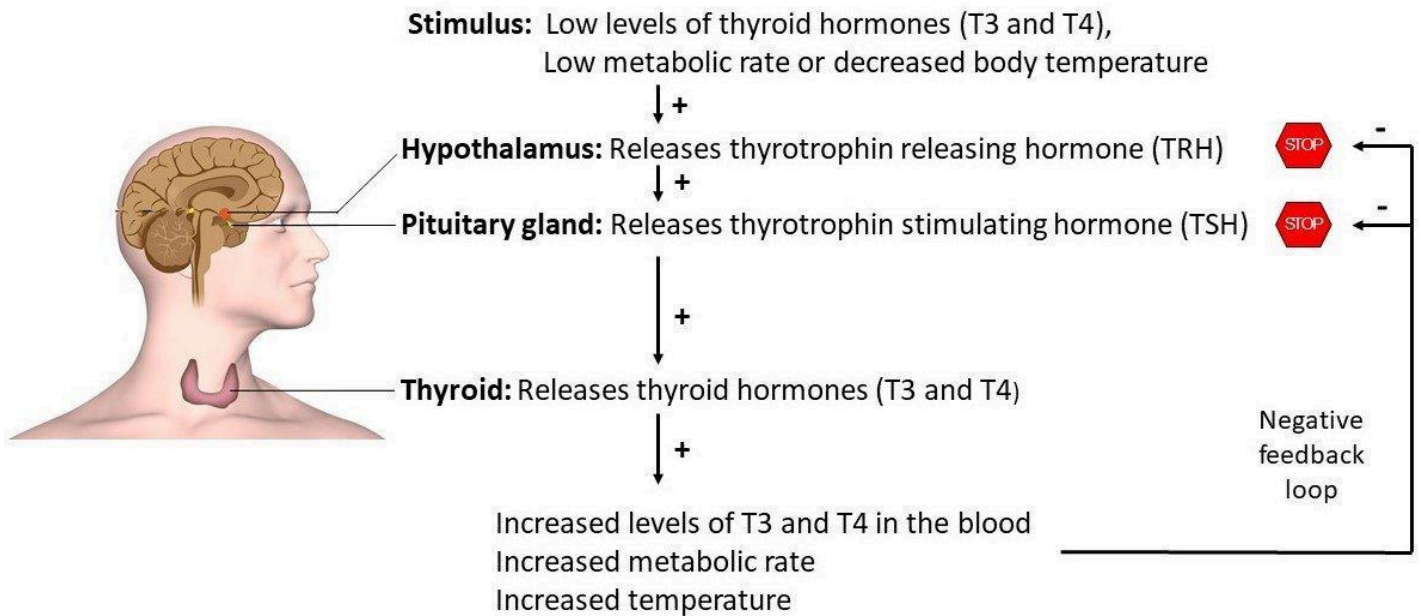
The table below shows how the three groups of offspring were produced.

Group A	Cross-pollination
Group B	Self-pollination
Group C	Vegetative Propagation

Which of the following correctly lists the groups from least genetically diverse to most genetically diverse?

- (A) Group A, Group B, Group C
- (B) Group A, Group C, Group B
- (C) Group C, Group B, Group A
- (D) Group C, Group A, Group B

20. Thyroid hormones are two hormones produced and released by the thyroid gland, namely triiodothyronine (T3) and thyroxine (T4). When food containing iodine is eaten, it is absorbed and enters your bloodstream. Your thyroid, which has tiny cells that capture the circulating iodine, and takes it in so that it can be used to create triiodothyronine (T3) and thyroxine (T4). These hormones spread throughout the body to increase the metabolic rate and regulate other processes. The thyroid gland requires dietary iodine to form T4 and T3. The negative feedback loop is shown:



What is the likely consequence of a lack of dietary iodine?

- (A) high TSH, low T4 and low T3 levels
- (B) low TSH, low T4 and high T3 levels
- (C) high TSH, low T4 and high T3 levels
- (D) low TSH, high T4 and high T3 levels

Section II

80 marks

Attempt questions 21 – 35

Allow about 2 hours and 25 minutes for this section

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Show all relevant working in questions involving calculations.

Question 21 (4 marks)

Many organisms can reproduce asexually.

- a) Identify one plant, and one other organism, which reproduces asexually. **(2 marks)**

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- b) Outline how asexual reproduction ensures the continuity of the species. **(2 marks)**

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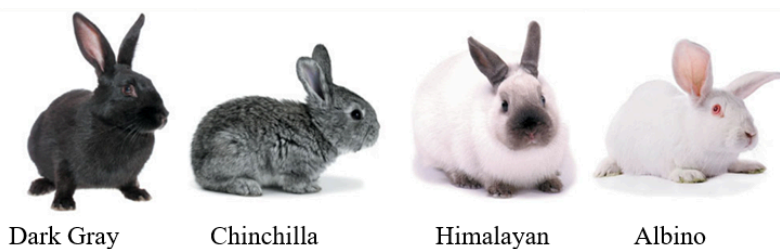
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Question 22 (9 marks)

Coat colour in rabbits is inherited according to the alleles below. Each allele has a different phenotype.

phenotype	allele	pattern of inheritance
dark grey coat	C	dominant to all other alleles
chinchilla	c ^{ch}	dominant to Himalayan and to white
Himalayan	c ^h	dominant to white
white/albino	c	recessive



- a) The inheritance of fur colour in rabbits is an example of what type of inheritance? **(1 mark)**

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- b) A dark grey rabbit with genotype Cc^{ch} is crossed with a Himalayan rabbit c^hc.
Determine the genotype and phenotype ratios of the resulting offspring. Show all working. **(4 marks)**

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Question 22 continues on the next page

Question 22 (continued)

- c) *“Genes alone are most important in influencing phenotypic expression.”*

Discuss this statement with reference to rabbits.

