

2021
Higher School Certificate
Trial Examination

Biology

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- NESA approved calculators may be used
- Write your student number and/or name at the top of every page

Total marks – 100

Section I – Pages 2–11
20 marks

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

Section II – Pages 12–33
80 marks

- Attempt Questions 21–32
- Allow about 2 hours and 25 minutes for this section

This paper MUST NOT be removed from the examination room

STUDENT NUMBER/NAME:

Section I**20 marks****Attempt Questions 1–20****Allow about 35 minutes for this section**

Select the alternative A, B, C or D that best answers the question and indicate your choice with a cross (X) in the appropriate space on the grid below.

	A	B	C	D
1				
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- 1 *Echeveria glauca* is a species of succulent whose leaves are coated with a powdery wax called *farina* which gives the plant a silvery-blue appearance.



Which of the following explains how *farina* helps the plant to maintain water balance?

- A. It reflects sunlight, preventing the absorption of excess heat.
 - B. It increases transpiration from the leaves.
 - C. It increases water being absorbed by the plant.
 - D. Attracts pollinators and deters insect attacks.
- 2 What is the probability of two heterozygous parents producing a child with a recessive phenotype?
- A. 25%
 - B. 50%
 - C. 75%
 - D. 100%

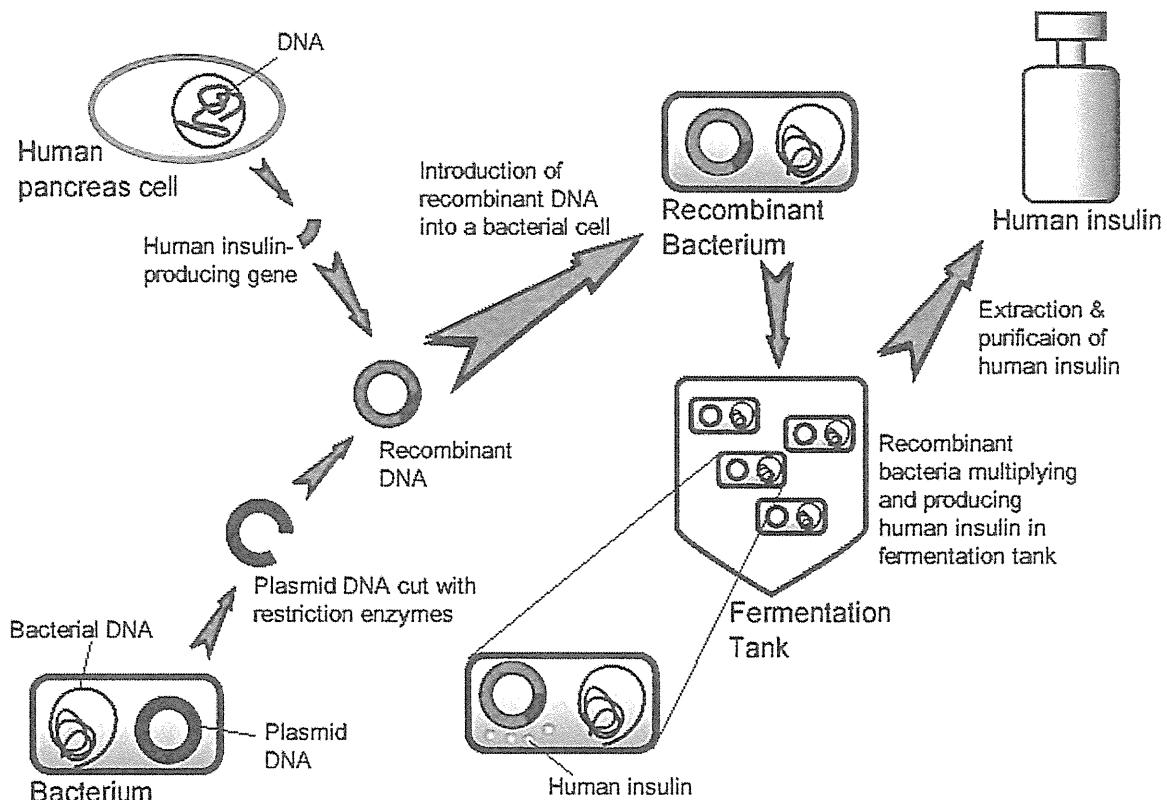
3 Some antibodies can be passed from mother to child during breastfeeding.

What is this type of immunity called?

- A. Artificial passive
- B. Natural active
- C. Artificial active
- D. Natural passive

4 The diagram represents the production of the hormone insulin in laboratory.

Human Insulin Production



The production of human insulin by *E. coli* is an example of the application of which of the following?

- A. Directed mutation
- B. Gene cloning
- C. Synthetic transplant
- D. Acquired immunity

- 5 In plants, what is the name given to the male gamete joining the female gamete?
- A. Pollination
 - B. Fertilisation
 - C. Insemination
 - D. Implantation
- 6 Which of the following explains the relationship between *proto-oncogenes* and cancer?
- A. Proto-oncogenes code for the production of CDK and cyclin proteins, which regulate the cell cycle.
 - B. Proto-oncogenes pause the cell cycle to allow for DNA repair.
 - C. A mutation in a proto-oncogene can lead to excessive CDK and cyclin production, which result in uncontrolled cell growth.
 - D. A mutation in a proto-oncogene can lead to excessive CDK and cyclin production, which prevents uncontrolled cell growth.
- 7 The Agapanthus plant is often used for creating microscope slides of *guard cells*.



Students strip the epithelium from the leaf to create a slide. Some students spill sap from the leaf onto their skin and develop a rash.

What is the mechanism in the plant to which this rash could be attributed?

- A. First line of defence
- B. Chemical barrier
- C. Adaptive immunity
- D. Innate immunity

8 Observe the following example of a mutation in DNA.

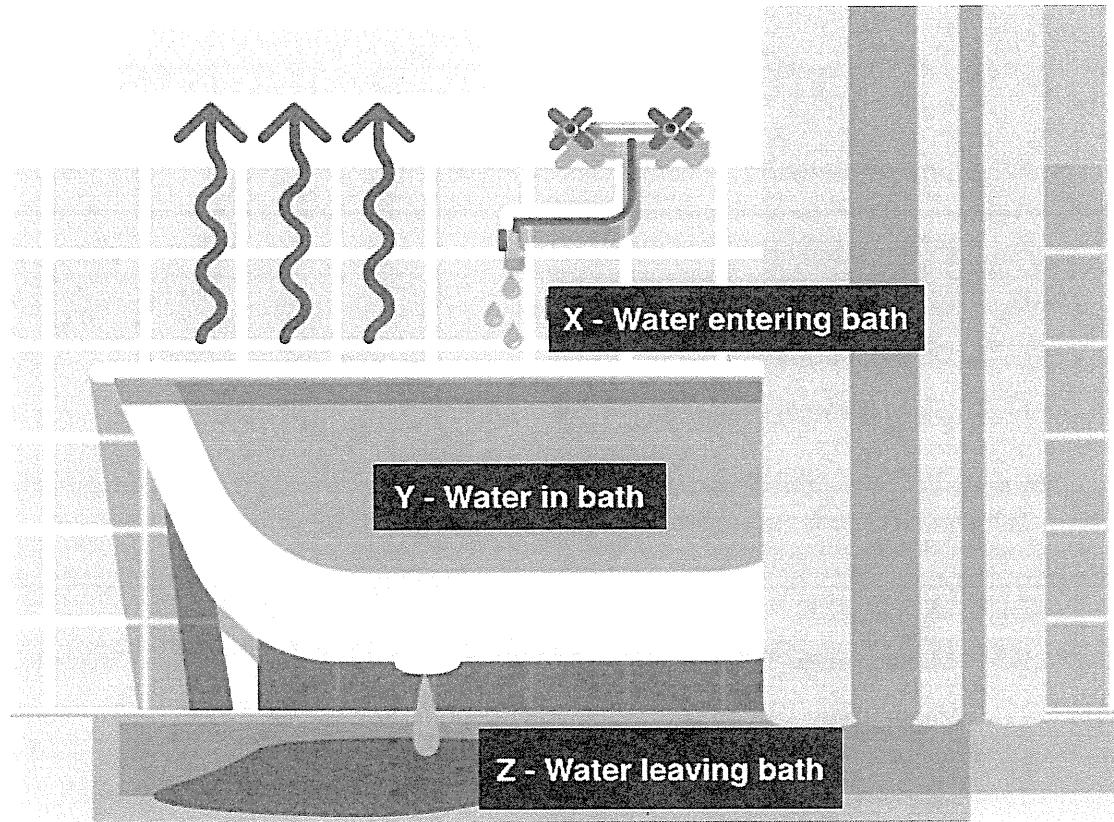


What type of mutation is seen in this example?

- A. Substitution point mutation
 - B. Insertion point mutation
 - C. Deletion point mutation
 - D. Chromosomal mutation
- 9 Which cell type is responsible for producing antibodies?
- A. Lymphocyte
 - B. Macrophage
 - C. Phagocyte
 - D. Red blood cell
- 10 What is the difference between co-dominance and incomplete dominance?

	<i>Co-dominance</i>	<i>Incomplete dominance</i>
A.	Neither allele is dominant	Both alleles are dominant
B.	One allele is dominant	Both alleles are dominant
C.	Both alleles are dominant	Neither allele is dominant
D.	Neither allele is dominant	One allele is dominant

- 11 The diagram below shows a ‘bathtub’ analogy which is often used to help explain the epidemiological concepts of *incidence*, *prevalence* and *mortality*.



If the water represents individuals in a population, which of the following correctly labels the concepts?

	X	Y	Z
A.	Incidence	Prevalence	Mortality
B.	Prevalence	Incidence	Mortality
C.	Incidence	Mortality	Prevalence
D.	Prevalence	Mortality	Incidence

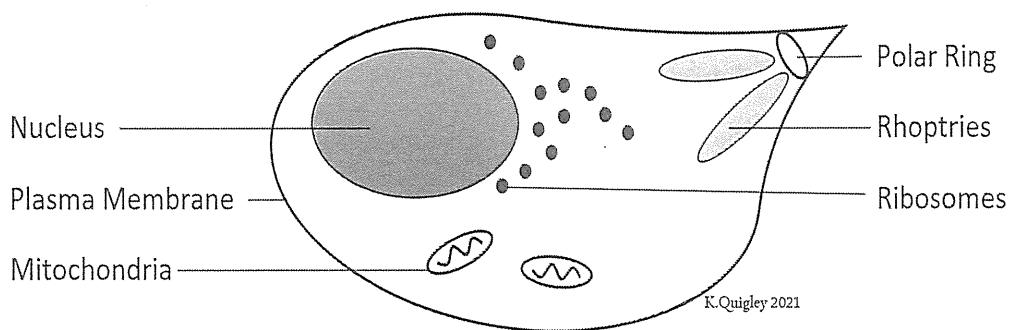
12 Which of the following is true of a somatic mutation?

