NSW EDUCATION STANDARDS AUTHORITY

Sample Questions

HIGHER SCHOOL CERTIFICATE EXAMINATION

This document shows the layout of the examination and provides some sample questions for each of the sections.

# Biology

**General Instructions**

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- For questions in Section II, show all relevant working in questions involving calculations
- NESA approved calculators may be used

**Total marks: 100**

**Section I – 20 marks** (pages 3–6)

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

**Section II – 80 marks** (pages 7–20)

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

The first HSC examination for the new Biology Stage 6 syllabus will be held in 2019.

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The Biology examination specifications can be found in the *Assessment and Reporting in Biology Stage 6* document.

Questions may require candidates to integrate knowledge, understanding and skills developed through studying the course. The Year 11 course is assumed knowledge for the Year 12 course.

There is no expectation that all of the Year 12 content will be examined each year. The examination will test a representative sample of the Year 12 content in any given year.

The following sample questions provide examples of some questions that may be found in HSC examinations for Biology. Each question has been mapped to show how the sample question relates to syllabus outcomes and content. Answers for the objective-response questions (Section I) and marking guidelines for the short-answer questions (Section II) are provided. The marking guidelines indicate the criteria associated with each mark or mark range.

In the examination, students will record their answers to Section I on a multiple-choice answer sheet and their answers to Section II in the spaces provided on the examination paper.

The sample questions, annotations and marking guidelines provide teachers and students with guidance as to the types of questions to expect and how they may be marked. They are not meant to be prescriptive. Each year the structure of the examination may differ in the number and type of questions, or focus on different syllabus outcomes and content.

Note:

- Comments in coloured boxes are annotations for the purpose of providing guidance for future examinations.
- Teachers and students should still refer to past HSC examination papers for examples of questions that may be included.

This is NOT a complete sample examination paper. Five sample questions are included in this section.

Past examination papers provide guidance for other types of multiple-choice questions that could be included.

## Section I

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

Use the multiple-choice answer sheet for Questions 1–20.

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**1** An investigation was undertaken to examine the cause of lactose intolerance, a non-infectious condition found in some humans who cannot digest milk. The investigation found variation in the occurrence of lactose intolerance in human populations from different parts of the world.

What is this investigation an example of?

A. A study of ecosystems

B. A microbiological study

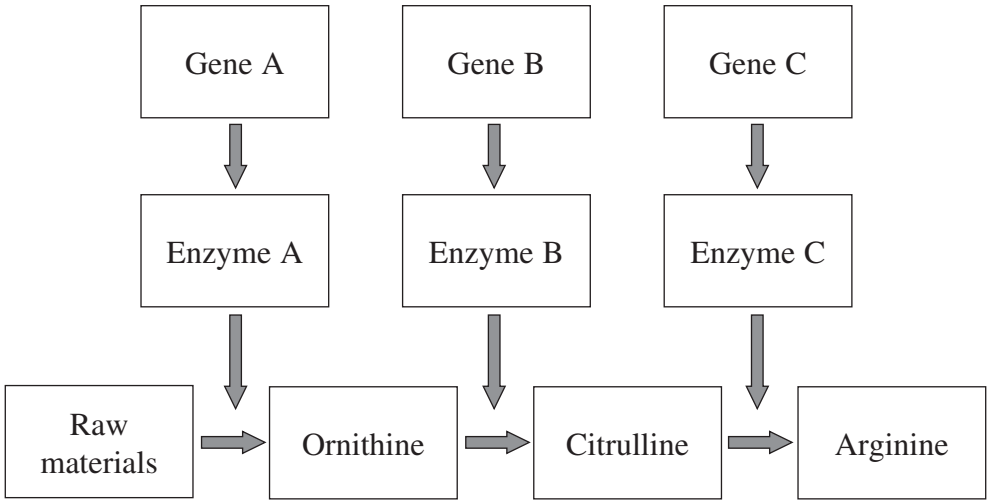
C. An epidemiological study

D. A study of the human immune system

A variety of stimulus material such as text, diagrams, pictures, graphs, photographs and illustrations may be included in questions in Section I. However, stimulus material will only be included when it is essential for answering the question.

Multiple-choice options (A–D) may be presented in different formats, for example, text, numbers, tables, graphs, photographs, diagrams.

**2** The bread mould, *Neurospora crassa*, normally produces its own amino acids from raw materials through a system of enzymes.




If a mutation occurred in gene B, the bread mould would still produce arginine if supplied with

A. citrulline.

B. ornithine.

C. enzyme C.

D. raw materials.

**3** Colour blindness is a sex-linked recessive trait.

Susan is not colourblind but her father is. Susan is married to James who is also not colourblind. Susan and James are expecting twins, a boy and a girl.

What is the probability that the boy or the girl will be colourblind?

| | *Boy* | *Girl* |
|---|---|---|
| A. | 0% | 0% |
| B. | 50% | 0% |
| C. | 0% | 50% |
| D. | 50% | 50% |

**4** Eight sick animals had the same symptoms. Blood tests showed that they were infected with the same type of bacterium.

Which of the following would be the best course of action to determine if this particular type of bacterium is the cause of the symptoms?

