

# Biology

**Section I**  
**20 marks**

Questions 1–20 (1 mark each)

Question	Answer	Outcomes Assessed	Targeted Performance Bands
1	A	BIO12-12	2-3
2	B	BIO12-12, BIO12-6	2-3
3	C	BIO12-14	2-3
4	B	BIO12-14	2-3
5	A	Bio 12-15	3-4
6	B	BIO12-14	3-4
7	D	BIO12-13, BIO12-5	3-4
8	B	BIO12-15, BIO12-5	3-4
9	C	BIO12-13, BIO12-5	3-4
10	D	BIO12-12	3-4
11	B	BIO12-12	3-4
12	C	BIO12-13	3-5
13	A	BIO12-12; BIO12-6	3-5
14	C	BIO12-5, BIO12-13	3-5
15	A	BIO12-15, BIO12-4	3-5
16	C	BIO12-15, BIO12-4	3-5
17	D	BIO12-13	4-6
18	D	BIO12-14; 12-5	5-6
19	A	BIO12-13	5-6
20	D	BIO12-12	5-6

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**Section II**  
**80 marks**

**Question 21 (5 marks)**

**Question 21 (a) (3 marks)**

**Outcomes Assessed: BIO12-12, BIO11/12-5**

**Targeted Performance Bands: 2-3**

Criteria	Marks
<ul style="list-style-type: none"> <li>Identifies hormone X as progesterone</li> <li>Describes the function of progesterone in the menstrual cycle</li> <li>Refers to the graph</li> </ul>	3
<ul style="list-style-type: none"> <li>Identifies hormone X as progesterone AND</li> <li>Describes the function of progesterone in the menstrual cycle</li> <li>OR</li> <li>Refers to the graph</li> </ul>	2
<ul style="list-style-type: none"> <li>Identifies hormone X as progesterone</li> <li>OR</li> <li>Provides some relevant information about oestrogen OR progesterone</li> </ul>	1

**Sample Answer:**

Hormone X is progesterone. Progesterone plays a role in preparing the body for a potential pregnancy. As shown in the data, following ovulation the levels of progesterone increase which triggers the lining of the uterus to thicken to accept a fertilised egg. If fertilisation does not occur, the levels of progesterone fall, and a new menstrual cycle begins.

**Question 21 (b) (2 marks)**

**Outcomes Assessed: BIO12-12, BIO11/12-5**

**Targeted Performance Bands: 2-3**

Criteria	Marks
<ul style="list-style-type: none"> <li>Identifies that the levels of oestrogen and progesterone would both continue to rise instead of falling as shown in the graph</li> </ul>	2
<ul style="list-style-type: none"> <li>Provides some relevant information about either oestrogen or progesterone</li> </ul>	1

**Sample Answer:**

If fertilisation was to occur following ovulation, the levels of both oestrogen and progesterone would continue to increase instead of fall.

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**Question 22 (3 marks)****Outcomes Assessed: BIO12-1, BIO 12-7****Targeted Performance Bands: 2-3**

Criteria	Marks
<ul style="list-style-type: none"> <li>Explains TWO ways that the pathogen could be transferred between individual plants, using appropriate terminology</li> </ul>	3
<ul style="list-style-type: none"> <li>Describes TWO ways that the pathogen could be transferred between individual plants OR</li> <li>Explains one way that black pod could be transferred between plants</li> </ul>	2
<ul style="list-style-type: none"> <li>Provides some relevant information</li> </ul>	1

**Sample Answer:**

Black pod rot could be transferred between plants via direct contact, meaning the infected pods touch a pod or part of an individual plant nearby, transferring the infectious particle to a new host. An additional means of direct transmission could be via wind, if the particles could be airborne and a gust of wind could move them from plant to plant.