(4 marks)

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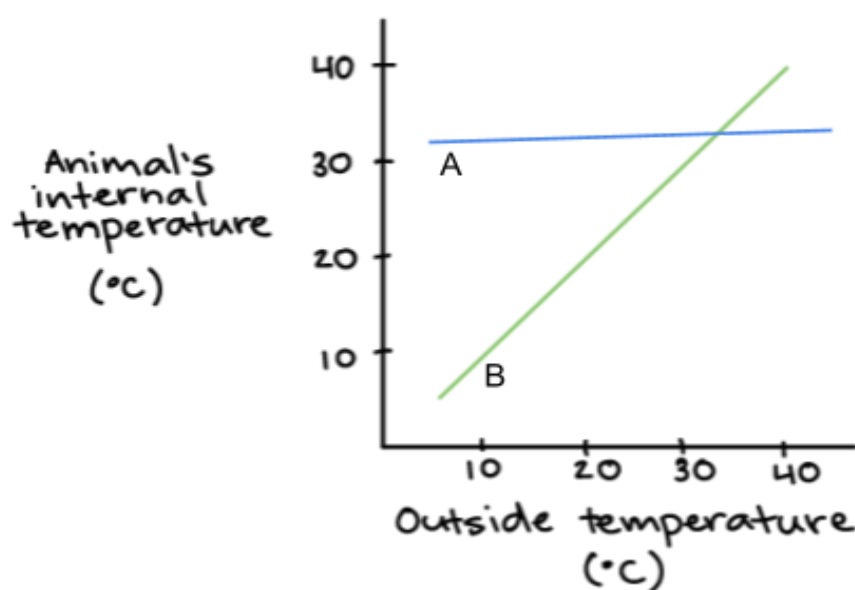
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Question 23 (5 marks)

Refer to the graph below.



- a) Which of the lines, A or B, is likely to be an endotherm? Justify your choice.

(2 marks)

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Question 23 continues on the next page

Question 23 (continued)

- b) Explain ONE adaptation of an endotherm to assist in thermoregulation. **(3 marks)**

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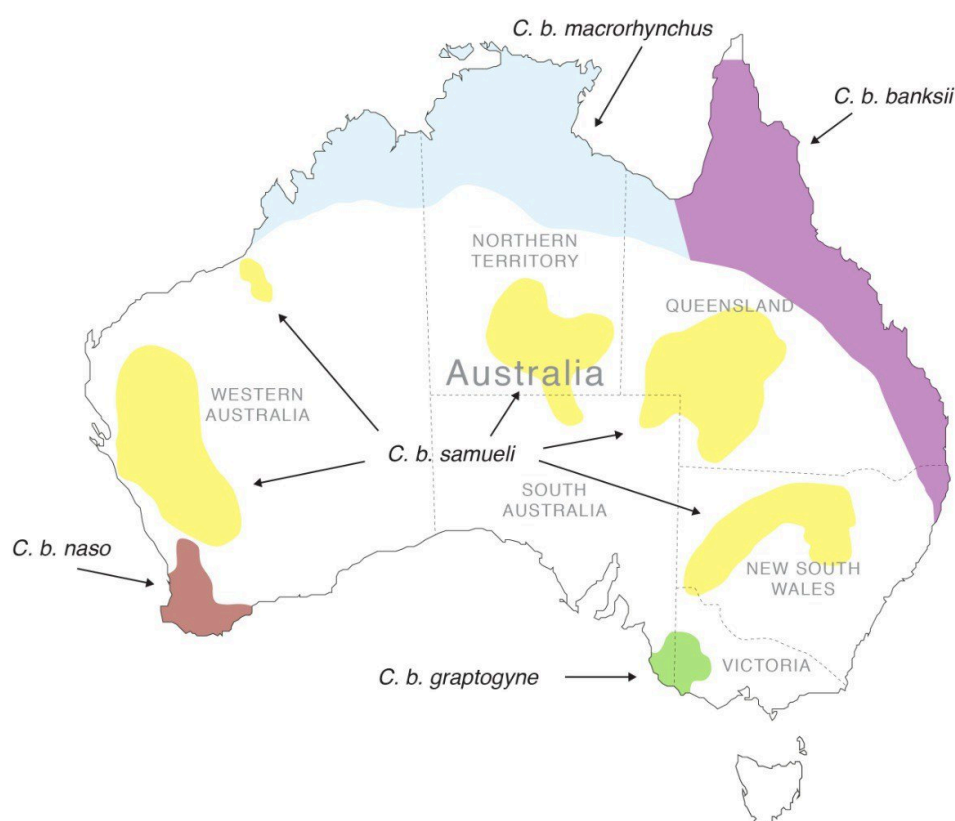
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Question 24 (7 marks)

Scientists from AMRI, University of Sydney, University of Edinburgh and CSIRO conducted the first comprehensive genetic assessment of the Red-Tailed Black Cockatoo across its entire distribution. The result is a new subspecies. It took extensive museum collections, carefully gathered over decades and an extensive genetic analysis to find them.



In the past, the species was divided into five groups ('subspecies'), known as *banksii*, *graptogyne*, *macrorhynchus*, *naso*, and *samueli*. These subspecies show physical differences in their plumage, body size, bill shape, and bill size, reflecting their different habitats and diets. But there has been debate about whether the five subspecies actually reflect the evolutionary history of the species.

Question 24 continues on next page

Question 24 (continued)

- a) Discuss a technology which may be used to determine the genetics of the 5 subspecies.

(4 marks)

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- b) Outline how population genetics data collected could aid in the conservation of the Red-Tailed Black Cockatoo.

(3 marks)

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Question 25 (6 marks)

A group of students carried out a practical investigation to grow and identify the bacteria in yoghurt. After examining a range of secondary sources, they hypothesised that they would find a species of *lactobacillus*.