A. Treat all eight animals with an antibiotic known to kill this type of bacterium. Check if they recover.

B. Find other animals with the same symptoms. Attempt to isolate the same type of bacterium from their blood.

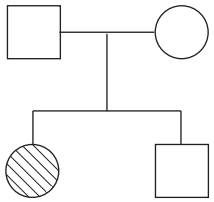
C. Inject blood from animals with the symptoms into suitable host individuals. Check if they develop the same symptoms.

D. Use bacteria from the blood of affected animals to inoculate healthy animals. If these healthy animals develop the symptoms, attempt to isolate the same bacterium from their blood.

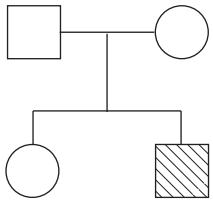
**5** It is suspected that a child has a recessive, sex-linked condition. An initial pedigree was developed.

Which of the following is most likely to depict this initial pedigree?

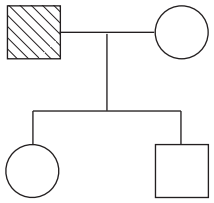
A.



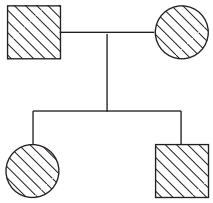
B.

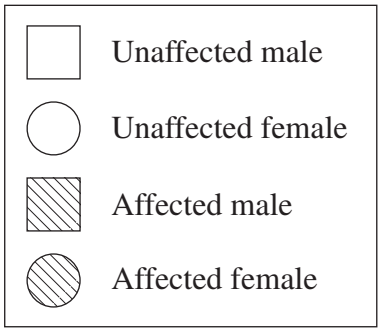


C.



D.






Multiple-choice options (A–D) may be presented in different formats, for example, text, numbers, tables, graphs, photographs, diagrams.

Sample Questions | HIGHER SCHOOL CERTIFICATE EXAMINATION

Questions in Section II may contain parts. There will be 20 to 25 items and at least two items will be worth 7 to 9 marks.

# Biology

# Section II
# Answer Booklet

This is NOT a complete sample examination paper. Seven sample questions (eight items) are included in this section.

**80 marks**
**Attempt Questions 21–XX**
**Allow about 2 hours and 25 minutes for this section**

**Instructions**

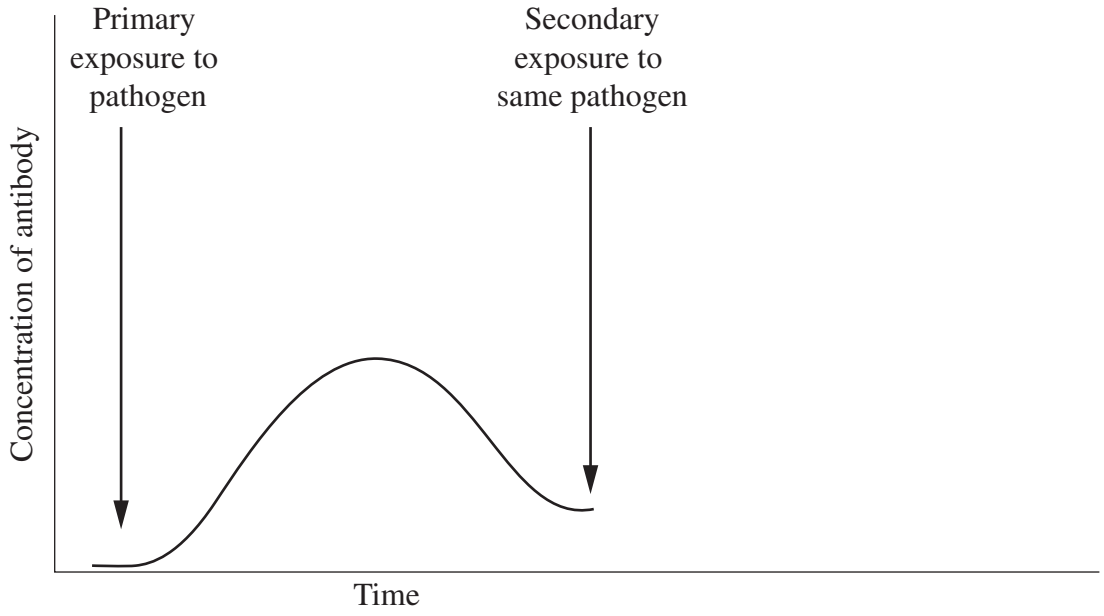
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Show all relevant working in questions involving calculations.
- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.

**Please turn over**

**Question 21** (6 marks)

A variety of stimulus material such as text, diagrams, pictures, graphs, photographs and illustrations may be included in questions in Section II. However, stimulus material will only be included when it is essential for answering the question.

The diagram below shows the immune response after primary exposure to a pathogen.




(a) On the diagram, continue the graph to show the immune response upon secondary exposure to the same pathogen. **2**

(b) Using annotations on the diagram, explain the shape of the entire graph. **4**

Whenever possible, question parts are sequenced in order of difficulty.

An incorrect graph in part (a) will not necessarily preclude students from achieving full marks in part (b).