- A. They are mutations passed on to offspring.
- B. They occur less often than germline mutations.
- C. They are mutations in gametes, germ cells or gametocytes.
- D. They are mutations in cells other than gametes, germ cells or gametocytes.

13 Which of the following best defines a *transgenic* organism?

- A. An organism that has had a portion of its genome deleted
- B. An organism that has had a synthetic gene inserted into its genome
- C. An organism that has been cross mated with a different organism
- D. An organism that has been modified to carry a gene derived from a different organism

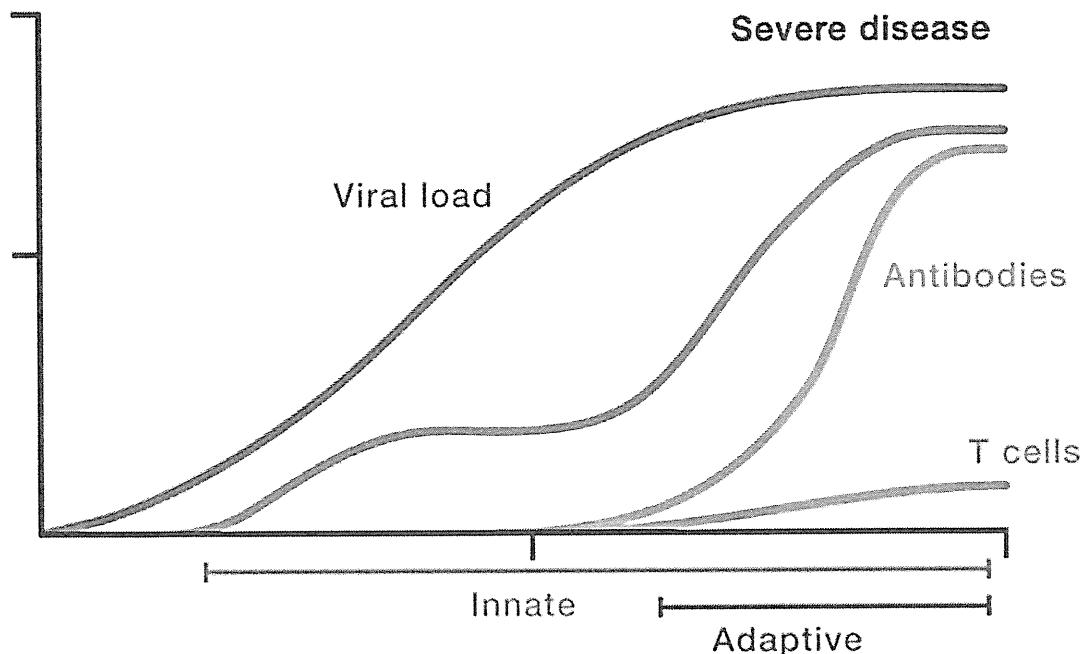
14 The disease Malaria is caused by Plasmodium. The main structural features of Plasmodium are shown below.



From the diagram, what is the most likely method of reproduction used by this organism in the human body?

- A. Spores
- B. Runners
- C. Binary fission
- D. Nuclear fusion

- 15 The following graph shows a response to COVID-19.



Source: [https://www.cell.com/cell/pdf/S0092-8674\(21\)00007-6.pdf](https://www.cell.com/cell/pdf/S0092-8674(21)00007-6.pdf)

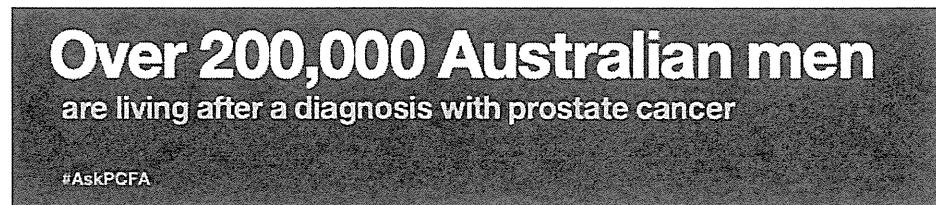
What does this graph best demonstrate?

- A. The response of a non-vaccinated person
- B. The response to a vaccine for COVID-19
- C. The first and second exposure to COVID-19
- D. The second exposure to COVID-19

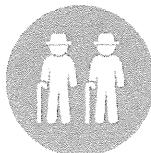
- 16 Which of the following correctly identifies a part of the human ear and its function?

	<i>Part</i>	<i>Function</i>
A.	Tympanic membrane	Receives vibrations from the ossicles and passes them on to the cochlea
B.	Auditory nerve	Transfers sound vibrations to the temporal lobe of the brain for processing
C.	Organ of Corti	Converts vibrations in the fluid of the cochlea into electrochemical signals
D.	Semicircular canals	Transfers vibrations from the ossicles to the cochlea

- 17 The Prostate Cancer Foundation of Australia has produced a number of materials aimed at raising awareness of prostate cancer. One of these materials are shown below.



MYTH 1

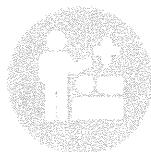


ONLY OLD BLOKES
GET PROSTATE CANCER

BUSTED

Age and risk of developing prostate cancer are related. However, there are other factors like genetics, family history, diet and lifestyle that can play a role. If you are a man over 50 (or 40 with a family history of prostate cancer) talk to your doctor about your prostate health.

MYTH 2

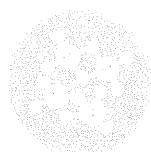


MEN DON'T DIE OF
PROSTATE CANCER

BUSTED

Whilst approximately 85% of people diagnosed with prostate cancer survive for at least 5 years, around 3,500 Aussie men still die of prostate cancer annually. Prostate cancer is estimated to be the 2nd most common cause of death from cancer in Australian men. If diagnosed early, the chances of a cure are higher.

MYTH 3



ALL PROSTATE CANCERS
ARE THE SAME

BUSTED

Research has shown that there are 29 types of prostate cancer. Prostate cancer can be indolent, harmless or of an aggressive nature. It can be contained within the prostate gland, spread to adjacent organs or to other parts of the body. Therefore, treatment for each of these cancers is different. For best outcomes, speak to your doctor about your diagnosis and prostate cancer treatment choices.

**RAISING AWARENESS
SAVES LIVES**

#AskPCFA

pcfa.org.au | 1800 22 00 99

Even if you are not experiencing any symptoms, if you have any concerns, book an appointment with your doctor today.

 Prostate Cancer Foundation of Australia

Source: <https://www.prostate.org.au/awareness-resources/>

What is the most valid way to assess the impact of this campaign?

- Compare data on the incidence and prevalence of prostate cancer before and after the campaign.
- Compare the number of men being screened for prostate cancer before and after the campaign.
- Survey men in the population to find out if they are aware of the campaign.
- Compare the mortality rate of men who are aware of the campaign with those who are not familiar with it.

- 18 The following table shows the frequency of different genotypes within a population.

Genotype	Frequency
RR	70%
Rr	20%
rr	10%

What is the allele frequency of R?

- A. 10%
 - B. 20%
 - C. 80%
 - D. 90%
- 19 What is the term used to describe B and T cells before they have been exposed to an antigen?
- A. Immunocompetent
 - B. Antibodies
 - C. Red blood cells
 - D. Naive
- 20 Which of the following is true of genetic mutations?
- A. Most are beneficial.
 - B. They are all harmful.
 - C. Most are detected but only symptoms are repaired.
 - D. Most are detected and repaired by enzymes.

Section II

80 marks

Attempt Questions 21–32

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. Extra writing space is provided at the back of this booklet.

If you use this space, clearly indicate which question you are answering.

Question 21 (4 marks)	Marks
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- (a) Define the term *mutagen*.

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- (b) Identify a type of mutagen and explain how it operates, using an example.

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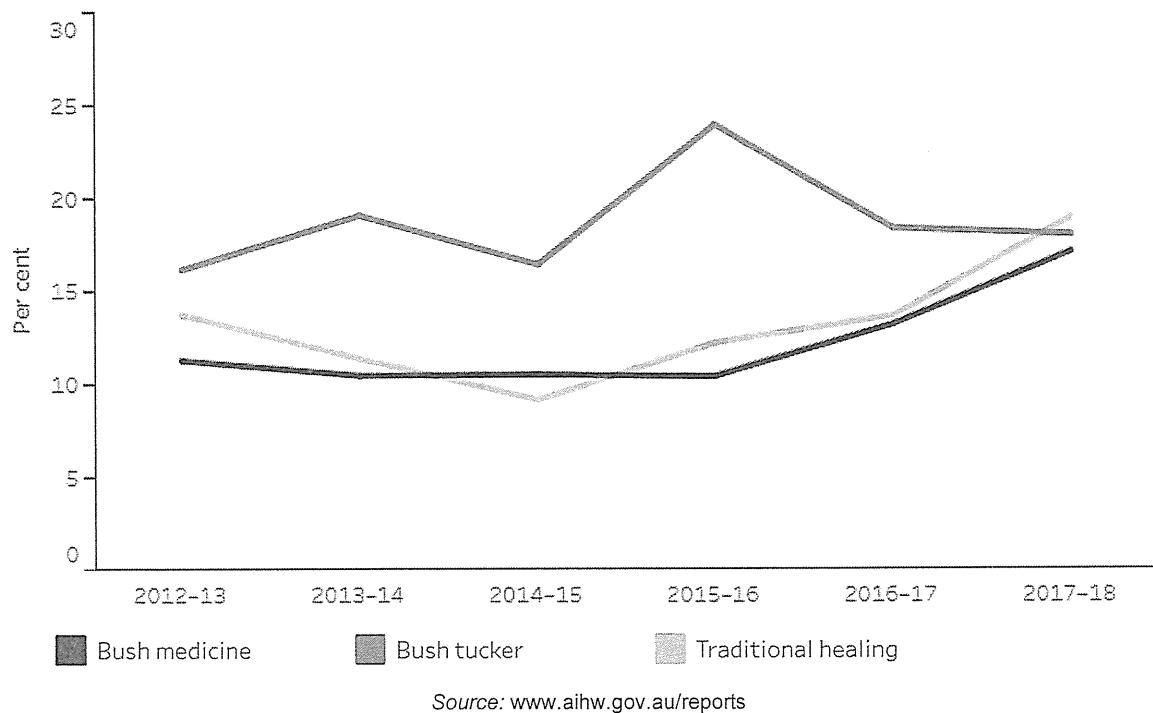
Question 22 (7 marks)

Marks

Some antibiotics and antivirals were first discovered in rainforest or bushland areas. Some organisations provide bush medicine and food programs in very remote areas to maintain the health of citizens. Indigenous Australian peoples have used bush medicine for thousands of years.