They set up four agar plates with a basic nutrient agar, sterilised their inoculating loop and applied yoghurt to three of the plates. One plate received no yoghurt as a control. Plates were then placed into an incubator at 23 degrees Celsius for five days. The colour, shape and profile of any bacterial colonies formed were then observed and compared with established data on *Lactobacillus* species.

They obtained the following results:

<i>Plate</i>	<i>Number of colonies matching Lactobacillus description</i>	<i>Number of colonies not consistent with Lactobacillus description</i>
<i>1</i>	13	10
<i>2</i>	20	15
<i>3</i>	15	25
<i>Control</i>	0	5

- a) What conclusion can be made from this data? Justify your response. **(2 marks)**

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- b) Explain TWO improvements that should be made to the students' experiment. **(4 marks)**

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Question 26 (3 marks)

Researchers are investigating viral antigen-producing genes that rarely mutate as a step in developing a universal flu vaccine.

If successful, this advance could reduce the need for yearly flu vaccinations as new flu strains arise.

Using your knowledge of the immune system, explain how this could be a successful approach in the prevention of influenza outbreaks. **(3 marks)**

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Question 27 (6 marks)

Reproductive technologies have been widely used in agriculture for centuries.

- a) Name a reproductive technology used in agriculture and identify one of its benefits. **(2 marks)**

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- b) Explain how a named reproductive technology in agriculture impacts biodiversity. **(4 marks)**

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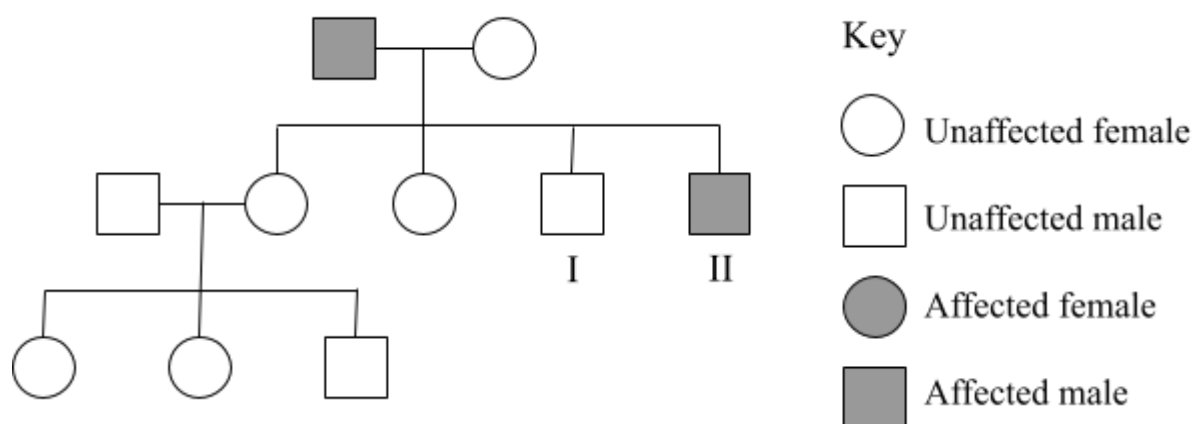
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Question 28 (7 marks)

Achondroplasia is a type of dwarfism present in humans characterised by shortened limbs. The trait has an autosomal dominant inheritance pattern. The pedigree shows the inheritance of this genetic disorder.



- a) Explain why inheritance patterns in Achondroplasia are autosomal, as opposed to sex-linked, with reference to individuals from the 1st and 2nd generations. **(3 marks)**

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- b) Predict the likelihood that the individuals labelled I and II will bear a child with Achondroplasia. Show your working. **(4 marks)**

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Question 29 (6 marks)

In the 1940s, it was discovered that if researchers wanted to change the traits of organisms they were studying, such as fruit flies, they could expose them to X-rays.

Using your knowledge of genetic change and technology, compare this technique of inducing genetic change to a more advanced technique used to manipulate genes. Assess both techniques. **(6 marks)**

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Question 30 (4 marks)

During the Covid-19 pandemic, there was confusion in the news and in social media around the terms ‘antigen’ and ‘antibody’. Explain clearly how antigens and antibodies differ and describe the role of each in the human immune system. **(4 marks)**

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Question 31 (5 marks)

Non-coding DNA used to be referred to as ‘junk’ DNA. As our understanding of non-coding DNA has improved, it was no longer considered appropriate to use the term ‘junk’ to describe it.

Assess the impact of mutations on both coding and non-coding DNA segments. **(5 marks)**

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Question 32 (3 marks)

The following diagram represents one cell that resulted from the first stage of meiosis and is about to undergo the second stage.



Construct a diagram showing the daughter cells that would result from this cell.

(3 marks)

Blank area for constructing the daughter cells diagram.

Question 33 (4 marks)

An athlete is running on a warm day.



The muscular activity is generating heat within her muscles and yet her core temperature varies hardly at all during the run.

Explain how this is achieved and show how this is an example of negative feedback. **(4 marks)**

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Question 34 (4 marks)

The following data are from a retrospective study of 195 HIV/AIDS patients who had received highly active antiretroviral therapy (HAART). The therapy involved patients taking a mixture of three different antiretroviral drugs at the same time. The researcher recorded the blood concentration of CD4+ T-lymphocytes (also known as Helper T-cells) at 6-monthly intervals since the patients started the therapy.