**Question 22** (3 marks)

A practical investigation is to be carried out to test for the microbes found in food. **3**

Complete the table to show how to minimise risks that are likely to arise in carrying out this investigation.

| *Risk* | *Procedure to minimise it* |
|---|---|
| | |
| | |
| | |

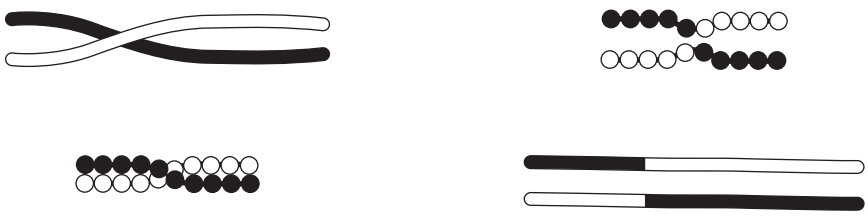
An alternative question without the table format is shown below:

Explain how to minimise risks that are likely to arise in carrying out this investigation.

In this section, students may need to express their responses in a particular format such as a graph, a table, a diagram or annotations. In some cases, a combination of formats may be required.

**Question 23** (4 marks)

The diagram shows a model of crossing over of homologous chromosomes developed in the early 20th century. **4**



Explain how the difference between this model and our current model of crossing over reflects an increased understanding of the way in which new combinations of genotypes are produced. Support your answer with a diagram.

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Some questions in this section may specify that the response must be supported with a diagram or other material such as a graph.

In some cases, students may find it useful to support their answer with a diagram or other material although no specific requirement is made in the question.

**Question 24** (5 marks)

Justify why internal fertilisation can be more advantageous than external fertilisation in ensuring the continuity of a species. **5**

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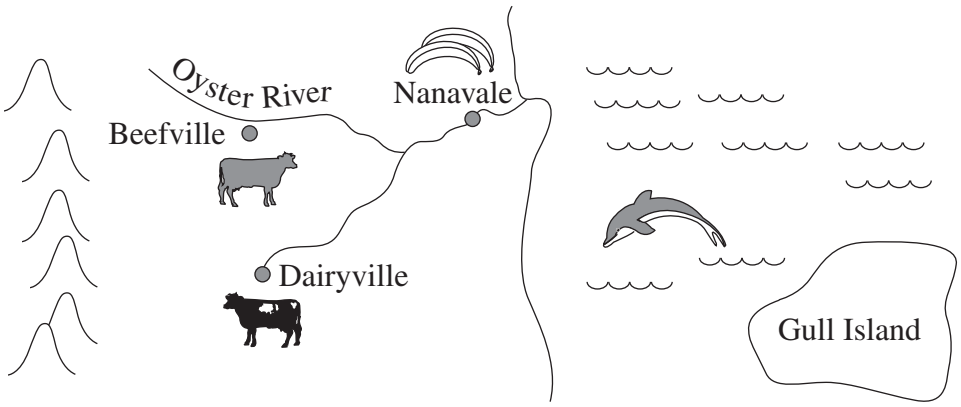
**Question 25** (7 marks)

The following diagram shows a rural coastal area and the associated towns, rivers and industry for each of the townships. **7**




An epidemic of a disease has broken out in Nanavale. The symptoms are stomach ache, vomiting and tiredness. Many families in Nanavale have only one member with the disease, therefore it appears to be non-infectious. The symptoms are worse in infants than in adults.

Isolated cases of this disease have occurred in the nearby towns of Dairyville and Beefville. No cases have been reported on Gull Island.

Design an epidemiological study to investigate the origin of the disease. Refer to features of validity and reliability in your answer.

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**Question 25 continues on page 13**

Question 25 (continued)

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**End of Question 25**

**Question 26** (8 marks)

Compare the processes and effects of point mutations and chromosomal mutations. Include examples in your answer. **8**

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**Question 26 continues on page 15**

Question 26 (continued)