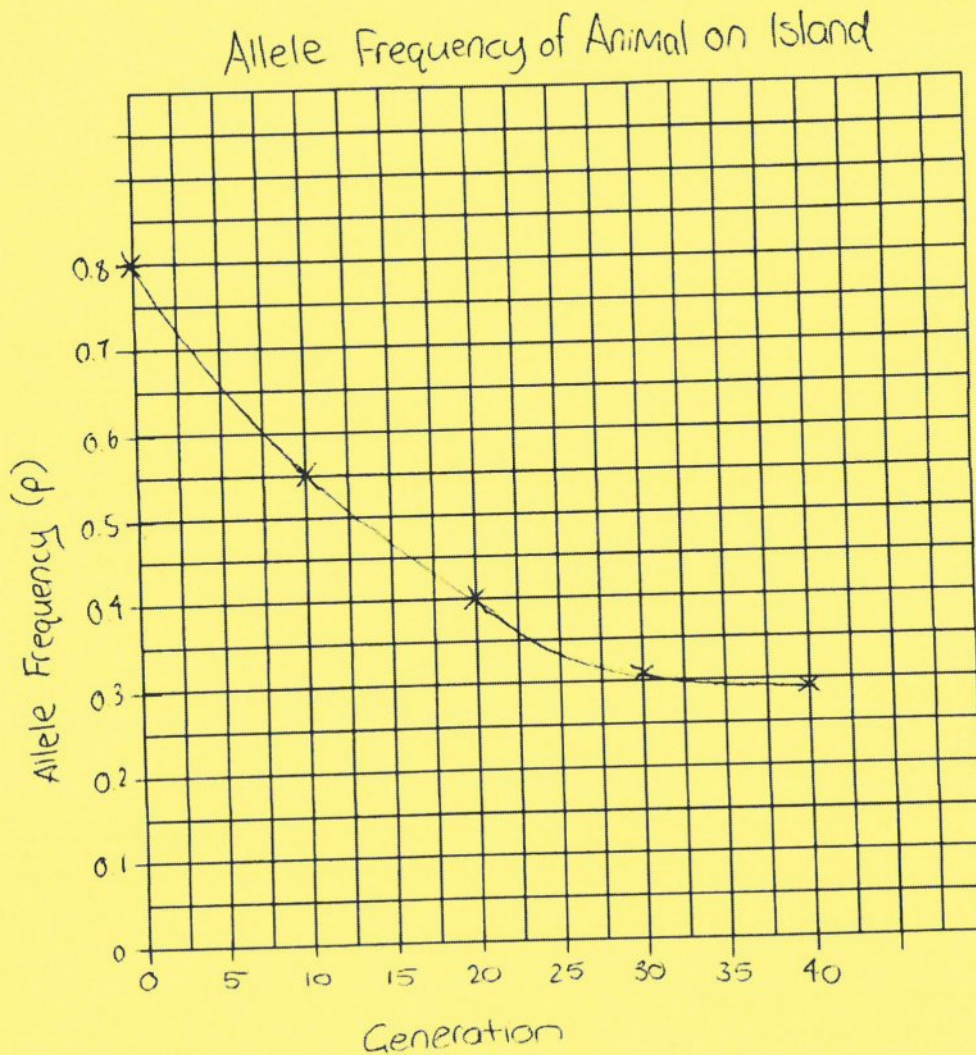
**Question 23 (8 marks)****Question 23 (a) (4 marks)****Outcomes Assessed: BIO12-4****Targeted Performance Bands: 3-5**

Criteria	Marks
<ul style="list-style-type: none"> <li>Provides a suitable graph</li> <li>Provides a graph that is correctly drawn including:               <ul style="list-style-type: none"> <li>Labels and units for axes</li> <li>Appropriate scales for axes</li> <li>Points plotted correctly</li> <li>Appropriate line of best fit</li> </ul> </li> </ul>	4
<ul style="list-style-type: none"> <li>Provides a suitable graph</li> <li>Provides a graph that includes three of the above features</li> </ul>	3
<ul style="list-style-type: none"> <li>Provides a suitable graph</li> <li>Provides a graph that includes two of the above features</li> </ul>	2
<ul style="list-style-type: none"> <li>Attempts to graph the data provided</li> </ul>	1

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**Sample Answer:**



**Question 23 (b) (2 marks)**

**Outcomes Assessed:** BIO12-13

**Targeted Performance Bands:** 3-5

Criteria	Marks
• Describes the main features of the trend	2
• Identifies a trend	1

**Sample Answer:**

The allele frequency decreases exponentially as generation increases, with a large decrease between generation 0 and generation 10.

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**Question 23 (c) (2 marks)**

**Outcomes Assessed: BIO12-13**

**Targeted Performance Bands: 3-5**

Criteria	Marks
• Correctly identifies simulation as gene flow	2
• uses relevant information from stimulus and/or graph to justify response	
• Provides some relevant information	1

**Sample Answer:**

This can be considered an example of gene flow, as the population originates from a small sample that migrated from another area.

OR

This can be considered an example of genetic drift, as the reduction in allele frequency could suggest that random events are non-selectively killing off individuals with a certain allele.

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**Question 24 (6 marks)****Outcomes Assessed: 12-15, BIO12-5****Targeted Performance Bands: 3-5**