7

Health care organisations offering Indigenous services



Use the information and data provided to justify the importance of recognition and protection of Indigenous cultural and intellectual property.

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More space to answer this question is provided on the next page

STUDENT NUMBER/NAME:

Question 22 (continued)

End of Question 22

Question 23 (4 marks)

Marks

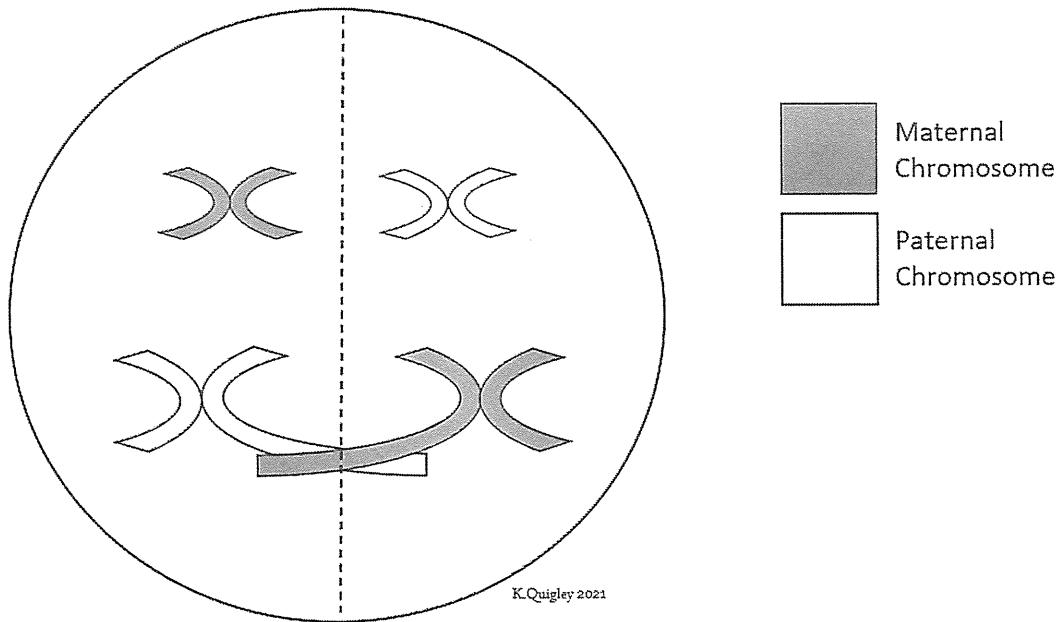
Discuss the role of epidemiological studies in addressing non-infectious diseases.

4

Question 24 (4 marks)**Marks**

The following diagram shows two pairs of homologous chromosomes. One pair of homologous chromosomes are crossing over.

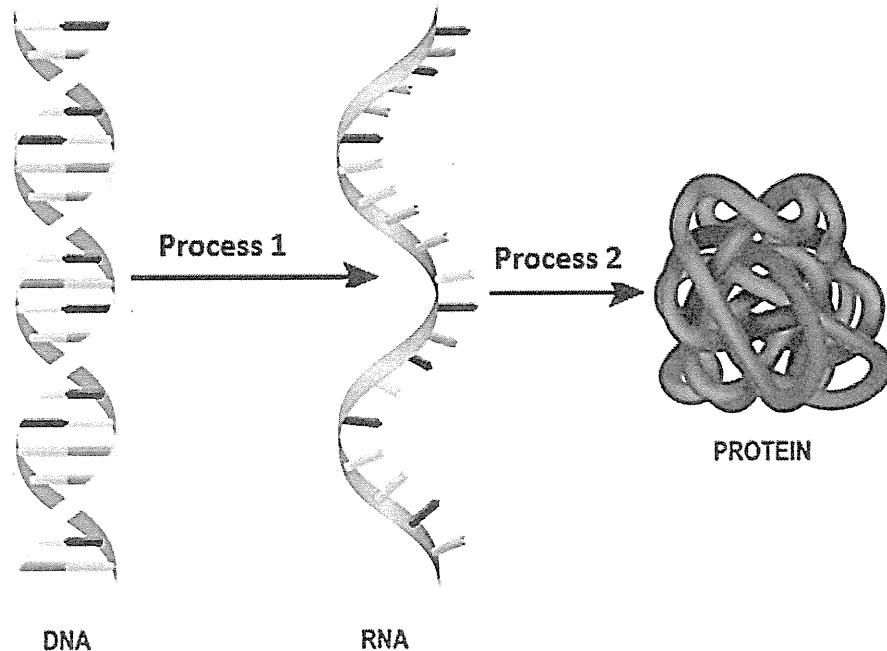
4



Use the key provided to draw the possible gamete chromosome combinations from this diagram.

Question 25 (5 marks)**Marks**

Genes provide information for building proteins. However, they do not directly create proteins. The production of proteins is completed through two processes.



- (a) Using the information above, identify Process 1. 1

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- (b) Identify the part of the cell in which Process 2 occurs. 1

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- (c) Using examples, compare TWO types of proteins. 3

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Question 26 (8 marks)

Marks

According to the most recent Australian Bureau of Statistics National Health Survey, over 13 million Australians have a long-term vision disorder, the most common being hyperopia (7.2 million) and myopia (6.3 million).

- (a) Explain the causes of hyperopia and myopia, using labelled diagrams to support your explanation. 4

Question 26 continues on the next page

Question 26 (continued)

Marks

- (b) Evaluate the effectiveness of TWO different technologies used to address vision disorders.

End of Question 26

Question 27 (6 marks)

Marks

Explain the advantages of artificial pollination and artificial insemination and describe ONE disadvantage that is common to both reproductive technologies.

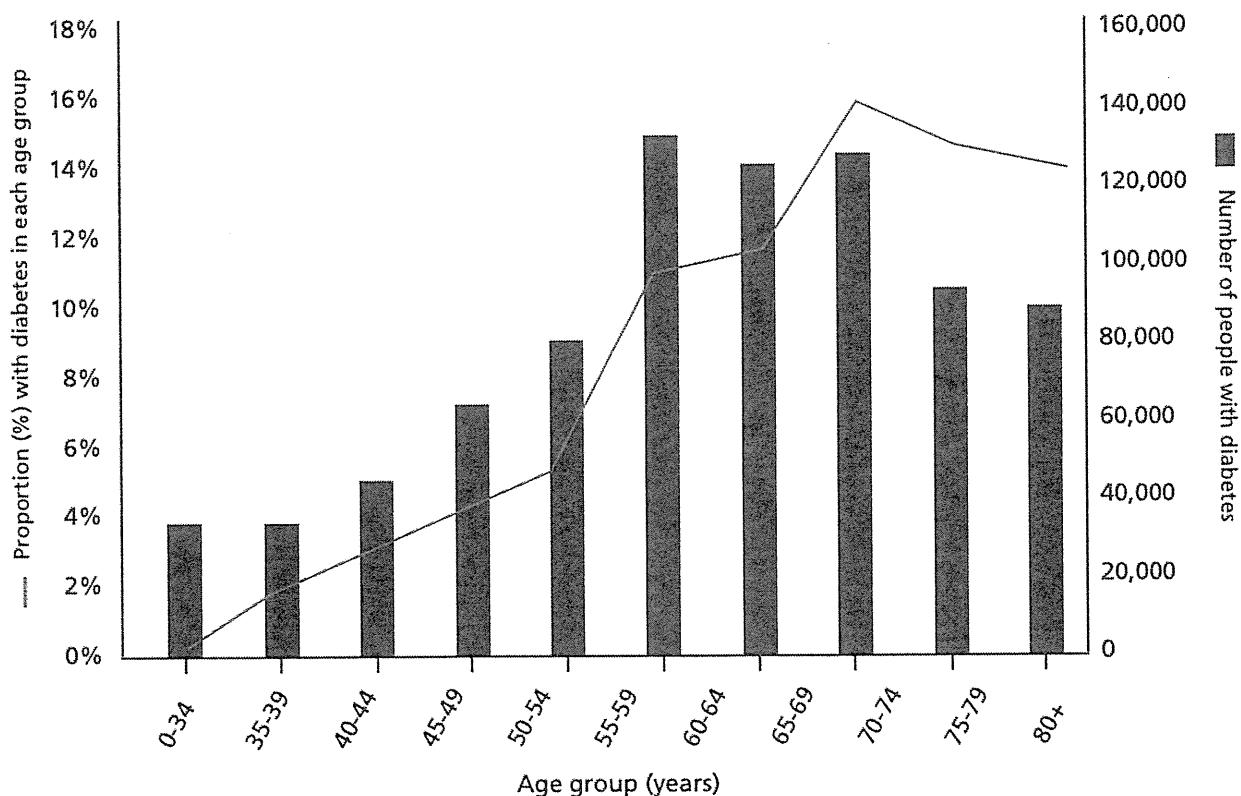
6

Question 28 (6 marks)

Diabetes Mellitus is a condition characterised by the inability to effectively transport glucose from the bloodstream into cells, often resulting in high blood glucose levels. This is either because a person's pancreas is not producing sufficient amounts of insulin, the hormone that facilitates glucose uptake, or because their cells don't respond normally to the insulin they produce.

Type 1 Diabetes (approximately 10% of all Diabetes cases) is an autoimmune disease, thought to be triggered by the interaction of genetic and environmental factors. Type 2 Diabetes (85–90% of all cases), while having a genetic component, is largely associated with poor nutritional choices and lack of exercise.