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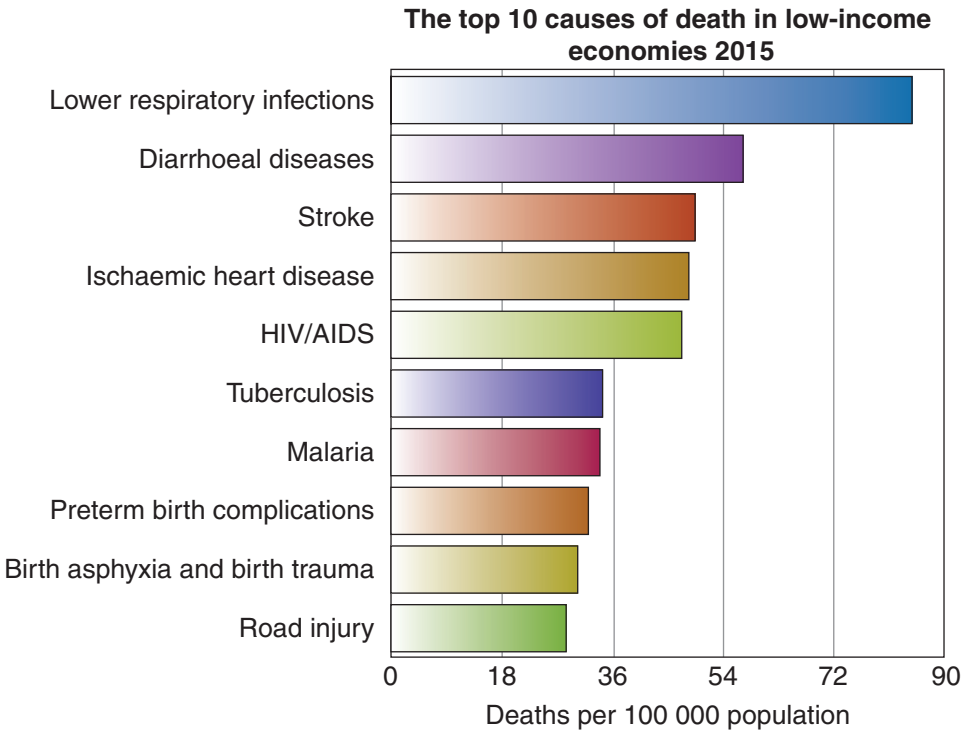
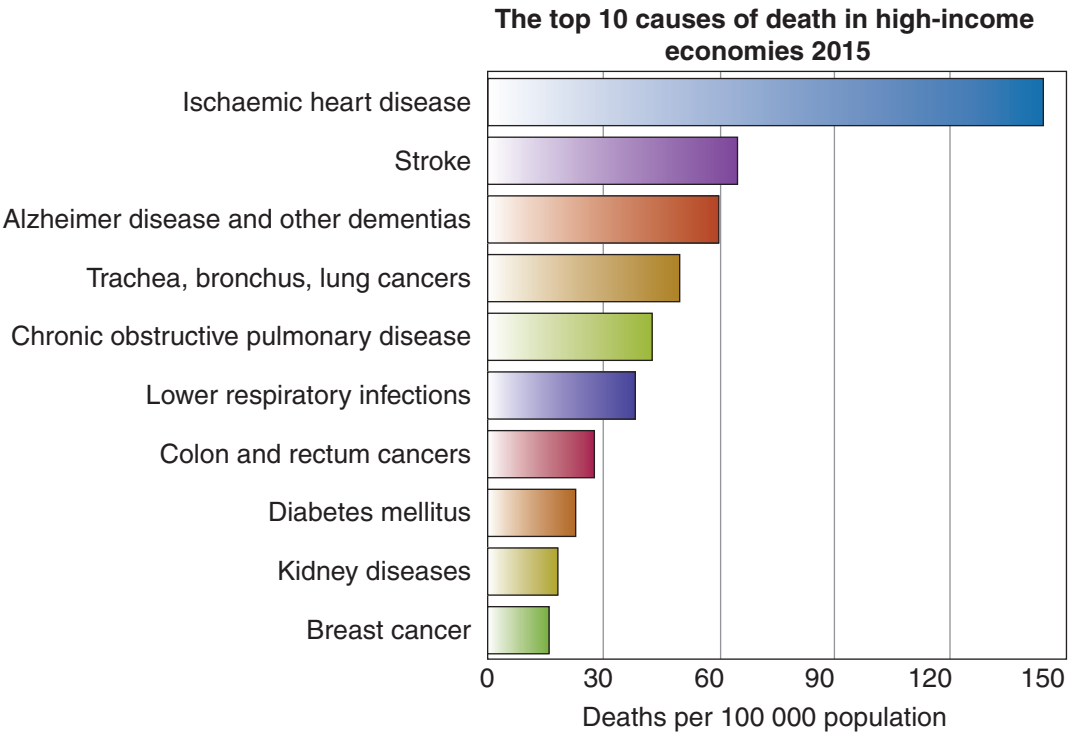
**End of Question 26**

**Question 27** (9 marks)

The graphs show the top 10 causes of death in low and high-income economies in 2015. **9**




Source: www.who.int/mediacentre/factsheets/fs310/en/index1.html (assessed 10/09/2017)

Note: Ischaemic heart disease is also known as coronary heart disease.

**Question 27 continues on page 17**

Question 27 (continued)

Suggest why the top 10 causes of death differed between low and high-income economies in 2015. Justify your answer with analysis of the graphs and your knowledge of diseases and disease categories.

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**Question 27 continues on page 18**

Question 27 (continued)

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**End of sample questions**

## Section II extra writing space

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## Section II extra writing space