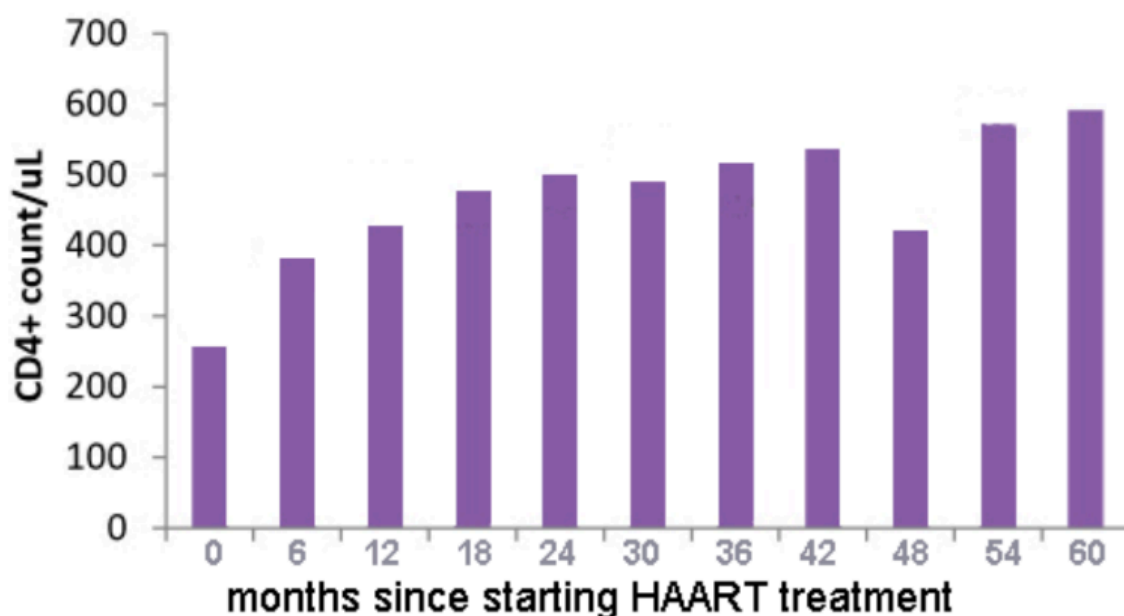


Figure 2. Blood concentration of CD4+ T-lymphocytes in patients undergoing highly-active antiretroviral therapy (HAART) before treatment (0 months) and at 6-monthly intervals since starting treatment.

- a) State one conclusion you could draw from this data, including support. **(2 marks)**

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- b) Explain the advantage of taking three different antiretroviral drugs (multidrug therapy) at the same time **(2 marks)**

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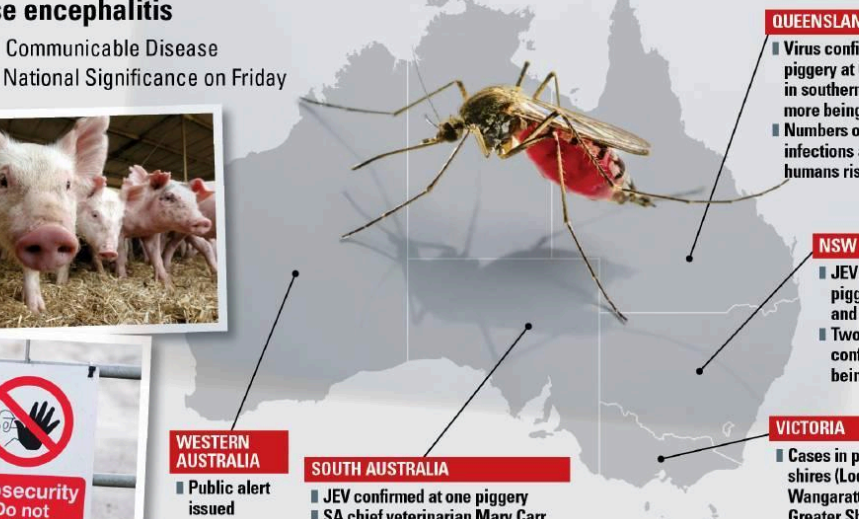
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Question 35 (7 marks)

JEV OUTBREAK

Japanese encephalitis

Declared a Communicable Disease
Incident of National Significance on Friday



The infographic features a central map of Australia with lines connecting to specific regions. A large mosquito is positioned over the map, and a photograph of piglets is in the top left. A biosecurity sign is in the bottom left. Text boxes for each region provide details on the outbreak.

- QUEENSLAND**
 - Virus confirmed at one piggery at Goondiwindi in southern Queensland, more being investigated.
 - Numbers of disease infections among humans rising.
- NSW**
 - JEV confirmed at six piggeries in western and southern NSW.
 - Two human cases confirmed, more being investigated.
- VICTORIA**
 - Cases in piggeries in six shires (Loddon, Campaspe, Wangaratta, Gannawarra, Greater Shepparton and Greater Bendigo)
 - Seven people hospitalised with JEV.
- SOUTH AUSTRALIA**
 - JEV confirmed at one piggery
 - SA chief veterinarian Mary Carr says "likely to be everywhere".
 - Multiple human cases of encephalitis infection investigated.
- WESTERN AUSTRALIA**
 - Public alert issued

Biosecurity
Do not enter

Farm Online March 2022

Japanese Encephalitis Virus (JEV is transmitted to pigs and then onto humans via a mosquito vector.

“Australia spends upward of \$1 billion on biosecurity each year but the world’s nasties keep sneaking in.” (*Farm online* March 2022)

Evaluate this statement in reference to specific preventative strategies. **(7 marks)**

[illegible]

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Student Number/Name:

Question 35 (continued)

This image shows a full page of a document template designed for handwritten notes or answers. It features approximately 28 evenly spaced horizontal dotted lines across the entire width of the page, providing a guide for letter height and placement. The background is plain white, and there are no margins, headers, or footers present.