Figure 1. Australians diagnosed with diabetes by age group in 2007-08 (Australian Institute of Health and Welfare 2011)



Source: <https://www.diabetesaustralia.com.au/wp-content/uploads/Diabetes-the-silent-pandemic-and-its-impact-on-Australia.pdf>

Question 28 continues on the next page

Question 28 (continued)

Marks

- (a) Explain the trend shown by the graph above.

3

- (b) Evaluate how effective an educational program or campaign could be as a strategy for reducing rates of Type 1 and Type 2 Diabetes in Australia. 3

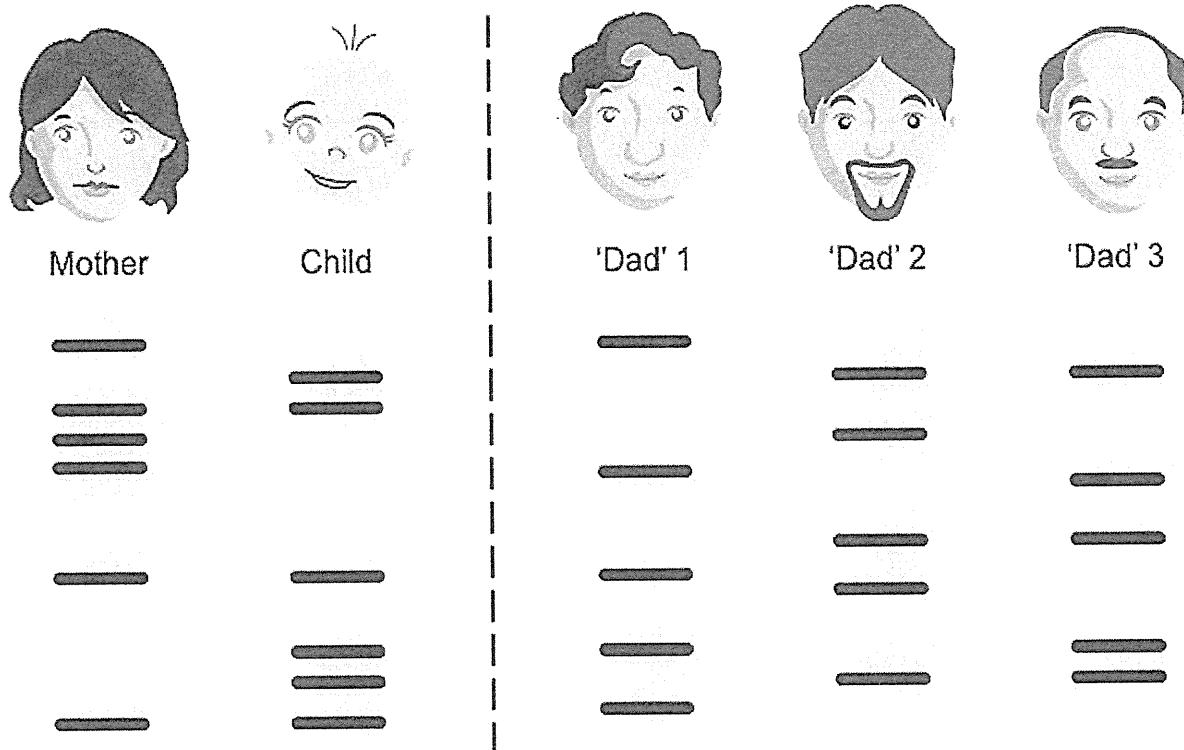
3

End of Question 28

Question 29 (3 marks)

Marks

DNA profiling is used to compare DNA in forensic investigations and paternity disputes. The diagram below shows the DNA profiles of 3 men, a mother and a child.



Source: <https://ib.bioninja.com.au/standard-level/topic-3-genetics/35-genetic-modification-and/dna-profiling.html>

Identify the most likely biological father of the child and explain reasons for your choice.

Question 30 (8 marks)

Marks

Analyse the importance of ethics in the use of biotechnology.
Include ONE plant and ONE animal example in your response.

8

Question 30 continues on the next page

STUDENT NUMBER/NAME:

Question 30 (continued)

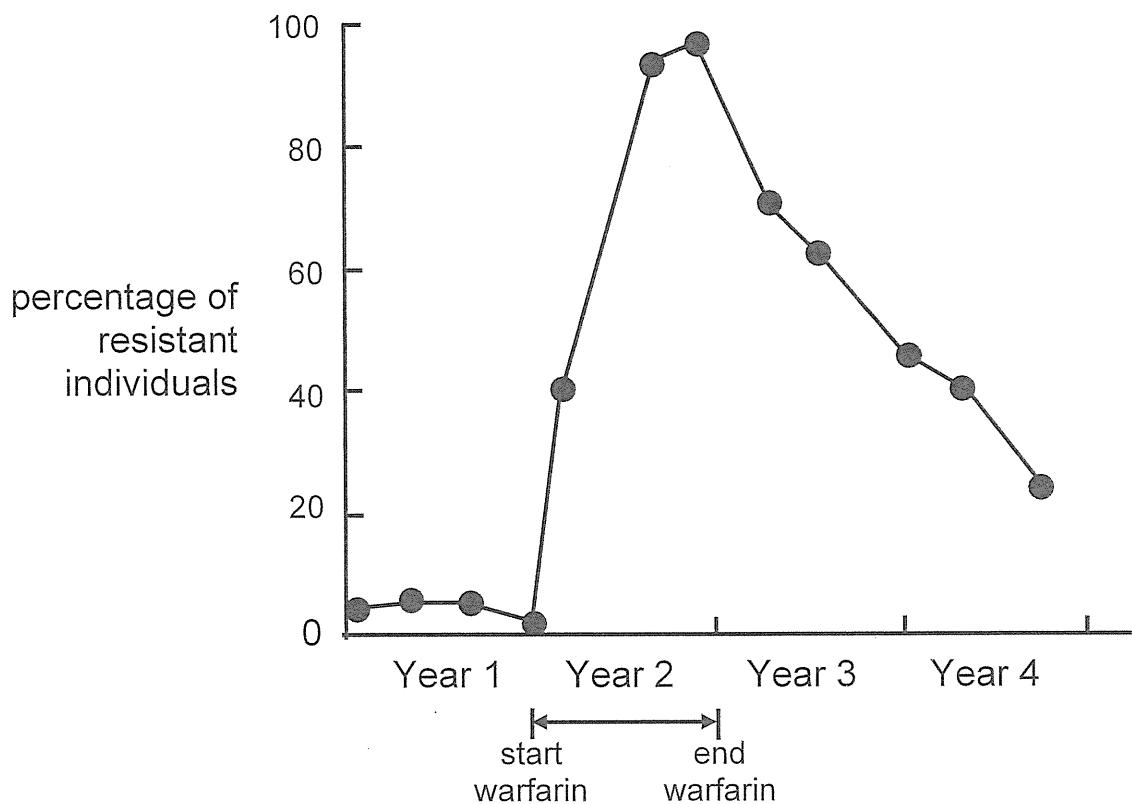
End of Question 30

Question 31 (6 marks)

Regions of NSW were recently impacted by increased populations of mice. Mice first reproduce from 6–8 weeks of age, then breed every 3 weeks.

Warfarin is a poison used in mice baits. Over a 4-year period, data was collected about the percentage of Warfarin-resistant mice in the population. Warfarin was used during Year 2. This data can be seen in Figure 1.

Figure 1. Warfarin resistant mice in a population



Question 31 continues on the next page

Question 31 (continued)

Marks

- (a) Explain why the percentage of resistant mice increased during Year 2.

- (b) Using the data in Figure 1, explain what can be concluded about the selective advantage to a mouse of being Warfarin-resistant compared to being non-resistant in an environment with no Warfarin.

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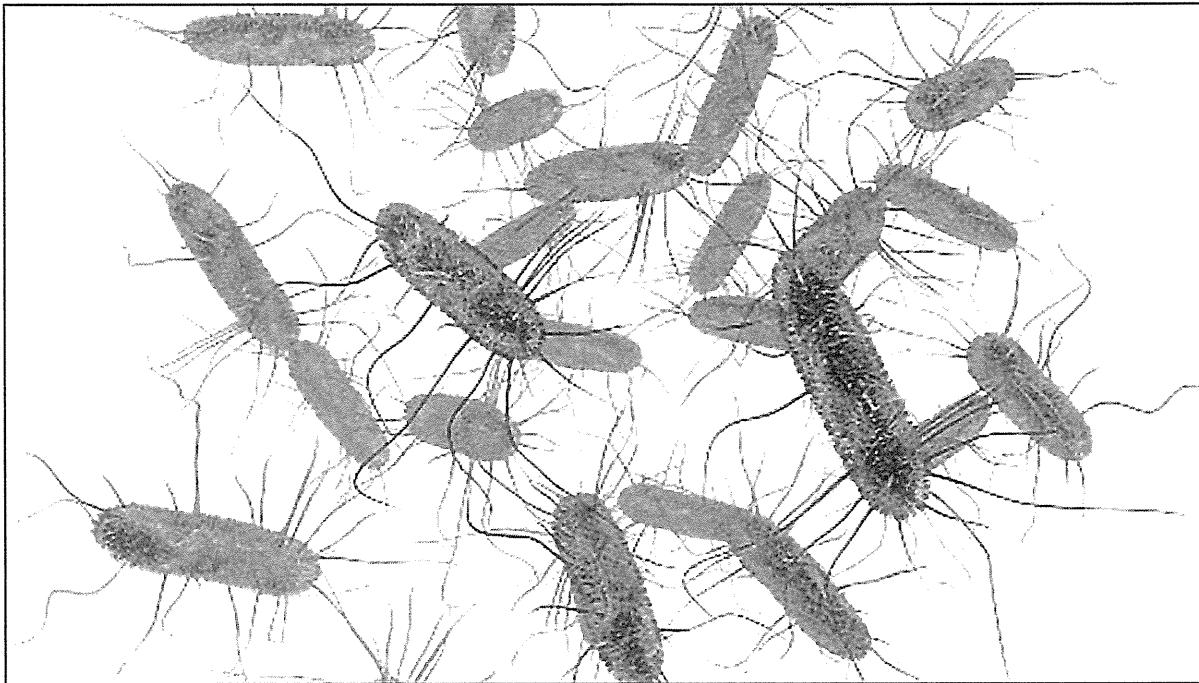
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End of Question 31

Question 32 (19 marks)**Marks**

Salmonella typhimurium is a bacterium adapted to survive temperatures of between 5.2 and 46.2 degrees Celsius. The proteins inside the bacterium resist denaturation at the human body's average internal temperature of 36–37.5 degrees Celsius and at 40 degrees with severe fever.