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

# HSC Biology Sample Questions
# Marking Guidelines

## Section I

### Multiple-choice Answer Key

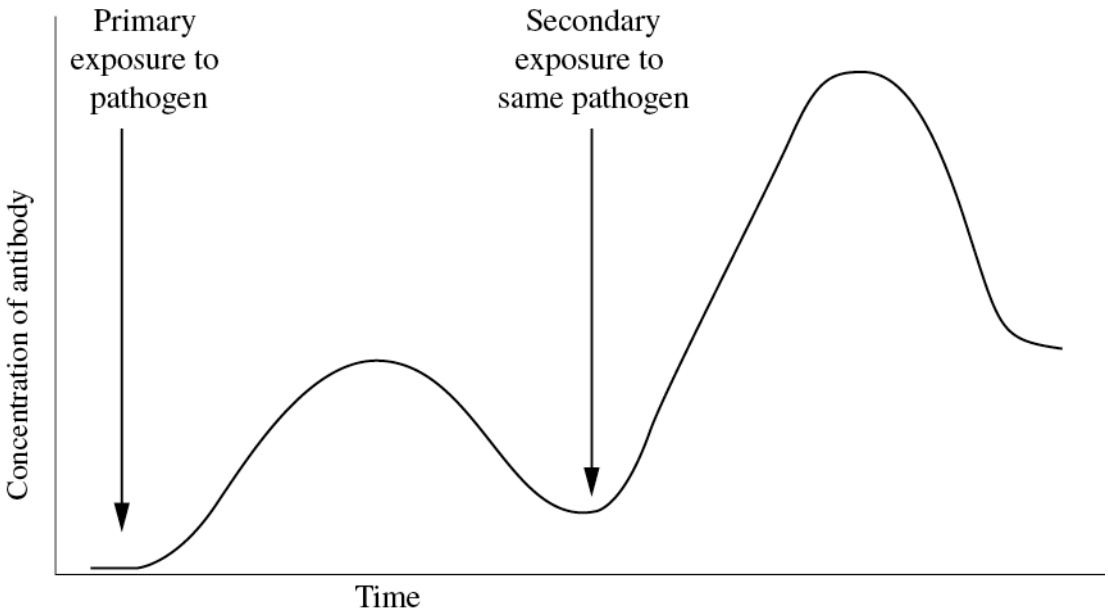
| Question | Answer |
|---|---|
| 1 | C |
| 2 | A |
| 3 | B |
| 4 | D |
| 5 | B |

# Section II

## Question 21 (a)

| Criteria | Marks |
|---|---|
| • Shows increase in concentration of antibody, peak and decline and a greater level of antibody at the end of the process | 2 |
| • Shows an increase in concentration | 1 |

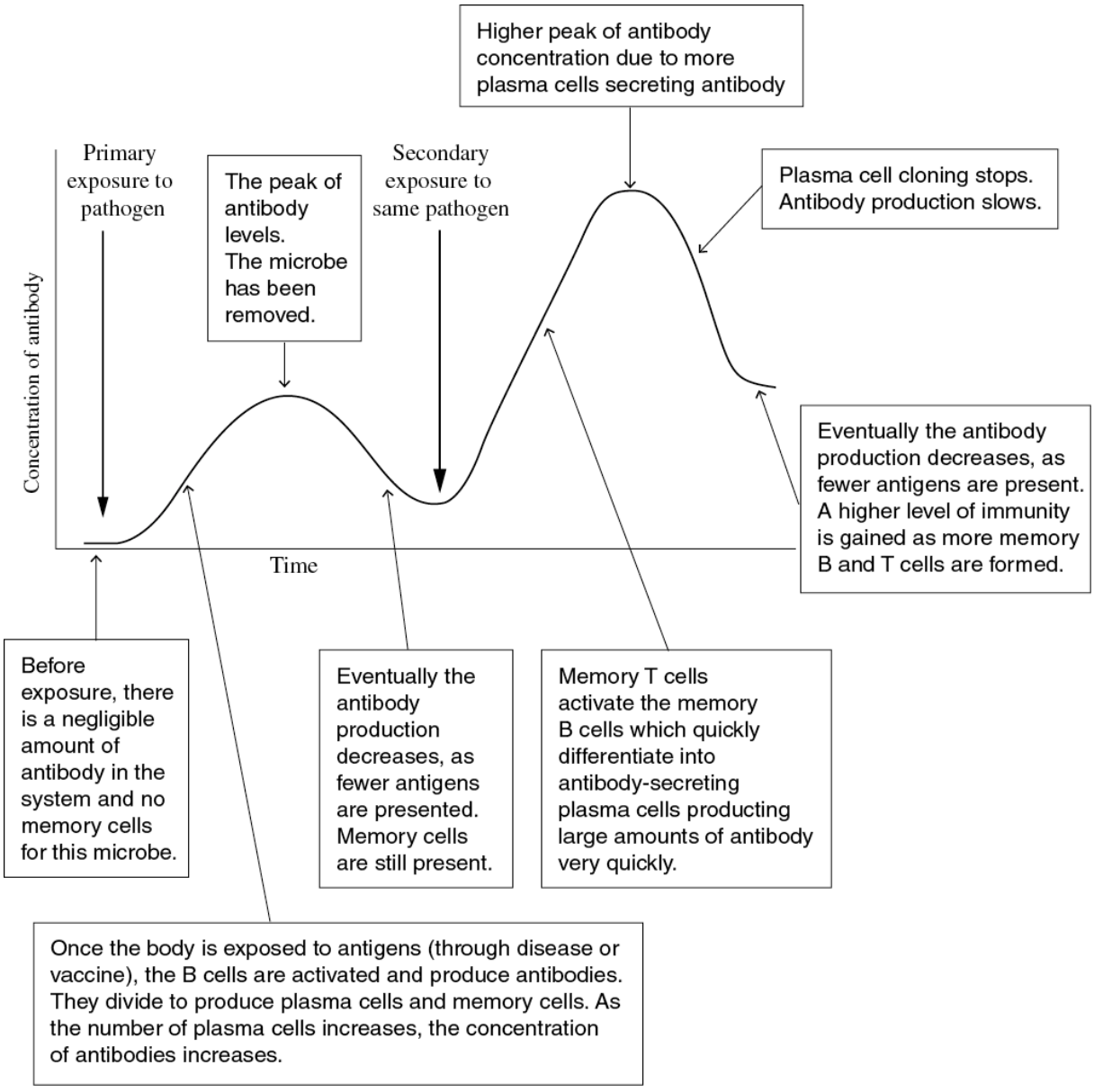
***Sample answer:***



## Question 21 (b)

| Criteria | Marks |
|---|---|
| • Explains the shape of the entire graph considering response of cells to antigens, antibody production and change in the level of immunity | 4 |
| • Provides some explanation of the shape of the graph considering response of cells to antigens and/or the antibody production and/or change in the level of immunity | 2–3 |
| • Provides some relevant information | 1 |