END OF PAPER

Student Number/Name:

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2022 HSC Biology Trial - Marking Guidelines

Section I Multiple Choice

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
C	B	D	C	A	B	C	B	A	A	D	C	C	B	D	B	D	D	C	A

Section II

Question 21

21 (a)

Criteria	Marks
Identifies a plant and one other organism that reproduces asexually	2
Identifies a plant or one other organism that reproduces asexually	1

Sample answer

Plant: Strawberry

Any organism: Starfish, bacteria

Markers notes: Either done well or not done well. Many need to revise the difference between asexual and sexual!

21 (b)

Criteria	Marks
• Sketches in general terms the advantage of asexual reproduction ensuring species continuity	2
• Identifies an advantageous feature of asexual reproduction OR defines the term Asexual Reproduction	1

Sample answer

Asexual reproduction produces offspring that are genetically identical to the parent because the offspring are all clones of the original parent. A single individual can produce offspring asexually and large numbers of offspring can be produced quickly. In an unchanging environment this is advantageous in ensuring the continuity of the species.

Markers notes: TWO main points: FAST and ENERGY EFFICIENT. Many other organisms can have large offspring and reproduce sexually, so is not a point specifically for asexual. Students need to be specific about energy requirements (accepted a broad 'no need to find a mate' - need to be careful though)

Question 22

(a)

Criteria	Mark
• Identifies the correct type inheritance	1

Answer

Inheritance through multiple alleles.

Markers notes: done poorly

22 (b)

Criteria	Marks
- Identifies parent phenotypes - Identifies parent gametes - Correct punnet square with genotypes - Correct genotype ratio - Correct phenotype ratio	4
- Identifies parent phenotypes - Identifies parent gametes - Correct punnet square with genotypes - Correct genotype ratio OR correct phenotype ratio	3
- Identifies parent phenotypes OR identifies parent gametes - Shows some working or a partial punnet square	2
Identifies parent phenotypes OR identifies parent gametes	1

Sample answer

Genotype	Cc^{ch}	X	c^hc
Gametes	C or c^{ch}		c^h or c
	Dark gray		Himalayan

	C	c^{ch}
c^h	Cc^h	c^hc^h
c	Cc	cc^{ch}

Genotype ratio 1 : 1 : 1 : 1
 $Cc^h : c^hc^h : Cc : cc^{ch}$
 Phenotype ratio 1 : 1
 Dark Gray : Chinchilla

Markers notes: mostly done well. (Remember to ALWAYS include a key with punnett squares though - this one was included in the question)

c)

Criteria	Marks
• Makes evident the relationship between genes and phenotypic expression • Makes evident the relationship between the environment and phenotypic expression • Makes reference to rabbit coat colour	4
• Sketches in general terms the relationship between genes and phenotypic expression • Sketches in general terms the relationship between the environment and phenotypic expression • Makes reference to rabbit coat colour	3
• Sketches in general terms the relationship between genes and phenotypic expression OR sketches in general terms the relationship between the environment and phenotypic expression • Identifies examples of phenotypic expression	2
• Identifies a feature of the influence of genes on phenotype OR identifies an example of the influence of environment on phenotype	1

Sample answer

There are certain situations in which the environment affects not only the growth and health of an organism, but also the use or deployment of the organism's genes.

Genes play an important part in influencing phenotype, but genes are not the only influence. Environmental conditions, such as temperature and availability of nutrients can affect phenotypes. For example, temperature affects coat colour in rabbits.

The dark points on the Himalayan rabbit are caused by a gene that codes for a temperature-sensitive enzyme. The enzyme, which causes a darkening of the rabbit's fur, is active only in the cooler parts of the body such as the tail, feet, ears, and area around the nose. Modern twin studies have shown that almost all human traits are at least partly influenced by genetic differences. Some characteristics, such as height, show a strong genetic influence, while other characteristics have an intermediate level of genetic influence, such as with intelligence.

Markers notes: Many did not refer specifically to genes and their influence as that is the reference in the quote. Many students did not give a specific example in reference to rabbits. Any correct environmental influence was acceptable- temperature affecting the fur coat colour, diet affecting the size etc. But this influence is BEFORE showing the effect on phenotypic expression.

Question 23

a)

Criteria	Marks
• Identifies correct line • Provides appropriate justification for choice	2
• Identifies correct line OR provides some relevant information	1

b)

Criteria	Marks
• Explains a relevant adaptation	3
• Describes a relevant adaptation	2
• Identifies a relevant adaptation or provides some relevant information	1

Markers notes: TOO many students are confusing endotherms with ectotherms. You DO NOT need to know ectotherms for this syllabus, so just learn about endotherms. If a) was incorrect, then b) was as well!

24

a)

Criteria	Marks
• Discusses a relevant technology and relates its use effectively to the example provided	4
• Discusses a relevant technology and provides some links to the example	3
Describes a relevant technology	
• Identifies a relevant technology	1

Sample answer

- a) *DNA sequencing could be used to determine the genetics of the 5 subspecies. It would rely on samples from the subspecies either from the wild or from museum specimens and consideration to the availability of those samples would need to be given. It involves sequencing the entire genomes and if enough genomes of birds from across the continents were sequenced and compared, the similarities and differences between the sequences would be very useful in ascertaining the evolutionary relationships between species and subspecies for the cockatoos. The more nucleotides the groups of birds have in common, the more closely related they are and the fewer in common, the less closely related they would be.*

A brief description only was required on how the technology works. Many wrote too much detail on the steps without the definition of pop gen.

The use of SNPs and/or STRs were very underrepresented.