Salmonella typhimurium replicates, causing vomiting and diarrhoea in the host. This increases the chance that the bacteria will spread if people do not wash their hands carefully.

Question 32 continues on the next page

Question 32 (continued)

Marks

- (a) Outline the impact of these adaptations on the incidence of *Salmonella typhimurium* in the community. 3

Question 32 continues on the next page

Question 32 (continued)

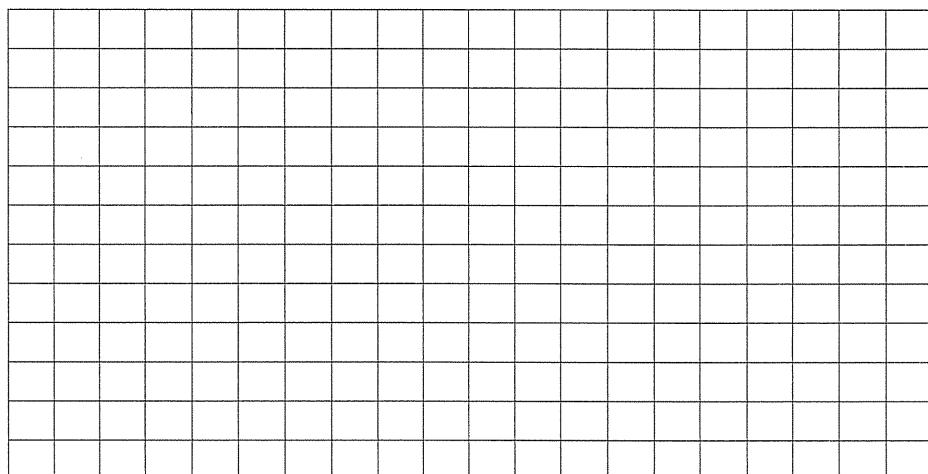
Marks

- (b) During term two, there was an outbreak of *Salmonella typhimurium* in a local school. Students were sent home when they showed symptoms of the bacterial infection. The following table shows the incident rate of children sent home each day over the week.

	Year level			
	Year 7	Year 8	Year 9	Year 10
Monday	5	2	2	1
Tuesday	6	3	3	2
Wednesday	8	4	3	1
Thursday	7	3	4	3
Friday	8	2	3	3
Totals				

- (i) Use the grid below to plot a bar graph of infections by Year group.

4



- (ii) Using data from your graph in (i), suggest a reason for one year group having different results.

1

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Question 32 continues on the next page

Question 32 (continued)

Marks

- (c) Public health scientists wanted to investigate the effect of ionising radiation on the growth of *Salmonella typhimurium* in the presence of antibiotics.

They grew bacterial colonies of *Salmonella typhimurium* in petri dishes labelled *A*, *B* and *C*.

The Petri dishes were kept at 36°C for 48 hours, with scientists observing the bacteria every 24 hours.

The results for this investigation are below.

Petri dish	Treatment	After 24 hours	After 48 hours
<i>A</i>	Was subjected to ionising radiation followed immediately by a dose of antibiotic <i>X</i>	Small spots of growth on surface	Large spots of growth on surface
<i>B</i>	An equal amount of antibiotic <i>X</i> was added (as was added to Petri dish <i>A</i>)	No growth	No growth
<i>C</i>	Was given neither ionising radiation nor antibiotic <i>X</i>	Growth across whole surface	Growth across whole surface

- (i) Explain the effect of the ionising radiation on the bacteria.

2

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- (ii) Identify the purpose of petri dish *C*.

1

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- (iii) Explain why scientists must continue to develop new antibiotics.

3

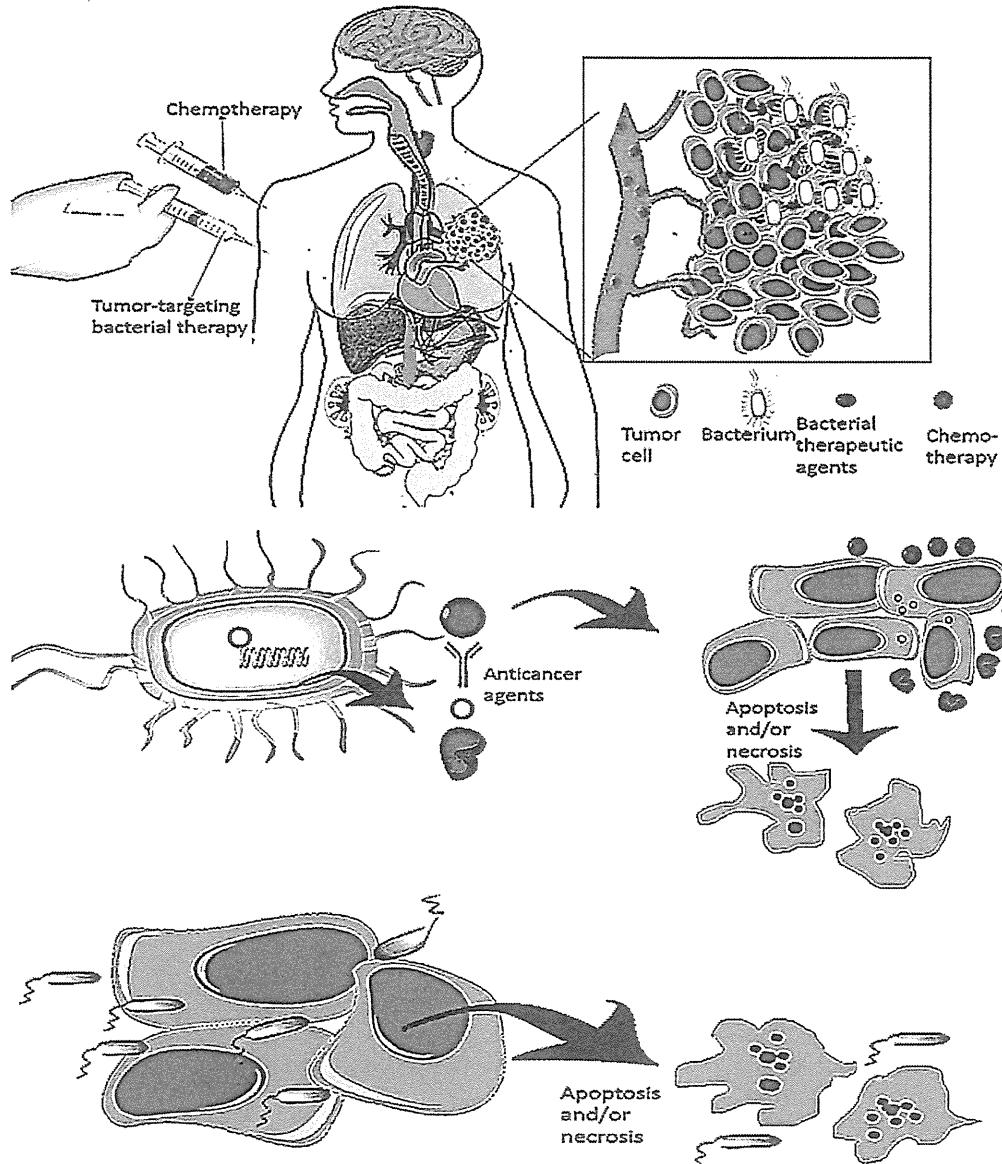
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Question 32 continues on the next page

Question 32 (continued)

Marks

- (d) Cancer is difficult to treat as many existing techniques cause harmful side effects for the patient. Bacterial-mediated cancer therapy (BMCT) is an emerging anti-tumour treatment. *Salmonella typhimurium* has the potential to colonise and proliferate inside targeted tumours and inhibit tumour growth. This can be used in combination with other therapeutic methods which regulate the tumour microenvironment, such as chemotherapy.



Source: https://www.researchgate.net/figure/Strategies-in-tumor-targeting-bacterial-therapy-A-Bacteria-have-adequate-tissue_fig1_267754257

Question 32 continues on the next page

Question 32 (continued)

Marks

Discuss, using specific examples, the potential benefits for society of continued research into the use of genetic technologies.

5

End of paper

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

NSW INDEPENDENT TRIAL EXAMS – 2021
BIOLOGY TRIAL HSC EXAMINATION
MARKING GUIDELINES

Section I

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

Section II

Question 21(a)

Criteria	Mark
• Provides a correct definition	1

Sample Answer: A mutagen is a physical or chemical agent that permanently changes genetic material, usually DNA, in an organism and thus increases the frequency of mutations above the natural background level.

Question 21(b)

Criteria	Mark
• Identifies a type of mutagen and provides an example	3
• Explains how the mutagen operates	
• Identifies a type of mutagen	2
• Explains how the mutagen operates	
• Identifies a type of mutagen	
OR	
• Provides some relevant information	1

Sample Answer: Types of mutagens can include radiation and chemicals. Benzene is an example of a chemical mutagen. Benzene binds DNA, inhibits DNA synthesis and causes double strand breaks, leading to aberrations in genes and chromosomes.

Question 22

Criteria	Mark
<ul style="list-style-type: none">• Uses data from the graph to demonstrate understanding of the use of Indigenous medicine and bush remedies• Discusses the importance of the recognition of Indigenous cultural and intellectual property• Discusses the importance of the protection of Indigenous cultural and intellectual property• Relates the importance of Indigenous knowledge to its benefits for all people's health• Makes a judgement about the importance of recognition and protection of Indigenous cultural and intellectual property	7
<ul style="list-style-type: none">• Refers to the graph to demonstrate understanding of the use of Indigenous medicine and bush remedies• Outlines the importance of the recognition of Indigenous cultural and intellectual property• Outlines the importance of the protection of Indigenous cultural and intellectual property• Relates the importance of Indigenous knowledge to its benefits for all people's health• Makes a judgement about the importance of recognition and protection of Indigenous cultural and intellectual property	6
<ul style="list-style-type: none">• Makes a reference to the data in the graph• Outlines the importance of the recognition of Indigenous cultural and intellectual property• Outlines the importance of the protection of Indigenous cultural and intellectual property• Outlines the importance of Indigenous knowledge to its benefits for all people's health	5
<ul style="list-style-type: none">• Makes a reference to the data in the graph• Identifies the importance of the recognition of Indigenous cultural and intellectual property• Identifies the importance of the protection of Indigenous cultural and intellectual property• Identifies the importance of Indigenous knowledge to its benefits for all people's health	4
<ul style="list-style-type: none">• Identifies the importance of the recognition of Indigenous cultural and intellectual property• Identifies the importance of the protection of Indigenous cultural and intellectual property• Identifies the importance of Indigenous knowledge to its benefits for all people's health or makes a reference to the data in the graph	3
<ul style="list-style-type: none">• Identifies reasons to recognise and/or protect Indigenous cultural and intellectual property	2
<ul style="list-style-type: none">• Provides some relevant information about Indigenous cultural and intellectual property or the data in the graph	1

Question 22 continues on the next page

Question 22 continued

Sample Answer:

Indigenous cultural and intellectual property includes stories, songs and knowledge that have been handed down through generations; this includes traditional knowledge of bush medicines and healing. The World Health Organisation, in its Traditional Medicine (TM) Strategy (2014–2023), promotes the integration of TM into contemporary healthcare policies and practices.