***Answers could include:***



## Question 22

| Criteria | Marks |
|---|---|
| • Correctly completes the table | 3 |
| • Shows how some relevant risks can be minimised | 2 |
| • Shows how a relevant risk can be minimised | 1 |

***Sample answer:***

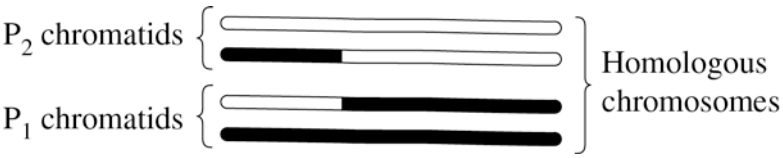
| *Risk* | *Procedure to minimise it* |
|---|---|
| Cross-contamination from bench | Use antiseptic to clean bench and work area |
| Growth of microbes harmful to humans | Incubate agar plates at below 35ºC, so microbes dangerous to humans will not grow |
| Infection | Wear protective clothing, eg gloves, masks, lab coat |

## Question 23

| Criteria | Marks |
|---|---|
| • Outlines gamete formation in the old and current models clearly showing the difference<br>• Relates the difference between the models to gamete production and genetic variation in potential offspring | 4 |
| • Outlines gamete formation in the old and current models<br>• Makes some link to gamete production and/or genetic variation in potential offspring | 3 |
| • Outlines gamete formation in the old and/or current model<br>AND/OR<br>• Outlines some implication in terms of gamete production and/or genetic variation in potential offspring | 2 |
| • Provides some relevant information | 1 |

***Sample answer:***

The old model shows one strand of each homologous chromosome. This means that when gametes are produced they would only contain the chromosomes showing the products of crossing over, ie showing the recombined genetic information. Our current model shows that DNA replication has occurred before crossing over takes place. Replicated homologous chromosomes line up in tetrads. Cross over happens between two chromatids within the tetrad, not between all chromatids. Therefore, there are parental chromatids that have undergone crossing over and parental chromatids that have not.




This means that when gametes are made, some will get unchanged parental chromosomes and some will get the chromatids that have undergone crossing over. This means that the range of gametes produced, and thus individuals produced through fertilisation, will show much greater variation.

## Question 24

| Criteria | Marks |
|---|---|
| • Provides a thorough justification<br>• Shows a thorough understanding of both internal fertilisation and external fertilisation in terms of ensuring the continuity of a species<br>• Shows clear understanding of the advantages of internal fertilisation over external fertilisation | 5 |
| • Shows a sound understanding of both internal fertilisation and external fertilisation<br>• Links both to ensuring the continuity of a species<br>• Outlines benefits and/or weaknesses of internal and external fertilisation | 4 |
| • Outlines features of both internal fertilisation and external fertilisation | 3 |
| • Identifies some features of internal fertilisation and/or external fertilisation | 2 |
| • Provides some relevant information | 1 |

***Sample answer:***

For the continuity of a species, each generation must successfully reproduce to produce sufficient numbers of the next generation. A critical number of embryos must survive to gestational maturity. This is less likely with external fertilisation.

Organisms that reproduce by external reproduction spend a substantial amount of energy and resources in the production and release of very large numbers of sperm and eggs. This is because each sperm and egg and the resulting embryos have limited chances of survival, not being protected by the parent for example in the open ocean. Chances of successful fertilisation are low in such vast aquatic environments. Larger numbers ensure some will be fertilised.

Internal fertilisation provides a smaller safer environment for release of gametes, fertilisation and maturation of the embryos. Chances of successful fertilisation are increased and embryos are protected from predators within the body of the parent. Even after birth/egg laying parental care assists survival of the offspring.

## Question 25

| Criteria | Marks |
|---|---|
| • Shows thorough understanding of designing an investigation that takes into account validity and reliability<br>• Shows thorough understanding of how an epidemiological study can be carried out in this scenario to investigate the origin of the disease<br>• Shows thorough understanding of analysing patterns of non-infectious diseases, gathering data and analysing results in this investigation | 7 |
| • Shows sound understanding of designing an investigation that takes into account validity and reliability<br>• Shows sound understanding of how an epidemiological study can be carried out in this scenario<br>• Shows sound understanding of analysing patterns of non-infectious diseases, gathering data and analysing results in this investigation | 6 |
| • Shows sound understanding of the main features of an epidemiological study<br>• Shows some understanding of analysing patterns of non-infectious diseases, gathering data and/or analysing results in this investigation<br>• Shows some consideration of validity and/or reliability in the design | 4–5 |
| • Shows some understanding of an epidemiological study and/or validity and/or reliability | 2–3 |
| • Provides some relevant information | 1 |

***Sample answer:***

In order to plan an epidemiological study it is important to look at all the evidence available.