Criteria	Marks
<ul style="list-style-type: none"> <li>• Provides a thorough explanation of the cause of astigmatism by:               <ul style="list-style-type: none"> <li>○ relating the shape of the eye (cause) to the resulting visual disorder (effect)</li> <li>○ Comparing the normal eye to the eye affected with astigmatism</li> </ul> </li> <li>• Describes an appropriate technology that could be used to treat astigmatism and explains how it could assist with the effects of the visual disorder by linking cause and effect</li> <li>• Makes a judgement on the effectiveness of the named technology</li> <li>• Uses correct scientific terminology</li> </ul>	6
<ul style="list-style-type: none"> <li>• Provides a thorough explanation of the cause of astigmatism by:               <ul style="list-style-type: none"> <li>○ relating the shape of the parts of the eye (cause) to the resulting visual disorder (effect)</li> <li>○ Comparing the normal eye to the eye affected with astigmatism</li> </ul> </li> <li>• Describes an appropriate technology that could be used to treat astigmatism and explains how it could assist with the effects of the visual disorder by linking cause and effect</li> <li>• Uses correct scientific terminology</li> </ul>	5
<ul style="list-style-type: none"> <li>• Provides a sound explanation of the cause of astigmatism by relating the shape of parts of the eye to the resulting visual disorder</li> <li>• Outlines an appropriate technology that could be used to treat astigmatism and explains how it could assist with the effects of the visual disorder</li> </ul>	4
<ul style="list-style-type: none"> <li>• Relates the shape of the eye to the resulting visual disorder OR</li> <li>• Compares the normal eye to the eye with astigmatism AND</li> <li>• Outlines an appropriate technology that could be used to treat astigmatism</li> </ul>	3
<ul style="list-style-type: none"> <li>• Identifies the cause and/or effect of astigmatism on vision OR</li> <li>• Outlines an appropriate technology that could be used to treat astigmatism</li> </ul>	2
<ul style="list-style-type: none"> <li>• Provides some relevant information</li> </ul>	1

**Sample Answer:**

Astigmatism is a visual disorder caused by a refractive error due to a cornea that is curved. In a normal eye, the round shape allows light to enter as a single ray and focus on one point on the retina, producing a clear image. In an eye with astigmatism, the shape of the eye is more oval-shaped meaning that light does not focus in one single point on the retina, resulting in blurred vision.

Laser eye surgery is a technology that could be used to treat astigmatism. During laser eye surgery, a laser is used to remove part of the cornea to correct the curvature of the eye. This would be an effective treatment as it would make the eye shape more rounded, and thus light would be able to focus on one single point on the retina producing clearer vision for the person.

*\*Other possible technologies to treat astigmatism include contact lenses or spectacles.*

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**Question 25 (5 marks)****Question 25 (a) (2 marks)****Outcomes Assessed: BIO12-15, BIO12-6****Targeted Performance Bands: 3-5**

Criteria	Marks
<ul style="list-style-type: none"> <li>Accounts for the use of images for providing information about disease prevention in Cambodia</li> </ul>	2
<ul style="list-style-type: none"> <li>Provides some relevant information</li> </ul>	1

**Sample Answer:**

Using images to share important health information are valuable in a place like Cambodia where children and adults may or may not be able to read. Using images makes the important prevention practices clear even if you cannot read.

**OR**

Children who learn about these prevention practices, who may or may not be able to read, can take this information home and help parents or elders to take the important steps in the poster. This can help more people than just the children to control the spread of Dengue fever.

**Question 25 (b) (3 marks)****Outcomes Assessed: BIO12-15, BIO12-6****Targeted Performance Bands: 3-5**

Criteria	Marks
<ul style="list-style-type: none"> <li>Explains an alternate method used in a local context to prevent the spread of disease</li> </ul>	3
<ul style="list-style-type: none"> <li>Describes an alternate method used in a local context that could prevent the spread of a disease</li> </ul>	2
<ul style="list-style-type: none"> <li>Provides some relevant information</li> </ul>	1

**Sample Answer:**

One additional practice could be training local peoples in the ways that prevent infection of infectious disease. Local people would have the trust of indigenous populations and could suggest safe methods that are specific to the people in the area. For example, in the Ebola outbreak in Western Africa, local traditions held that during a burial of a loved one, family members would touch the dead body. If the dead person had Ebola, contact with body fluids could transmit Ebola. Having a local, trusted person suggest other practices that might enable dignified burials might lower the transmission of this deadly disease.

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**Question 26 (6 marks)****Question 26 (a) (2 marks)****Outcomes Assessed: BIO12-15****Targeted Performance Bands: 4-5**

Criteria	Marks
<ul style="list-style-type: none"> <li>Makes a judgement on the validity of the source</li> <li>Supports judgement with relevant justification</li> </ul>	2
<ul style="list-style-type: none"> <li>Attempts to make a judgement of the source using justification</li> </ul>	1

**Sample Answer:**

Source 1 is not a valid source for determining the potential effect of e-cigarettes and vaping products on Australian teenagers. The survey data in Source 1 was collected by the Centers for Disease Control and Prevention and the U.S. Food & Drug Administration and based on U.S. teenagers in high schools. The original survey would need to be examined to ensure it was correctly cited by the National Associated Press News.

Source 1 is not a survey of the Australian teenager population and it does not have any information about the potential effects of e-cigarettes and vaping products on the health of individuals. Furthermore, the survey only indicates that there an increasing use of e-cigarettes especially from 2017–2019. Therefore, more information would need to be collected about the health effect of vaping and e-cigarettes and the use of these products amongst the Australian teenage population.