A key point many students did not include was that the data collected is used for a comparison, then the similarities and differences are analysed

b)

Criteria	Marks
• Makes evident the relationship between the data that could be collected and the similarities and differences between the subspecies, using reference to data that would be appropriate (e.g. nucleotide bases, SNPs or STRs)	3
• Links the data that could be collected in some way to the distinction between subspecies, using reference to data that would be appropriate (e.g. nucleotide bases, SNPs or STRs)	2
• Identifies relevant data	1

Sample answer

- b) *Population genetics data, which is data that determines allele frequency in a population, from DNA sequencing could be used in conservation to establish the genetic diversity of different populations of species. For endangered groups of birds with small population sizes, lack of genetic diversity could threaten the longevity of the population, so gaining data on which groups are the most genetically vulnerable through the collection of data from sequencing could help conservationists to target their efforts towards the vulnerable populations and develop programs such as wildlife or migratory corridors to help those populations to survive of interbreed with other groups or birds bred in captivity. This would improve the genetic diversity of the group and aid in their conservation.*

Markers notes: Must DEFINE Population Genetics.

Key point that many students missed was lack of genetic diversity as well as suggesting a program...such as a breeding program

25a

Criteria	Mark
- Identifies that there is some evidence to support the students' hypothesis AND/OR identifies that the validity of the data is questionable - Provides an appropriate justification for their conclusion, e.g., the plated having significant growth on unexpected bacteria OR the control having some microbial growth OR the wrong temperature being used	2
ONE of the above	1

Sample Answer: Colonies matching the *Lactobacillus* description were identified within the yoghurt samples, supporting the students' hypothesis. However, colonies of other bacteria were also present in similar amounts, with some even on the control plate. It can be concluded therefore that while *Lactobacillus* species appear to be present, contamination has occurred and that the results are not valid without improvements to the method.

Markers notes: Students not all reading the question and missing the JUSTIFY part. Many just identifying that the lactobacillus bacteria is present. BUT they needed to state that the hypothesis was supported as there was none of this bacteria in the control (which was not exposed to the yogurt)

25b

Criteria	Mark
- Outlines TWO suitable improvements - Gives specific reasoning for why each improvement is needed	4
- Outlines TWO suitable improvements - Gives general reasoning for why each improvement is needed	3
- Outlines AT LEAST ONE suitable improvement AND a reason for it - OR - Outlines TWO suitable improvements	2
Outlines ONE improvement	1

Markers notes: Mostly well done. Although some did not give the reasoning behind the improvement. Some students are confusing validity with reliability. If the incorrect reasoning was given with an improvement then only 1 mark was paid.

26

Question 26

Criteria	Marks
- Demonstrates a thorough understanding of the specificity of immunity provided by vaccination - Explains how a vaccine based on regions of viral proteins that rarely mutate could provide a universal flu vaccine	3
- Demonstrates some understanding of the specificity of immunity provided by vaccination - Explains how a vaccine based on regions of viral proteins that rarely mutate could provide a universal flu vaccine	2
Provides some relevant information	1

Sample Answer

The immune response following vaccination is highly specific so a vaccine is only effective if the antigen on the pathogen is the same as the antigen used in the vaccine. If the viral antigens change, due to mutation, then the vaccine will no longer protect an individual from developing the disease. By producing a flu vaccine based on regions of viral proteins that rarely mutate, one vaccine could continue to protect in spite of mutations that might arise in other antigens in the viral population.

Marking notes

- Many students giving broad overview of acquired immunity, without relating mutation rate to new strains of virus and vaccination based on genes that rarely mutate to longer term efficacy against new strains
- Many students giving detailed information on acquired immunity without addressing the question.
- Better answers make the connection between the low mutation rate of the genes and protection against new strains.
- The best answers make the connection between the fact that the low mutation rate is in the genes that produce antigens and link that to long-term recognition of novel strains by the memory lymphocytes
- Common misconceptions: body exposure to genes of virus triggers response, vaccine itself mutates

27

Criteria	Mark
• Recognises and names a reproductive technology used in agriculture • Identifies an appropriate benefit	2
• Recognises and names a reproductive technology used in agriculture	1

Sample Answer

Artificial insemination (GMO). Allows farmers to more efficiently breed cows with bulls that have desirable traits.

Marking notes

- Very well answered in general
- Be careful of adding unnecessary detail to a simple question that could create a contradiction
- Lots of descriptions, which aren't necessary in naming and identifying
- Be careful of using words like "ideal" in an answer - what is an "ideal" banana? A big one? One that tastes delicious? One that is pest resistant? One that transports well? "A banana with preferable/desirable traits" is more accurate as, sadly, no banana is perfect.

27 b)

Criteria	Marks
Makes evident the relationship between the use of the reproductive technology in agriculture and biodiversity	4
Sketches in general terms the impact of the reproductive in agriculture on biodiversity	3
Relates some aspect of the technology to biodiversity	2
Describes a reproductive technology that is used in agriculture	1

Sample answer

An example of an agricultural reproductive technology is Artificial Insemination, in which semen from a selected sire, such as a bull, is inserted into the uterus of a breeding female in order to increase the chances of fertilisation and to manipulate the traits of the livestock. Due to these benefits, the process is widely used in farming, which can negatively impact biodiversity. This can occur as, in selecting breeding stock with desirable traits, there is a loss of genetic diversity in the stock, and this effect can be magnified when a particularly desirable male is used to inseminate hundreds or thousands of females thus limiting the variety of alleles in the offspring. This leads to a smaller gene pool among the breed, and therefore increases its susceptibility to disease and environmental stressors.