The use of bush medicine, tucker and healing continues to increase, from between 10–15% in 2012 to between 15–20% in 2018.

It is vital that, when working with Aboriginal and Torres Strait Islander Peoples and communities regarding bush medicines, their knowledge is recognised through ethical partnerships which actively involve Indigenous people at all stages of the research process, including collection and preparation of plant materials and laboratory investigations. These partnerships and associated research and findings help to also protect Indigenous cultural and intellectual property by ensuring knowledge is retained for future generations, including the importance of protecting the native landscape. It is also important that Indigenous cultural and intellectual property is protected through laws.

Indigenous knowledge of bush tucker and bush medicines could positively impact the health of all people, for example, the Kakadu Plum is an important bush food for people in northern Australia; the fruits and seeds were eaten raw and it was used to treat colds and flus. Scientists have discovered that the Kakadu Plum fruit contains the highest recorded level of natural vitamin C of any plant globally, more than 100 times that of oranges and it therefore has enormous potential for use in dietary supplements and health foods.

As we learn more about the pharmaceutical properties of the natural landscape, and the Indigenous knowledge about specific species of plants and animals, our ability to positively impact the health of our communities increases.

It is vital that Indigenous cultural and intellectual property is recognised and protected both for Indigenous peoples to pass on their knowledge to future generations and for ethical partnerships to flourish in order to create a positive health impacts for Indigenous and non-Indigenous people.

Question 23

Criteria	Mark
• Describes AT LEAST TWO different ways that epidemiological studies can contribute towards addressing non-infectious diseases	4
• Describes AT LEAST ONE limitation of epidemiological studies	
• Outlines AT LEAST TWO different ways that epidemiological studies can contribute towards addressing non-infectious diseases	3
• Outlines AT LEAST ONE limitation of epidemiological studies	
• Outlines ONE way that epidemiological studies can contribute towards addressing a non-infectious disease	2
• Outlines ONE limitation of epidemiological studies	
• Outlines ONE way that epidemiological studies can contribute towards addressing a non-infectious disease	
OR	
• Outlines ONE limitation of epidemiological studies	1

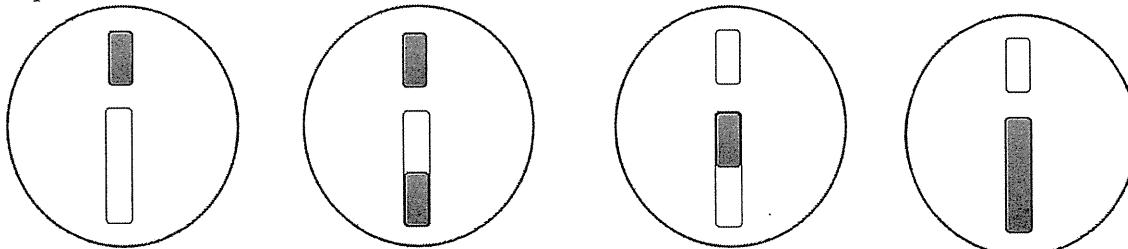
Sample Answer: Epidemiological studies are used to find the causes of health outcomes and diseases in populations and are vital in our understanding of non-infectious diseases and how to address them.

Epidemiological studies can determine causation of a disease. By conducting descriptive studies, cohort studies and case-control studies, strong correlations between particular factors and the incidence of a disease can be discovered and explored further to try and establish causation. Once causation of a particular disease is understood, strategies for preventing it and/or limiting its incidence and/or mortality rates can be developed. Descriptive studies can allow epidemiologists to discover what groups within a population are most likely to be affected by a non-infectious disease. This allows any interventions made ,e.g. ,by government health departments, to be more efficient because they are being targeted at the group/s in society who most need it. One downside of epidemiological studies is that the quality of the data they produce very much depends on the quality of the study design and biases. For example, if researchers have a preconceived idea about what is causing a particular disease, it may affect the groups within society that they choose to participate in the study. This could lead to relevant factors being missed because a particular group of people was not included in the study.

Question 24

Criteria	Mark
• Correct diagrams showing all of the following features: – Four gametes. – Each gamete has 2 single chromosomes. – Each gamete has 1 larger chromosome and 1 smaller chromosome. – 2 gametes show correct recombination of the larger chromosome. – 2 gametes show no recombinant chromosomes. – Correct use of key	4
• Correct diagrams showing FOUR of the features above	3
• Correct diagrams showing TWO – THREE of the features above	2
• Diagram shows ONE correct feature	1

Sample Answer:



Question 25(a)

Criteria	Mark
• Correctly identifies Process 1	1

Sample Answer: Transcription.

Question 25(b)

Criteria	Mark
• Correctly identifies the ribosome	1

Sample Answer: Ribosome.

Question 25(c)

Criteria	Mark
• Correctly identifies TWO types of proteins and describes their role	3
• Identifies at least TWO examples of each type of protein	
• Identifies the role of ONE of the types of proteins named	2
• Identifies at least ONE example of ONE of the types of protein	
• Provides some relevant information related to different types of proteins	1

Sample Answer: Structural proteins are responsible for support for cells and their organelles and also provide support to major structures such as cartilage and hair. Examples include collagen and keratin. Functional proteins are involved in biochemical reactions and help to maintain normal immune function. Examples include enzymes (e.g. avidin) and immunoglobulins.

Question 26(a)

Criteria	Mark
• Explains the cause of myopia AND includes a correct, labelled diagram	4
• Explains the cause of hyperopia AND includes a correct, labelled diagram	
• Explains the cause of myopia	3
• Explains the cause of hyperopia	
• Includes diagrams of myopia and hyperopia which are mostly correct	
Includes TWO of the following:	
• Identifies the cause of myopia	2
• Identifies the cause of hyperopia	
• Includes diagram of myopia or hyperopia	
• Provides some relevant information about myopia and/or hyperopia	1

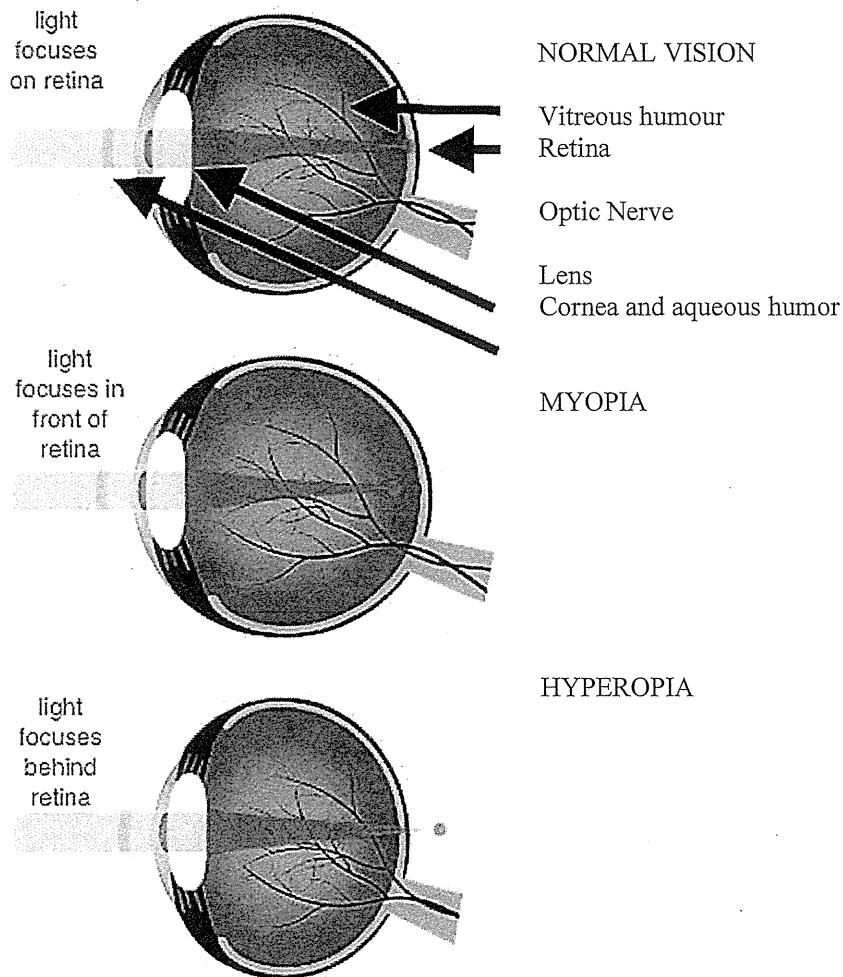
Question 26(a) continues on the next page

Question 26(a) continued

Sample Answer: In the top diagram, showing normal vision, the light can be seen being refracted through the cornea, aqueous humour, lens and vitreous humour and coming to a focus on the retina, which converts the light energy into electrochemical impulses that are sent through the optic nerve to the occipital lobe of the brain for processing.

Myopia – the eyeball is too long and the light focuses in front of the retina, causing the image seen to be blurred/not sharp.

Hyperopia – either the eyeball is too short or the lens is not able to refract light sufficiently and the focal point of light entering the eye is behind the retina, again causing the image seen to be blurred/not sharp.