**Question 26 (b) (4 marks)****Outcomes Assessed: BIO12-15****Targeted Performance Bands: 4-5**

Criteria	Marks
<ul style="list-style-type: none"> <li>Explains how the campaign could reduce non-infectious disease</li> <li>Supports response with at least TWO points, demonstrating a thorough understanding of public health campaigns</li> <li>Supports points with strong links to stimulus</li> </ul>	4
<ul style="list-style-type: none"> <li>Describes how the campaign could reduce non-infectious disease.</li> <li>Supports response with at least ONE point, demonstrating a sound understanding of public health campaigns</li> <li>Supports points with links to stimulus</li> </ul>	3
<ul style="list-style-type: none"> <li>Identifies how the campaign could reduce non-infectious disease</li> <li>Supports response with at least ONE relevant point</li> </ul>	2
<ul style="list-style-type: none"> <li>Identifies relevant information</li> </ul>	1

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**Sample Answer:**

The 'Do You Know What You're Vaping' NSW Government campaign would be potentially highly effective at reducing the incidence of non-infectious disease. Source 1 informs the viewer that there is an increase use of e-cigarettes and vaping amongst high school students. Infographic 1 and 2 informs the viewer on the harmful chemicals in vape products, and links it to everyday items so that young children and teenagers can easily understand. For example, in Infographic 1 nail polish remover is illustrated as it is a common household product that most people would know to be a poisonous substance. This may make teenagers think seriously before using vape products. In Infographic 2 the campaign informs viewers of the addictive nature of vaping by informing teenagers that one fruity vape may contain the equivalent of 50 cigarettes of nicotine. This may help debunk the idea that vapes are safer than cigarettes, resulting in a lower incidence of lung cancer in young people later in life.

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**Question 27 (5 marks)**

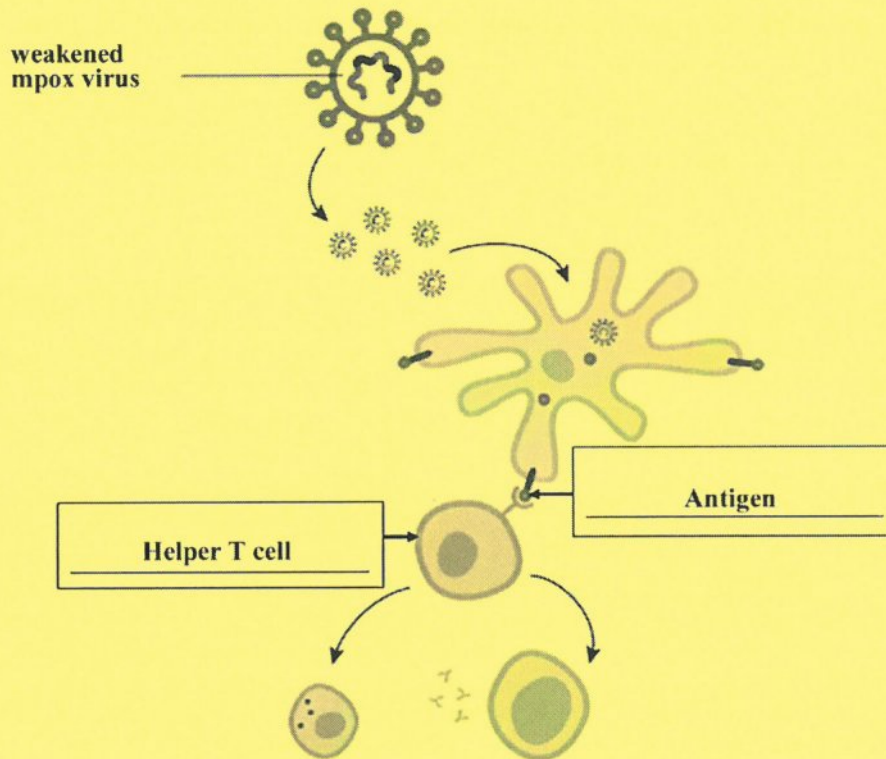
**Question 27 (a) (2 marks)**

**Outcomes Assessed: BIO12-14**

**Targeted Performance Bands: 4-5**

Criteria	Marks
• Correctly labels both parts	2
• Correctly labels one part	1

**Sample Answer:**



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**Question 27 (b)** (3 marks)

**Outcomes Assessed:** *BIO12-14*

**Targeted Performance Bands:** *4-5*

Criteria	Marks
<ul style="list-style-type: none"><li>• Provides a detailed explanation of how the vaccine results in immunity to the virus including reference to the role of B and T cells</li><li>• Includes clear reference to the stimulus</li></ul>	3
<ul style="list-style-type: none"><li>• Provides a sound explanation of how the vaccine results in immunity to the virus</li><li>• Includes a reference to the stimulus</li></ul>	2
<ul style="list-style-type: none"><li>• Provides some relevant information</li></ul>	1

**Sample Answer:**

A weakened copy of the mpox virus is introduced to a person through a vaccine. The virus does not cause the disease; however, it still replicates inside the body. Helper T lymphocytes will detect the antigen and alert other immune cells. B lymphocytes are activated to produce antibodies and killer (cytotoxic) T lymphocytes to destroy the cells.