Marking notes

- Very well answered in general
- Some students did not include a description of the technology, which then made it hard for them to explain the relationship between that technology and biodiversity
- The best answers related biodiversity to genetic diversity or genetic concepts such as alleles
- Some students chose answers that, while technically correct, made their description more involved than it needed to be, such as whole organism animal cloning through somatic nuclear transfer or artificial insemination of non-mammalian species. This is also less frequently used in agriculture and so its impact on biodiversity, while again technically correct, is negligible in practice.
- Be careful of contradictory answers and careless explanations. Quite a few students suggesting that artificial insemination and artificial pollination lead to an initial increase in genetic diversity, but this is only the case if that is the goal of the breeders. In many contexts, from the outside those technologies are seeking to pass on desirable traits in livestock and crops and will therefore immediately begin to reduce the gene pool of the population. (transgenic organisms lead to that initial increase in diversity, however, on its own, transgenic/GMO technology is not a reproductive technology)

Q28

Question 28(a)

Criteria	Mark
• Uses a valid example from the 1st generation to show why the condition cannot be sex-linked/must be autosomal • Uses a valid example from the 2nd generation to show why the condition cannot be sex-linked/must be autosomal • Cause and effect clear	3
• Uses an example from the 1st generation to show why the condition cannot be sex-linked/must be autosomal • Uses an example from the 2nd generation to show why the condition cannot be sex-linked/must be autosomal	2
• Gives some relevant information	1

Sample Answer: If this trait was sex-linked/x-linked dominant then it would not be possible for any of the females born in the second generation to be unaffected. This is because the father would pass on the trait to all his daughters as they would inherit his x-chromosome that carries the dominant allele. If Y-linked, it would also not be possible to yield an unaffected son in the second generation as he would have to inherit the y-chromosome from his father. Thus, it can be concluded that the inheritance pattern for this trait must be autosomal.

28a marking notes

- Best answers made explicit reference to generations and individuals to ensure their answers were clear (full marks could only be given if reference to individuals in both generations were clear)
- Best answers were thorough in arguing that the case could not be sex-linked inheritance, by making reference to what would occur if there was x-linked inheritance. Some also included arguments against it being y-linked inheritance, however that was not necessary for full marks
- Some otherwise good arguments were undermined by lack of clarity around which individuals were being described, or by contradictory logic
- Some answers only considered Y-linked inheritance, which is a far less common case, and should be considered only after the possibility of X-linked inheritance, if at all.

Note - there were multiple ways to interpret the question, so all reasonable interpretations were accepted

Criteria	Marks
All of: - Working shown (Punnett squares or text explanation covering same information as Punnett squares) and correct - Key to letters used for alleles provided - Genotypes correctly interpreted based on stimulus material - Genotype ratios correctly linked to phenotype ratios - Any assumptions made are clear (e.g. "assuming the partners for both males were unaffected")	4
Missing one of the above	3
Missing two to three of the above	1-2

If a = recessive, A = dominant.
 I = aa (as unaffected for a dominant condition)
 Assuming partner is also unaffected:

$$\begin{array}{c|c} A & a \\ \hline a & Aa \\ a & Aa \end{array}$$
 offspring
 genotype = 100% heterozygous recessive
 phenotype = 100% unaffected.

II = Aa (as affected, with unaffected mother)
 Assuming partner is affected

$$\begin{array}{c|c} A & a \\ \hline A & AA \\ a & Aa \\ a & Aa \end{array}$$
 offspring
 genotype = 50% heterozygous
 50% homozygous recessive
 phenotype = 50% affected
 50% unaffected

Marking notes

- Very well answered on the whole
- Punnett squares provided more efficient, easier-to-follow working than text

Q29 X-rays

Criteria	Marks
• Correctly identifies a recent technology • Contrasts the process and outcomes of X-rays and the chosen technology • Assesses both techniques	5-6
• Correctly identifies a recent technology • Contrasts the process or outcomes of X-rays and the chosen technology • Assesses one or both techniques	3 - 4
• Describes a relevant technology or some assessment of X-rays	2
• Provides some relevant information	1

Marking notes

- The best answers were explicit in their assessment of both technologies, usually with reference to efficiency
- Some very good answers implied assessment of the technologies in their comparison using language such as “more precise” or “more targeted”, but did not do so explicitly
- Some answers focused too much on ethical concerns or safety and less on the processes and outcomes relevant to researchers working on fruit flies
- Some answers focused too much on the detail of advanced genetic techniques, leaving less scope for comparison and assessment, and, at times, adding incorrect detail to an otherwise good answer

Q30

Criteria	Marks
• Demonstrates a thorough understanding of the difference between antigens and antibodies • Demonstrates a thorough understanding of the role of antigens and antibodies in the human immune system	4
• Demonstrates a sound understanding of the difference between antigens and antibodies • Outlines the role of antigens and antibodies in the human immune system	3
• Demonstrates a sound understanding of the difference between antigens and antibodies OR • Outlines the role of antigens and antibodies in the human immune system	2
• Provides some relevant information	1

Sample Answer

An antigen is a protein (*or other molecule**) found on the surface of cells, which signals to the immune system whether a cell is ‘foreign’ or ‘self’. Foreign antigens on pathogen cells give rise to an immune response, stimulating macrophage action, replication of B- and T-lymphocytes that are specific to the antigen, and production of memory B- and T-lymphocytes.

Antibodies are Y-shaped proteins that are carried on the surface of B-lymphocytes and are produced in large quantities in response to a foreign antigen. Antibodies in the bloodstream bind specifically to antigens on the surface of pathogens, preventing them from infecting cells and causing them to clump together, which enhances the action of macrophages. Antibody binding to the surface of a pathogen also stimulates complement activity, which destroys the pathogen.

(* Polypeptides and polysaccharides can also act as antigens.)