Question 26(b)

Criteria	Mark
<ul style="list-style-type: none"> • Correctly identifies TWO specific technologies • Outlines benefits AND limitations of each technology • Gives a judgement on the effectiveness of EACH technology in addressing a specific vision disorder 	4
<ul style="list-style-type: none"> • Correctly identifies TWO specific technologies • Outlines AT LEAST ONE benefit AND limitation of each technology • Gives a judgement on the effectiveness of EACH technology in addressing a specific vision disorder 	3
<ul style="list-style-type: none"> • AT LEAST TWO of the criteria above OR • All of the above, but lacking detail 	2
<ul style="list-style-type: none"> • AT LEAST ONE of the criteria above 	1

Sample Answer: Myopia can be corrected by wearing glasses with a concave lens, to adjust the angle of light entering the eye so that it focuses on the retina. Glasses can be very effective, depending on whether the right lens for a person's eye has been selected. The benefits of wearing glasses are that they allow a person with myopia to see detail around them accurately which is vital for being able to drive, read, play some sport etc. The downsides of glasses include that they can be expensive and uncomfortable if not fitted correctly and they are not suitable for some (e.g. high-contact sport) activities.

Implanted lenses can be used to restore the vision of people suffering blindness from cataracts. A surgical procedure removes the damaged lens and replaces it with an artificial one. The implanted lens has its limitations, primarily because the lens is not able to change shape or accommodate for light reflected off objects that are different distances away. Having surgery also carries the risk of infection. However, since cataracts cause blindness, an artificial lens can very effectively restore sight to a person, allowing them to live independently, drive, recognise people, etc. The surgery is quick and relatively painless and will very significantly improve a person's quality of life.

Question 27

Criteria	Mark
<ul style="list-style-type: none"> • Correctly defines <i>artificial insemination</i> and <i>artificial pollination</i> • Outlines TWO or more advantages of artificial pollination • Outlines TWO or more advantages of artificial insemination • Describes ONE disadvantage common to both artificial pollination and artificial insemination 	6
<ul style="list-style-type: none"> • Correctly defines <i>artificial insemination</i> and <i>artificial pollination</i> • Outlines ONE or more advantages of artificial pollination • Outlines ONE or more advantages of artificial insemination • Outlines ONE disadvantage common to both artificial pollination and artificial insemination 	4–5
<ul style="list-style-type: none"> • Correctly defines <i>artificial insemination</i> and/or <i>artificial pollination</i> • Outlines ONE advantage of artificial pollination • Outlines ONE advantage of artificial insemination • Outlines ONE disadvantage common to both artificial pollination and artificial insemination 	2–3
• Provides some relevant information	1

Sample Answer: Artificial pollination is the dusting, often by hand, of fertile stigmas with the pollen from plants with desired characteristics. Artificial insemination is the injection of male semen into a female of the same species.

- Artificial pollination advantages – offspring with desirable traits created. Relatively easy technique. Could assist with creating a reliable nutrition source for the global population.
- Artificial insemination advantages – allows farmers to mate animals with the most desirable characteristics even when large distances are involved; this is also usually cheaper. Offspring with desirable traits created. Could assist with the conservation of particular species.
- Common disadvantage for both – long term variation in the species (of plant or animal) is reduced and this could make the species' population more susceptible to changing selection pressures, e.g., a disease.

Question 28(a)

Criteria	Mark
• Describes the trend shown	3
• Explains the trend using the information provided and data from the graph	
• Identifies the trend shown	2
• Outlines the trend using the information provided or data from the graph	
• Identifies some relevant information about the trend in the graph	1

Sample Answer: The graph indicates that Diabetes rates are low (<4%) in those aged under 40 years, but increase significantly over the age of 45 years to a peak of around 14%, before tapering off a little after the age of 75.

Most cases of Diabetes (85–90%) are Type 2 Diabetes and Type 2 is correlated with poor nutrition and exercise practices; low rates in early life are most likely made up of those with Type 1 Diabetes (not related to lifestyle choices). Poor lifestyle choices can take some time to cause disease in a person, so the rise in Diabetes diagnoses in middle age is most likely due to people developing Type 2 because of long periods of poor nutritional and exercise choices in their younger years. The lowered rate of Diabetes in older age may be due to people with Diabetes passing away due to complications related to the disease. This is supported by the percentage of the population with diabetes remaining high.

Question 28(b)

Criteria	Mark
• Describes AT LEAST ONE benefit AND limitation of educational programs in reducing non-communicable diseases	3
• Provides a judgement on the value of educational programs for Type 1 and Type 2 Diabetes	
• Identifies AT LEAST ONE benefit AND limitation of educational programs in reducing non-communicable diseases	2
• Provides a judgement on the value of educational programs for Type 1 or Type 2 Diabetes	
• At least ONE of the above	1

Sample Answer: Educational campaigns would be of no use in preventing Type 1 Diabetes as this form of the disease is not believed to be related to lifestyle factors. However, it could have a significant effect in reducing the incidence of Type 2 Diabetes, because Type 2 can be avoided with the right dietary and exercise choices.

An educational campaign would raise people's awareness of the causes of the disease and the potential impacts of their current choices on their future health. This awareness may be enough to motivate preventative behaviours such as a more healthy diet, exercise and getting blood glucose levels checked to identify whether an individual's blood glucose levels are putting them in danger of developing the disease. However, educational campaigns are always limited because knowledge is not the only motivator of people's behaviour – just because people know what's healthy/unhealthy for them does not guarantee that they will choose a better diet or partake in regular exercise.

Question 29

Criteria	Mark
• Correctly identifies the biological father	3
• Explains reasons for choosing the biological father	
• Correctly identifies the biological father	2
• Identifies reasons for choosing the biological father	
• Correctly identifies the biological father	1
OR	
• Identifies a reason for choosing the biological father	

Sample Answer: Dad 3 is the biological father. Each of us inherits our DNA from our biological mother and our biological father. DNA profiling allows us to determine these relationships. Polymorphisms called short tandem repeats are specific regions of DNA that vary highly between people. This is what is reviewed in DNA profiling and in this example we can use them to determine an offspring's parents. Each line (DNA fragment) in the child's profile can be found in either the Mother's DNA profile or the profile of 'Dad' 3.

Question 30

Criteria	Mark
• Defines <i>biotechnology</i> • Outlines features of considerations related to ethical decision-making • Demonstrates an extensive knowledge of the ethical considerations of ONE plant example • Demonstrates an extensive knowledge of the ethical considerations of ONE animal example • Identifies reasons for the need for the ethical use of biotechnology • Communicates scientific information succinctly and logically using precise scientific terminology	8
• Defines <i>biotechnology</i> • Outlines features of considerations related to ethical decision-making • Demonstrates a thorough knowledge of the ethical considerations of ONE plant example • Demonstrates a thorough knowledge of the ethical considerations of ONE animal example • Identifies reasons for the need for the ethical use of biotechnology • Communicates scientific information logically using precise scientific terminology	7
• Defines <i>biotechnology</i> • Outlines a feature of ethical decision-making • Demonstrates sound knowledge of the ethical considerations of ONE plant example • Demonstrates sound knowledge of the ethical considerations of ONE animal example • Identifies a reason for the need for the ethical use of biotechnology • Communicates using scientific terms	5-6
• Provides relevant information about the ethical use of biotechnology • Includes ONE plant example OR • Includes ONE animal example • Provides relevant information about the ethical use of biotechnology	3-4 1-2

Question 30 continues on the next page

Question 30 continued

Sample Answer: Biotechnology is the use of organisms or their parts or products to provide a valuable substance or process. We currently place limits on some biotechnologies, but not on others, based on our perceptions, the intents of the interventions and our legal processes for making ‘ethical’ decisions.

A common approach to thinking about the ethics of using biotechnology is by evaluating safety and weighing potential risks and benefits. For example, potential risks to the environment and wildlife, potential risks to human health, potential socio-economic effects, potential risk to public trust in the result of the biotechnological process. Alternatively, with regard to potential benefits, there are potential benefits to agricultural productivity through the development of crops more resistant to pests, disease, and severe weather, decreasing the risk of devastating crop failure, potential benefits to the environment, potential benefits to human health and wellbeing and societal or global benefits.

Plant example – Bt cotton is an example of a transgenic species created by scientists. It provides a benefit to society as it reduces the need to spray cotton crops with insecticides. This saves people time and money; it also means that crops are more successful and there is greater yield for use by humans (as clothing) and animals (as a feed supplement). An advantage to the environment is that Bt cotton reduces the use of insecticides, which benefits food chains and food webs. One disadvantage of this crop is that farmers have to buy the seeds each year and are dependent on large companies. Another disadvantage of Bt cotton is that it reduces biodiversity as it means large areas of crops are genetically identical; it is also potentially toxic to non-target animals.

Biotechnology on animals has increased significantly, and the use of this technology brings with it ethical issues, some of which relate to animal welfare, which is defined by the World Organisation for Animal Health as “the state of the animal ... how an animal is coping with the conditions in which it lives”. Genetic engineering technology has numerous applications involving companion, wild, and farm animals, and animal models used in scientific research.

Animal example – Transgenic Salmon with the BGH (Bovine Growth Hormone) gene incorporated in its genome. An advantage of these fish growing faster is there are higher yields and profitability for fisheries. Another advantage for society is that there is more product available for commercial use which could also lead to cheaper salmon meat for consumers. A disadvantage is that the fish have to be kept in ponds, which may not be conducive to maximising their health. Another disadvantage is that they may destroy natural ecosystems if they make their way into river systems.

Of course, both human wellbeing and environmental safety are of concern, as outlined here. However, we also must be concerned with justice and the common good. Therefore the need for the ethical use of biotechnology is imperative in relation to human and environmental sustainability, the just distribution of nutritious food and should have appropriate regulations that address the necessary human and environmental protections.

Question 31(a)

Criteria	Mark
• Identifies variation exists in the population	
• Outlines that Warfarin resistance must be an inheritable trait	4
• Explains how the Warfarin increases the proportion of resistant mice in the population	
• Identifies variation exists in the population	
• Identifies that Warfarin resistance must be an inheritable trait	3
• Outlines how the Warfarin increases the proportion of resistant mice in the population	
• TWO of the above	2
• ONE of the above	1

Sample Answer: Warfarin resistant mice already existed in the population before the use of Warfarin. When Warfarin was introduced to the population, non-resistant mice are killed (and therefore are unable to reproduce) and the Warfarin resistant mice are able to survive to reproduce. This ensures that the allele for Warfarin resistance is inherited and therefore passed on to next generation. Over several generations, the proportion of Warfarin resistant mice in the population increases.