Once the cells infected with the virus are removed, T and B lymphocytes develop immune memory and remain in the body to respond quickly if the antigen is encountered again (as shown in the last stage of the diagram). If the person is exposed to the mpox virus again, a rapid and large response will be triggered by the memory cells.

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**Question 28 (6 marks)****Outcomes Assessed: BIO12-15****Targeted Performance Bands: 2-6**

Criteria	Marks
<ul style="list-style-type: none"> <li>• Designs a detailed and relevant method to study the incidence of silicosis in Australian construction workers, including ALL of the following:               <ul style="list-style-type: none"> <li>○ Specific and logical steps.</li> <li>○ A clear independent and dependent variable.</li> <li>○ At least two steps to ensure validity (e.g. controlled variable, a control group, set parameters etc.).</li> </ul> </li> <li>• Explains TWO relevant benefits of engaging in an epidemiological study, demonstrating a thorough understanding.</li> <li>• Makes direct and relevant links to the stimulus</li> </ul>	6
<ul style="list-style-type: none"> <li>• Designs a relevant method to study the incidence of silicosis in Australian construction workers, including at least TWO of the following:               <ul style="list-style-type: none"> <li>○ Specific and logical steps.</li> <li>○ A clear independent and dependent variable.</li> <li>○ A step to ensure validity (e.g. controlled variable, a control group, set parameters etc.).</li> </ul> </li> <li>• Explains TWO relevant benefits of engaging in an epidemiological study, demonstrating a sound understanding.</li> <li>• Makes links to the stimulus</li> </ul>	5
<ul style="list-style-type: none"> <li>• Designs a relevant method to study the incidence of silicosis in Australian construction workers.</li> <li>• Describes TWO relevant benefits of engaging in an epidemiological study.</li> <li>• Makes a link to the stimulus</li> </ul>	4
<ul style="list-style-type: none"> <li>• Outlines a relevant method to study the incidence of silicosis.</li> <li>• Outlines a benefit of engaging in an epidemiological study</li> </ul>	3
<ul style="list-style-type: none"> <li>• Outlines a relevant method to study the incidence of silicosis. OR</li> <li>• Outlines a benefit of engaging in an epidemiological study</li> </ul>	2
<ul style="list-style-type: none"> <li>• Identifies a way to study the incidence of silicosis. OR</li> <li>• Identifies a benefit of engaging in an epidemiological study</li> </ul>	1

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### **Sample Answer:**

#### **Method:**

1. *Gather a sample of 20 workers from the one construction company. The workers must meet the following criteria:*
  - *Working in construction for the same company for 10+ years.*
  - *Wear breathing protection less than 50% of the time.*
2. *Complete a medical test to determine the breathing capacity for each of the workers and record an average.*
3. *Gather a sample of a different set of 20 workers from the same construction company that meet the following:*
  - *Working in construction for the same company for 10+ years.*
  - *Wear breathing protection for more than 50% of the time.*
4. *Complete a medical test to determine the breathing capacity for each of the workers and record an average.*
5. *Compare both sets of results to determine if breathing protection has affected the average breathing capacity of the workers.*

Conducting such an epidemiological study is beneficial as it allows for medical professionals to determine a cause-effect relationship between an environmental factor and a non-infectious disease. In this case, it can be determined that silica dust does indeed cause breathing problems, leading to better measures to prevent exposure on job sites.

Conducting a study is also beneficial as it allows for risk factors to be better determined. For example, by conducting a study across different occupations, industries can determine if silicosis severity differs between miners and stonemasons, allowing for job-specific interventions to be put into place.

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**Question 29 (15 marks)****Question 29 (a) (5 marks)****Outcomes Assessed: BIO12-13, BIO12-14****Targeted Performance Bands: 5-6**

Criteria	Marks
<ul style="list-style-type: none"> <li>Provides though explanation of the relationship between the inheritance of two copies of IFNAR1 mutation to IFNAR1/interferon deficiency and severity of viral infection</li> <li>Describes the main response of the innate and adaptive immune systems to viruses</li> <li>Links IFNAR1 deficiency to a weakened immune response</li> </ul>	5
<ul style="list-style-type: none"> <li>Explains the relationship between the inheritance of two copies of IFNAR/interferon deficiency and severity of viral infection</li> <li>Describes some responses of the innate immune system to viruses</li> <li>Links IFNAR1 deficiency to a weakened immune response</li> </ul>	4
<ul style="list-style-type: none"> <li>Describes the relationship between the inheritance of two copies of IFNAR1/interferon deficiency and severity of viral infection</li> <li>Outlines some responses of the innate immune system to viruses</li> <li>Links IFNAR1 deficiency to a weakened immune response</li> </ul>	3
<ul style="list-style-type: none"> <li>Describes a link between the inheritance of two copies of IFNAR1/interferon deficiency and severity of viral infection OR</li> <li>Outlines a response of the innate immune systems to viruses AND</li> <li>Links IFNAR1 deficiency to a weakened immune response</li> </ul>	2
<ul style="list-style-type: none"> <li>Provides some relevant information</li> </ul>	1