Stomach ache, vomiting and tiredness tend to indicate that a pathogen was ingested with either food or water. As mentioned, it does not seem to be infectious but as yet we don't know whether various unsanitary practices may affect the transmission of the disease. One would expect symptoms to be worse in children than in adults as they will very quickly dehydrate.

We are probably looking for a water-borne pathogen or infected food. Initially we would want to interview all families with affected individuals. By interviewing all affected families we are gathering data on:

- what they have been doing
- where they have been
- where they have eaten
- what they have eaten
- what they have drunk
- whether they have been swimming over the past few days.

We would try to correlate the data to find any common features or activities.

While we are interviewing the affected families we would want to collect stool samples to look for a common pathogen by undertaking a microbiological analysis.

If we find common features, we would then interview a number of unaffected families to see whether they had been to the same places or done the same things but not been affected. This

would increase the validity of our study. The more people we are able to interview the more reliable our study becomes.

Our microbiological investigations may identify a common pathogen, for which we may be able to suggest antibiotics. If there is no common pathogen grown, it may be because the pathogen is a virus or some other organism eg a protozoan like giardia.

The more data we can accumulate the more likely we are to find the root cause of the affliction.

## Question 26

| Criteria | Marks |
|---|---|
| • Provides a comprehensive comparison<br>• Shows thorough understanding of the processes and effects of point mutations and chromosomal mutations<br>• Includes examples of both point mutations and chromosomal mutations | 8 |
| • Shows a sound understanding of the processes and effects of point mutations and chromosomal mutations<br>• Includes examples of point mutations and/or chromosomal mutations | 6–7 |
| • Outlines some processes and/or effects of point mutations and chromosomal mutations<br>• Includes example(s) of point mutations and/or chromosomal mutations | 4–5 |
| • Identifies some features of point mutations and/or chromosomal mutations | 2–3 |
| • Provides some relevant information | 1 |

***Sample answer:***

All mutations are changes to DNA. They occur during DNA replication during
- mitosis (for cell proliferation and growth of the organism)
- meiosis (for the production of gametes).

Point mutations are changes that occur in a single nucleotide. These changes can be substitution with the wrong nucleotide, an extra nucleotide added (addition) or a nucleotide not included (deletion). It is possible to have multiple point mutations along a chromosome.

The order of nucleotide bases determines the protein that is produced by the cell. The point mutation may have no effect on the protein produced as the change may still enable a triplet code for the same amino acid, or the change of one amino acid might not have a significant effect on the resulting protein.

The point mutation may mean that the triplet code initiates a stop sequence, in which case the protein will not be produced, or it may mean that a range of proteins is not produced at all or that greater quantities of protein are produced.

A frameshift point mutation is caused by an addition or deletion. Every triplet on the DNA after the point mutation is affected. This can radically change the protein product of the cell.

Chromosomal mutations involve large sections of the chromosome breaking off completely (deletion), or breaking off and reassembling in reverse order (inversion) or breaking off and adhering to another chromosome (translocation).

These breakups of chromosomes move genes to new loci and can break up genes by splitting the chromosome in the middle of the gene sequence.

These types of chromosome changes can radically affect cell activity.

Chromosomal mutations can also include non-disjunction of homologous chromosomes at anaphase, resulting in cells with too many or too few chromosomes. These mutations can have radical effects on cell activity and the organism.

Both point mutations and chromosomal mutations can cause disease. For example, point mutations: cystic fibrosis, sickle cell anaemia; chromosomal mutations: Down's syndrome, Turner's syndrome.

Both kinds of mutations have also generated new alleles which have in some cases been adaptive and contributed to evolution.

## Question 27

| Criteria | Marks |
|---|---|
| • Comprehensively analyses the data in areas such as types of disease, numbers of people succumbing to the diseases and socioeconomic distribution of diseases<br>• Provides possible reasons for why the prevalent causes of death differed between low and high-income economies in 2015<br>• Shows clear relationship between the suggested reasons and the results of analysis displaying a thorough understanding of infectious and non-infectious diseases | 9 |
| • Provides a high level of data analysis in some areas such as types of disease, numbers of people succumbing to the diseases and socioeconomic distribution of diseases<br>• Relates the results of analysis to why the prevalent causes of death differed between low and high-income economies<br>• Shows a sound understanding of infectious and non-infectious diseases | 7–8 |
| • Provides a sound level of data analysis in some areas such as types of disease, numbers of people succumbing to the diseases and socioeconomic distribution of diseases<br>• Links the results of the analysis to some reasons for the prevalent causes of death in low and/or high-income economies<br>• Shows a sound understanding of infectious and/or non-infectious diseases | 5–6 |
| • Provides some analysis of data in areas such as types of disease and/or numbers of people succumbing to the diseases and/or socioeconomic distribution of diseases<br>AND/OR<br>• Outlines reason(s) for the prevalent causes of death in low and/or high-income economies<br>AND/OR<br>• Shows some understanding of infectious and/or non-infectious diseases | 3–4 |
| • Identifies relevant information from the graph(s)<br>AND/OR<br>• Shows an understanding of infectious and/or non-infectious diseases | 1–2 |