Question 31(b)

Criteria	Mark
• Explains correct conclusion about the selective advantage	
• Refers to data from graph	2
• Outlines correct conclusion about the selective advantage	
OR	
• Refers to data from graph	1

Sample Answer: When Warfarin is no longer used, in years 3 and 4, the graph shows a significant decrease in the percentage of resistant mice in the population from approximately 95% to 25%. This implies that these mice are at a selective disadvantage in an environment that is free from Warfarin. It follows that being non-resistant is a selective advantage in a Warfarin free environment.

Question 32(a)

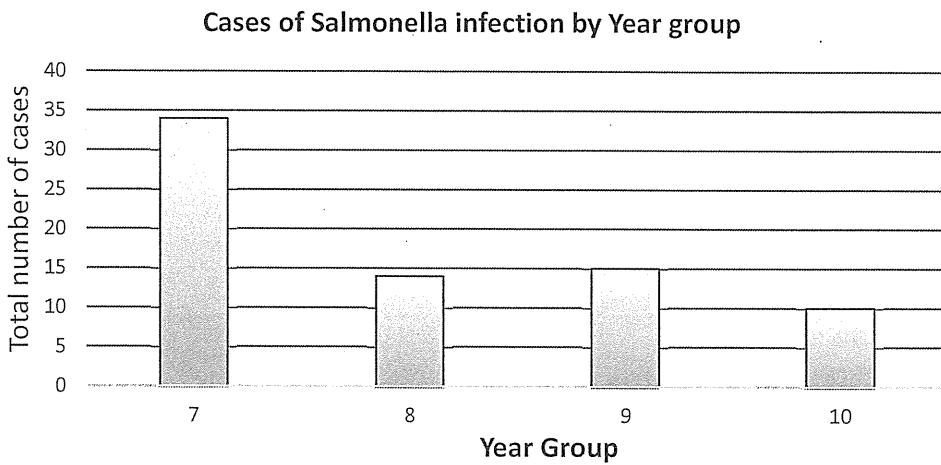
Criteria	Mark
• Provides details of the impact of the successful adaptation	3
• Relates the adaptation to its impact on incidence	2
• Outlines a reason for the impact of the adaptation	2
• Provides some relevant information	1

Sample Answer: Incidence refers to the number of individuals who develop a specific disease or experience a specific health-related event during a particular time period. The adaptation of Salmonella to survive under a broad range of temperatures, results in the increased replication and survival rate of the bacterium in the host's body. The host has limited time to respond to the bacteria using the second line of defence, the non-specific mechanisms such as phagocytes and macrophages. As the Salmonella is able to be passed on in bathrooms if a host does not wash their hands well and can survive in food as it can withstand higher temperatures when food is cooked or heated, the adaptation has a large impact on the successful infection of more hosts and therefore a large impact on the incidence in the community (a large number of people can be infected in a short period of time).

Question 32(b)(i)

Criteria	Mark
• Relevant title for graph	
• X-axis and Y-axis correctly labelled	4
• Appropriate scale for Y-axis	
• Data displayed as bar graph and is correct for information in the table	
• THREE of the above	3
• TWO of the above	2
• ONE of the above	1

Sample Answer:



Question 32(b)(ii)

Criteria	Mark
• Relevant suggestion made for a single year to be higher or lower in case numbers	
• Refers to the data	1

Sample Answer: The total number of cases for Year 7 is more than double each of the other Year groups. Year 7 maybe be more likely to pass on the bacteria due to lack of hand washing or closer contact, leading to the bacteria being shared when they spend time together. Another hypothesis may be that younger people can spread the bacterium for longer before showing symptoms. It should be noted that all would require further investigation.

Question 32(c)(i)

Criteria	Mark
• Identifies that ionising radiation can cause mutations	2
• Correctly explains the effect of the ionising radiation on the bacteria	1

Sample Answer: The ionising radiation increased the mutations in the bacteria, allowing some to become resistant to the antibiotic.

Question 32(c)(ii)

Criteria	Mark
• Identifies petri dish C as a control	1

Sample Answer: A control for the experiment.

Question 32(c)(iii)

Criteria	Mark
• Explains how mutations in bacteria lead to resistant strains which require new antibiotic treatments	3
• Outlines how a mutation in bacteria requires new antibiotic treatments	2
• Provides some relevant information	1

Sample Answer: Bacteria, such as *Salmonella typhimurium*, can mutate during reproduction either spontaneously or via exposure to mutagens. Such mutations could cause resistance to certain antibiotics. This resistance can be passed on via reproduction, leading to a new strain of antibiotic resistant bacteria. Therefore, treatment for this new strain of bacteria would require a new type of antibiotic to be developed.

Question 32(d)

Criteria	Mark
• Defines <i>genetic technologies</i> • Identifies TWO or more specific genetic technologies and describes their uses • Describes how continued research into genetic technologies can benefit society	5
• Defines <i>genetic technologies</i> • Identifies TWO specific genetic technologies and describes their uses • Outlines how continued research into genetic technologies can benefit society	4
• Defines <i>genetic technologies</i> • Identifies a specific genetic technology and describes its use/s • Outlines how continued research into genetic technologies can benefit society	3
• Defines <i>genetic technologies</i> • Identifies a specific genetic technology	2
OR	
• Describes how continued research into genetic technologies can benefit society	
OR	
• Defines <i>genetic technology</i>	1
OR	
• Identifies a specific genetic technology	

Sample Answer: Genetic technologies are techniques used for the direct modification, removal or transfer of gene/s or other genetic material. Microorganisms and plant-based substances are now being manipulated using genetic technologies to benefit society via medical treatments. For example, mRNA technologies have enabled the production of vaccines, such as the COVID-19 vaccines. The mRNA encodes a key protein of SARS-CoV-2; once the mRNA gets inside our cells, our bodies produce this protein. That acts as the antigen, the foreign molecule that triggers an immune response. Genetic technologies have also enabled the creation of bacterial-mediated cancer therapies to assist in the treatment of various cancers by using the bacteria as vectors for therapeutic cancer medication.

Both medical examples have positive benefits to society via increasing the health of individuals (and therefore their ability to contribute positively to society) and through the reduction in the healthcare and societal costs associated with these diseases.

NSW INDEPENDENT TRIAL EXAMS – 2021
BIOLOGY TRIAL HSC EXAMINATION
MAPPING GRID

Question	Marks	Content	Syllabus outcomes	Target performance bands
Section I				
1	1	Mod 8 – homeostasis	Bio12-15	2-3
2	1	Mod 5 – genetic variation	Bio12-12	3-4
3	1	Mod 7 – immunity	Bio12-14	4-5
4	1	Mod 6 – genetic technologies	Bio12-7, Bio12-13	2-3
5	1	Mod 5 – reproduction	Bio12-12	3-4
6	1	Mod 8 – cause and effects	Bio12-15	5-6
7	1	Mod 7 – responses to pathogens	Bio12-14, Bio12-2	3-4
8	1	Mod 6 – mutation	Bio12-7, Bio12-13	2-3
9	1	Mod 7 – immunity	Bio12-14	3-4
10	1	Mod 5 – genetic variation	Bio12-12	4-5
11	1	Mod 8 – epidemiology	Bio12-6, Bio12-15	3-4
12	1	Mod 6 – mutation	Bio12-6, Bio12-13	3-4
13	1	Mod 6 – biotechnology	Bio12-7, Bio12-13	2-3
14	1	Mod 5 – reproduction	Bio12-12	5-6
15	1	Mod 7 – prevention, treatment and control	Bio12-14, Bio12-4	5-6
16	1	Mod 8 – technologies and disorders	Bio12-15	3-4
17	1	Mod 8 – prevention, skills/problem solving	Bio12-6, Bio12-15	4-5
18	1	Mod 5 – genetic variation	Bio12-12	4-6
19	1	Mod 7 – responses to pathogens	Bio12-14	4-5
20	1	Mod 6 – mutation	Bio12-13	5

NSW INDEPENDENT TRIAL EXAMS – 2021
BIOLOGY TRIAL HSC EXAMINATION
MAPPING GRID - cont'd

Section II				
Question	Marks	Content	Syllabus outcomes	Target performance bands
21(a)	1	Mod 6 mutation	Bio12-6, Bio12-7, Bio12-13	3
21(b)	3	Mod 6 mutation	Bio12-6, Bio12-7, Bio12-13	4-5
22	7	Mod 7 – prevention, treatment and control	Bio 12-4, Bio12-5, Bio 12-14	5-6
23	4	Mod 8 – epidemiology	Bio12-15	4-6
24	4	Mod 5 – cell replication	Bio12-6, Bio12- 12	3-4
25(a)	1	Mod 5 – dna and polypeptide synthesis	Bio12-5, Bio12-6, Bio12-12	3-4
25(b)	1	Mod 5 – dna and polypeptide synthesis	Bio12-12	2-3
25(c)	3	Mod 5 – dna and polypeptide synthesis	Bio12-12	3-4
26(a)	4	Mod 8 – technologies and disorders	Bio12-7, Bio12-15	4-5
26(b)	4	Mod 8 – technologies and disorders	Bio12-15	4-6
27	6	Mod 6 – biotechnology Mod 6 – genetic technologies	Bio12-13	4-5
28(a)	3	Mod 8 – causes and effects	Bio12-5, Bio12-15	3-4
28(b)	3	Mod 8 – revention	Bio12-15	5-6
29	3	Mod 5 – inheritance patterns in a population	Bio12-6, Bio12-12	4-5
30	8	Mod 6 – biotechnology	Bio12-13	5-6
31(a)	4	Mod5 – reproduction Mod 5 – inheritance patterns in a population	Bio12-6, Bio12-12	4-5
31(b)	2	Mod 5 – genetic variation Mod 5 – inheritance patterns in a population	Bio12-5, Bio12-12	2-3
32(a)	3	Mod 7 – causes of infectious disease Mod 7 – responses to pathogens	Bio12-6, Bio12-14	3-4
32(b)(i)	4	Mod 7 – causes of infectious disease	Bio12-4, Bio12-14	4-5
32(b)(ii)	1	Mod 7 – causes of infectious disease	Bio12-5, Bio12-14	3-4
32(c)(i)	2	Mod 6 – mutation Mod 7 – prevention, treatment and control	Bio12-13, Bio12-14	4-5
32(c)(ii)	1	Mod 7 – prevention, treatment and control	Bio12-2, Bio12-14	2-3
32(c)(iii)	3	Mod 6 – mutation Mod 7 – prevention, treatment and control	Bio12-13, Bio12-14	4-5
32(d)	5	Mod 6 – biotechnology Mod 8 – causes and effects	Bio12-13, Bio12-15	4-5