**Sample Answer:**

Interferons such as the IFNAR1 protein play an important role in the body's defence against viruses by enhancing the innate immune responses. The innate immune responses include fever to increase internal body temperature which denatures viral protein, inflammation which also increases temperature and brings infection-fighting cells to the site of infection, including phagocytes which engulf and destroy foreign pathogens. Interferons also play a role by hindering viral replication within cells. These innate responses are essential to slow down viral replication, providing enough time for the adaptive immune system to mount a specific defence against the virus.

Individuals with at least one functional copy of the IFNAR1 gene can produce the IFNAR1 protein. Individuals who inherit two faulty copies of the gene, do not have the instructions to make the INFAR1 protein and therefore have a weakened innate immune response to viruses (including vaccines containing live virus). A weakened innate immune response means that the virus can replicate in the cells unhindered, and an individual may become severely ill before the adaptive immune response can be initiated.

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**Question 29 (b)** (5 marks)

**Outcomes Assessed:** BIO12-12, 12-13

**Targeted Performance Bands:** 2-6

Criteria	Marks
Extensive explanation including each of the following components: <ul style="list-style-type: none"><li>• Explains how mutation can enter the population</li><li>• Explains how heterozygous individuals are carriers) as not affected</li><li>• Explains how offspring can inherit the mutation to be carriers or affected</li><li>• Appropriate Punnet square</li></ul>	5
• Explains using three of the above components	4
• Explains using two of the above components	3
• Shows basic understanding of at least two of the above components	2
• Provides some relevant information	1

**Sample Answer:**

Mutations such as the IFNAR1 mutation can only enter the population if they occur in a germline cell (a cell that will undergo meiosis to produce gametes). If a gamete containing the mutation undergoes fertilisation and results in offspring, that offspring will have the mutation in all of his/her cells and may be able to pass the mutation to their offspring, and future progeny. If someone inherits one normal IFNAR1 allele, and one faulty allele, they are considered to be heterozygous carriers. Carriers have one copy of the recessive allele which may be passed to future generations, but because they still have a dominant, functional IFNAR1 gene to express, they will not have IFNAR1 deficiency.

The below Punnet square shows how two heterozygous individuals, who are both carriers but do not have IFNAR deficiency have a 25% chance of having a child with the condition.

I = allele for normal IFNAR protein  
i = mutated allele for IFNAR protein

	<b>I</b>	<b>i</b>
<b>I</b>	II	Ii
<b>i</b>	Ii	ii (individuals with this genotype will be IFNAR deficient)

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**Question 29 (c) (5 marks)**

**Outcomes Assessed: BIO12-13, 12-14**

**Targeted Performance Bands: 2-6**

Criteria	Marks
<ul style="list-style-type: none"><li>• Thorough understanding of relevant prevention and treatment measures AND</li><li>• Makes a judgement about the importance of understanding unique mutations of 'at-risk' and/or indigenous communities</li></ul>	5
<ul style="list-style-type: none"><li>• Sound understanding of some relevant prevention and treatment measures AND</li><li>• Makes a judgement about the importance of understanding unique mutations of 'at-risk' and/or indigenous communities</li></ul>	4
<ul style="list-style-type: none"><li>• Provides a relevant prevention and treatment measure AND</li><li>• Makes a judgement about the importance of understanding unique mutations of 'at-risk' and/or indigenous communities</li></ul>	3
<ul style="list-style-type: none"><li>• Provides a relevant prevention and treatment measure OR</li><li>• Makes a judgement about the importance of understanding unique mutations of 'at-risk' and/or indigenous communities</li></ul>	2
<ul style="list-style-type: none"><li>• Provides some relevant information</li></ul>	1

**Sample Answer:**

Prevention strategies could include:

- Screening techniques for at-risk populations (e.g. people of Polynesian decent)
- Avoiding use of vaccines that do not contain live virus for people at risk, additional research into alternative vaccines
- Careful isolation of at-risk individuals
- Different mutations may have different effects on the immune system so important to have a better understanding of this
- Any other relevant prevention strategy

Treatment strategies could include:

- Provision of early antiviral treatment or management of symptoms for at-risk people
- Research into more advanced antiviral treatments
- Any other relevant treatment strategy

**Judgement**

Identification of this rare mutation in some Polynesian children illustrates the importance of studying other isolated populations to better understand mutations unique to these populations. The above prevention and treatment strategies can only be applied if at-risk individuals are first identified through genetic screening, which is only possible if these mutations are first identified and understood. Furthermore, the better we understand mutations such as the IFNAR1 mutation and the people most at risk, the greater the likelihood of developing better treatment strategies, and vaccines that are appropriate for these populations.