***Sample answer:***

Types of diseases listed in decreasing prevalence for income groups:

| *Low Income* | | *High Income* | |
|---|---|---|---|
| *Infectious* | *Non-infectious* | *Infectious* | *Non-infectious* |
| Lower respiratory infections | Stroke | Lower respiratory infections | Coronary heart disease |
| Diarrhoeal | Coronary heart disease | | Stroke |
| HIV/AIDS | Preterm birth complications | | Dementias |
| Tuberculosis | Birth trauma | | Lung cancers |

| | | | |
|---|---|---|---|
| Malaria | Road injury | | Pulmonary disease |
| | | | Colon and rectum cancers |
| | | | Diabetes mellitus |
| | | | Kidney diseases |
| | | | Breast cancer |

Common diseases: (deaths per 100 000 population) for income groups

| *Low Income* | | *High Income* | |
|---|---|---|---|
| *Infectious* | *Non-infectious* | *Infectious* | *Non-infectious* |
| Lower respiratory infections (85) | Stroke (50) | Lower respiratory infections (40) | Coronary heart disease (142) |
| | Coronary heart disease (48) | | Stroke (65) |

In assessing this data, it is clear that the lower income economies are more likely to die from infectious diseases (approx. 240/100 000) than non-infectious diseases (approx. 180/100 000). The infectious diseases are generally those that can be relatively easily eliminated or treated, eg diarrhoeal diseases are preventable by providing clean water supplies, malaria is preventable by providing nets, insecticides, draining swamps or using preventative medicine, and TB can be inoculated against. These diseases are not represented at all in the data for high-income economies because clean water and preventative medical procedures are in place due to socioeconomic factors.

The only common infectious disease among low and high-income economies is lower respiratory tract infections. These infections are essentially influenza type diseases, pneumonias and bronchitis. While influenza is a viral infection, the others are usually bacterial and can be treated with antibiotics. Many at-risk people in the high-income economies are encouraged to get preventative flu injections. These are often provided free for the elderly who are most at risk and those who work in confined spaces where infection is likely to occur, eg schools, hospitals and office environments. The effect on mortality in low-income economies is approximately two times as great as in high-income economies.

The greatest killers in high-income economies are heart disease and stroke, killing approximately twice as many people per 100 000 than in low-income economies. These are often seen to be ‘lifestyle diseases’ that are greatly affected by diet and exercise. When we compare the number of deaths attributed to non-infectious diseases in high-income economies they are more than 2.5 times more prevalent (approx. 445:185/100 000) than low-income economies, but there are also dementias and cancers which are often diseases of old age, indicating that those living in high-income economies live longer. This is probably due to levels of sanitation and consistent health care.

The data provided indicates many differences between the two economies, but also provides suggestions on how these differences can be addressed, eg provision of a clean water supply which would greatly improve the quality of health and life in low-income economies.

# HSC Biology Sample Questions Mapping Grid

**Section I**

| Question | Marks | Content | Syllabus outcomes | Targeted performance bands |
|---|---|---|---|---|
| 1 | 1 | Mod 8 Epidemiology | BIO11/12–7, BIO12–15 | 2–3 |
| 2 | 1 | Mod 6 Mutation | BIO11/12–6, BIO12–13 | 3–4 |
| 3 | 1 | Mod 5 Genetic Variation | BIO11/12–5, BIO11/12–6 BIO12–12 | 4–5 |
| 4 | 1 | Mod 7 Cause of infectious disease<br>Mod 7 Prevention, treatment and control | BIO11/12–2, BIO12–14 | 5–6 |
| 5 | 1 | Mod 5 Genetic Variation | BIO11/12–5, BIO11/12–6, BIO12–12 | 5–6 |

**Section II**

| Question | Marks | Content | Syllabus outcomes | Targeted performance bands |
|---|---|---|---|---|
| 21 (a) | 2 | Mod 7 Immunity | BIO11/12–4, BIO12–14 | 2–3 |
| 21 (b) | 4 | Mod 7 Immunity | BIO11/12–6, BIO11/12–7, BIO12–14 | 2–5 |
| 22 | 3 | Mod 7 Causes of infectious disease | BIO11/12–2, BIO11/12–6, BIO12–14, BIO11/12–3 | 2–4 |
| 23 | 4 | Mod 5 Genetic Variation | BIO11/12–4, BIO11/12–5, BIO11/12–6, BIO12–12 | 2–5 |
| 24 | 5 | Mod 5 Heredity: Reproduction | BIO11/12–6, BIO12–12 | 2–6 |
| 25 | 7 | Mod 8 Epidemiology | BIO11/12–2, BIO11/12–4, BIO11/12–5, BIO11/12–6, BIO11/12–7, | 2–6 |
| 26 | 8 | Mod 6 Mutation | BIO11/12–4, BIO11/12–6, BIO12–13 | 2–6 |
| 27 | 9 | Mod 7 Causes of Infectious Disease<br>Mod 7 Prevention, Treatment and Control<br>Mod 8 Cause and responses<br>Mod 8 Epidemiology<br>Mod 8 Prevention | BIO11/12–4, BIO11/12–5, BIO11/12–6, BIO11/12–7, BIO12–14, BIO12–15 | 2–6 |