Marking notes

- Best responses included
 - Antigens trigger an immune response as they are recognised as “non self”
 - antibodies are specific to a particular antigen
 - A description of the role of each (a detailed explanation was not required)
- Best responses were accurate throughout, containing no contradictions or misconceptions
- Some responses included the misconception that antigens themselves “attack” body cells or directly cause disease rather than just being present on invading pathogens

Q31 - M6
Junk DNA

Criteria	Marks
- Assesses the impact of mutations on both types of DNA - Uses examples of different effects of mutations to compare and contrast the impact for both types of DNA	5
- Assesses the impact of mutations on both types of DNA - Includes some comparison of the impacts between the two types of DNA or includes examples to support their assessment	3 - 4
Distinguishes between the impacts on the types of DNA or outlines the impact on one type of DNA	2
Provides some relevant information	1

Sample response

Mutations on both coding and non-coding DNA can have a range of impacts and both have the potential to dramatically alter the functioning of an organism. Mutations in coding DNA can have no impact (“silent” mutations) or can lead to altered or incomplete protein formation (missense or nonsense mutations) if a substitution or frameshift is involved. Depending on the protein and its role, this could cause minor damage to the functioning of the organism, a serious disease (such as Cystic Fibrosis) or could stop the organism from functioning. While non-coding DNA does not directly code for proteins, it can still be responsible for the regulation of protein production - including promoting or inhibiting the production of proteins. Mutations in non-coding DNA could therefore cause proteins to be produced in the wrong time or place or not to be produced when required. The effects of this could be as serious as those of coding DNA depending on the role of the protein and the degree of interference with gene expression. Other effects of non-coding DNA mutations could include interfering with the production of tRNA, which could also lead to diseases associated with faulty protein synthesis. While mutations to coding DNA are more commonly associated with genetic diseases and disorders, the range and potential seriousness of effects for mutations in both types of DNA could mean an enormous impact on organisms.

Marking notes

- Best responses provide a clear assessment for both types of DNA, even if arguing that the impacts can be similar
- Best responses clearly distinguish between roles of coding and non-coding DNA
- Best responses acknowledge the range of impacts (deleterious → silent → beneficial) that mutations on both types of DNA have and qualify well throughout (using words such as “can” or “could” rather than “do” or “are”)
- Some responses confuse non-coding segments with non-coding strand
- Some responses focus too much on processes of mutation without relating to impact

Q32

Criteria	Marks
All of: 2 gametes 4 chromatids per gamete - Accurate possible arrangement of chromatids - Non-identical gametes	4
Three of: 2 gametes 4 chromatids per gamete - Accurate possible arrangement of chromatids - Non-identical gametes	3
Two of:	2

- 2 gametes - 4 chromatids per gamete - Accurate possible arrangement of chromatids - Non-identical gametes	
One of: - 2 gametes - 4 chromatids per gamete - Accurate possible arrangement of chromatids - Non-identical gametes	1

33

Marking Criteria	Marks
• Definition of negative feedback stated or implied. • Receptor identified • Response(s) identified	3
• 1-2 of the above	1-2

As the runner exercises, the heat from her muscles is transferred to her blood. The hypothalamus detects this rise in temperature of the blood and sends a message to the brain which, in turn, sends nervous messages to certain effectors such as sweat glands, to make them produce sweat and cool the body by evaporation, and to the muscles in the walls of peripheral arteries, to make them dilate and lose heat into the air. This is a negative feedback reaction because the stimulus – increased blood temp – stimulates a response – sweating, vasodilation – which counteracts it.

34

a)

Criteria	Marks
• Correct conclusion supported with reference to the graph	2
• Correct conclusion	1

Sample Answer

HAART Therapy increases the concentration of CD4+ lymphocytes in the blood of AIDS patients. This can be seen by the increase in concentration of the lymphocytes from X untreated to Y at Z point in treatment.

b)

Criteria	Marks
• Explains the advantage of taking three different antiretroviral drugs (multidrug therapy) at the same time	2
• Provides some relevant information	1

Sample Answer

When viral diseases are treated with a drug it is possible that the virus will develop resistance to the drug over time due to mutational changes. When a patient is treated with several drugs at the same time, it is unlikely that a single virus will develop resistance to all of them at the same time.

Question 35

+

Criteria	Marks
● Makes evident the relationships between methods employed to prevent entry of JEV into or spread across Australia and their effectiveness ● Makes a <u>judgement</u> about the effectiveness of different methods employed to prevent the spread of JEV disease	7
● Sketches in general terms methods employed to prevent the spread or entry of JEV ● Sketches in general terms technologies used to rectify kidney disorders. ● Makes a <u>judgement</u>	5 - 6
● Sketches in general terms a method employed to prevent the spread or entry of JEV ● Makes a <u>judgement</u>	3 - 4
● Identifies methods employed to prevent the spread or entry of disease	2
● Identifies a method employed to prevent the spread or entry of disease	1

Sample answer

Hygiene practices, quarantine, vaccination, public health campaigns, use of pesticides and genetic engineering are methods employed to prevent the spread of disease. Japanese Encephalitis Virus is relatively new to Australia. The virus is carried from a host to humans through a vector, the mosquito. Being relatively new, JEV would not yet be part of our immunisation program and neither livestock or humans would be protected. This assumes the disease has already entered the country. Generally good hygiene practices are an effective way to slow the rate of spread of some infectious diseases. The virus is not spread through direct contact so washing hands, social distancing, covering of the mouth when sneezing and other hygiene practices would not serve to prevent this disease's entry into the country. Public Health Campaigns could provide information regarding the source of an infectious disease and how it can spread to people. This information can be provided to people to make them wary of the dangers. An example would be to cover up at dusk and dawn to prevent mosquito bites or to remove water reservoirs where mosquitoes may breed. Pesticides can be used to eliminate vectors that are carriers of the disease. Without mosquitoes the risk of transmission is much reduced. Spraying containers from overseas would kill suspect mosquitoes. Genetic engineering serves to deal with pathogen once they are established and so would be ineffective. Quarantine and border security would be the best method of stopping the entry of disease-causing microorganisms. Quarantine laws can prevent the entry of items that might be risky and thus prevent the spread of that disease. Checks at all entry points; land and sea would mean that the vector does not enter the country and the pathogen cannot be transmitted. Items that may be risky could be quarantined to ensure they are safe before being introduced.