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**Question 30 (7 marks)****Outcomes Assessed: BIO12-12, BIO12-13,****Targeted Performance Bands: 2-6**

Criteria	Marks
<ul style="list-style-type: none"> <li>• Demonstrates an extensive understanding of relevant biological knowledge, including the structure and function of DNA, reproduction and at least TWO genetic technologies</li> <li>AND</li> <li>• Makes a judgment clearly linking the biological knowledge to development of the de-extinction process</li> <li>• Uses the stimulus to support the answer</li> </ul>	7
<ul style="list-style-type: none"> <li>• Demonstrates a thorough understanding of relevant biological knowledge, including the structure and function of DNA, reproduction and TWO genetic technologies</li> <li>AND</li> <li>• Makes a judgment relating most of the biological knowledge to development of the de-extinction process</li> <li>• Uses the stimulus to support the answer</li> </ul>	6
<ul style="list-style-type: none"> <li>• Demonstrates a sound understanding of most of the relevant biological knowledge, including the structure and function of DNA, reproduction and at least ONE genetic technology</li> <li>AND</li> <li>• Makes a judgment relating some of the biological knowledge to development of the de-extinction process</li> <li>• Uses the stimulus to support the answer</li> </ul>	5
<ul style="list-style-type: none"> <li>• Demonstrates a sound understanding of some of the relevant biological knowledge, including the structure and function of DNA, reproduction and/or genetic technology</li> <li>AND</li> <li>• Makes a judgment relating at least one aspect of the biological knowledge to development of the de-extinction process</li> </ul>	4
<ul style="list-style-type: none"> <li>• Demonstrates an understanding of the structure of function or DNA, reproduction or a genetic technology</li> <li>AND</li> <li>• Demonstrates an understanding of relevant biological knowledge</li> <li>OR</li> <li>• Demonstrates an understanding of relevant biological knowledge, including at least TWO of: the structure of DNA, reproduction of DNA, genetic technology</li> </ul>	3
<ul style="list-style-type: none"> <li>• Outlines some relevant features of the structure and function of DNA, reproduction, or a genetic technology</li> </ul>	2
<ul style="list-style-type: none"> <li>• Provides some relevant information</li> </ul>	1

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**Sample Answer:**

Knowledge of DNA structure and function, reproduction and genetic technologies were essential in developing the cloning for de-extinction process. Understanding of the structure of DNA underlies other genetic technologies including CRSPR and DNA sequencing. Scientists had to first understand that each molecule of DNA contains thousands of genes and is composed of nucleotides. The sequence of nucleotide bases is what determines the amino acid sequence of the polypeptide for which the gene codes. Once this information was understood, the process to sequence DNA could be developed. DNA sequencing is essential to the above process so that the DNA of the thylacine and dunnart could be compared. CRSPR technology is also very important so that after the differences in the DNA between the thylacine and dunnart were understood, the genome of the dunnart could be altered to resemble the thylacine genome. Understanding reproductive processes was also of utmost importance. In sexual reproduction, a haploid sperm and egg fuse to form a diploid zygote, which then develops into an embryo. Normal gestation occurs within the female body (uterus). This understanding was necessary in the development of cloning whole organisms using SCNT. The de-extinction process is a modified version of SCNT technology, where a somatic cell is used and fused with an empty egg. Since a somatic cell is used in this process and the egg has no nucleus, the resulting cell will still be diploid and will hopefully act as a zygote and develop into an embryo. Embryos of most mammals, including marsupials, must still develop inside the mother's body. Therefore, the embryo will need to be transferred into the uterus of a surrogate marsupial in order to gestate normally.

**Question 31 (6 marks)**

**Question 31 (a) (2 marks)**

**Outcomes Assessed: BIO12-2, BIO12-4, BIO-6, BIO12-13**

**Targeted Performance Bands: 2-6**

Criteria	Marks
• Explains why data collected may be invalid	2
• Outlines why the data collected may be invalid	1

**Sample Answer:**

When asked for information about personal habits, people may not be truthful, therefore data might not be a true representation of factors affecting accelerated age.

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**Question 31 (b)** (4 marks)

**Outcomes Assessed:** *BIO12-2, BIO12-4, BIO12-13*

**Targeted Performance Bands:** 2-6

Criteria	Marks
<ul style="list-style-type: none"><li>• Provides a comprehensive analysis and interpretation of the data</li><li>• Clearly identifies the two factors that advance aging the most (smoking and alcohol use)</li><li>• Uses the data to support conclusions</li></ul>	4
<ul style="list-style-type: none"><li>• Provides analysis or interpretation of the data or uses data to support conclusions</li><li>• outlines links between lifestyle groups and the data</li></ul>	3
<ul style="list-style-type: none"><li>• Identifies trends in the data OR links between the lifestyle groups and the data</li></ul>	2
<ul style="list-style-type: none"><li>• Provides some relevant information</li></ul>	1

**Sample Answer:**

The graph displays the relationship between the different lifestyle habits of teenagers and the signs of chemical aging in their DNA. Group C5 that is unhealthy and are daily smokers and use alcohol seem to have the most chemical signs of ageing in their blood-based DNA, showing advanced aging of nearly 2 years. This suggests that smoking and alcohol consumption have had a negative effect on the bodies of 21-25 year-olds. This group shows a higher level of advanced aging than the C4 group who smoke and have a higher body fat and only show advanced aging of 1 year. This suggests that alcohol consumption has a greater effect than body fat on the aging process.

The healthy people, in group C1 show a 1-year of advanced aging, which suggests that being healthy results in less advanced aging. Interestingly being healthy with less physical activity (Group C2) shows the greatest benefit with a 2-year result with advanced aging suggesting that not being physically active does not contribute to advanced aging. Perhaps the value of physical activity isn't does not show benefits until later in life or physical activity was not reliably reported in the questionnaires or that any even a low level of physical activity provides benefits that affect the chemical markers in the blood.

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**Question 32 (8 marks)****Outcomes Assessed: BIO12-5, BIO12-12, BIO12-13, BIO12-14, BIO12-15, BIO12-6****Targeted Performance Bands: 4-6**

Criteria	Marks
<ul style="list-style-type: none"> <li>• Demonstrates extensive knowledge and understanding of the process of protein synthesis for production of protein by ERAP2 gene</li> <li>• Provides a thorough explanation of how the gene mutation provides a beneficial immune response, with reference to bubonic plague</li> <li>• Provides thorough explanation of how the gene mutation provides a harmful immune response, with reference to Crohn's disease</li> <li>• Draws on relevant information from the stimulus</li> <li>• Use of appropriate terminology throughout response</li> </ul>	8
<ul style="list-style-type: none"> <li>• Demonstrates thorough knowledge and understanding of the process of protein synthesis for production of protein by ERAP2 gene</li> <li>• Provides explanation of how the gene mutation provides a beneficial immune response, with reference to bubonic plague</li> <li>• Provides explanation of how the gene mutation provides a harmful immune response, with reference to Crohn's disease</li> <li>• Draws on information from the stimulus</li> </ul>	7
<ul style="list-style-type: none"> <li>• Demonstrates sound knowledge and understanding of the process of protein synthesis for production of protein by ERAP2 gene</li> <li>• Provides explanation of how the gene mutation provides a beneficial immune response, with reference to bubonic plague</li> <li>• Provides explanation of how the gene mutation provides a harmful immune response, with reference to Crohn's disease</li> <li>• Draws on information from the stimulus</li> </ul>	6
<ul style="list-style-type: none"> <li>• Demonstrates sound knowledge and understanding of the process of protein synthesis</li> <li>• Demonstrates sound knowledge and understanding of the process of protein synthesis</li> <li>• Provides explanation of the function of the immune system in BOTH bubonic plague AND Crohn's disease</li> </ul>	4-5
<ul style="list-style-type: none"> <li>• Demonstrates some knowledge and understanding of protein synthesis AND/OR the immune system</li> <li>OR</li> <li>• Demonstrates some knowledge and understanding of the immune system AND how the gene mutation can be beneficial AND/OR harmful</li> </ul>	2-3
<ul style="list-style-type: none"> <li>• Provides some relevant information</li> </ul>	1

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**Sample Answer:**

Certain Europeans have inherited certain segments of DNA, a mutated gene, from their ancestors that contain information coding for proteins that protected them from bubonic plague.

This gene is transcribed in the nucleus using enzymes like helicase and RNA polymerase that unzips and reads the template strand to make a complementary RNA copy of the template segment of DNA. This copy is called mRNA and is small enough to leave the nucleus and be carried to the ribosome. In the ribosome this mRNA and its codons are read and tRNA brings the appropriate amino acids to be joined by peptide bonds to produce a polypeptide. This polypeptide forms coils and folds and may join with others to produce a specifically shaped protein.

In the plague example, the protein produced by the ERAP 2 gene version functions as an immune protein and snips away part of the invading plague protein antigen. This antigen is placed on the membrane of the infected immune cell (like a dendritic cell) bound to an MHC protein. This attracts T-cells. T-cells like Killer T-cells can kill the infected cell via apoptosis, and help to produce a memory of the infection, and attract macrophages to ingest the pathogen. The gene that produces a protein that helps in this immune response results in a faster response and therefore survival from the plague and long-lasting memory/protection in the future.

In the Crohn's example, the protein produced by the same gene can also cut pieces off microflora (beneficial bacteria) and places its protein on the surface of the dendritic cell so that the beneficial bacteria are attacked by T cells and this process may produce harmful cytokines that can cause inflammation and pain in the gut. Therefore, the gut will not function properly and cause pain.

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