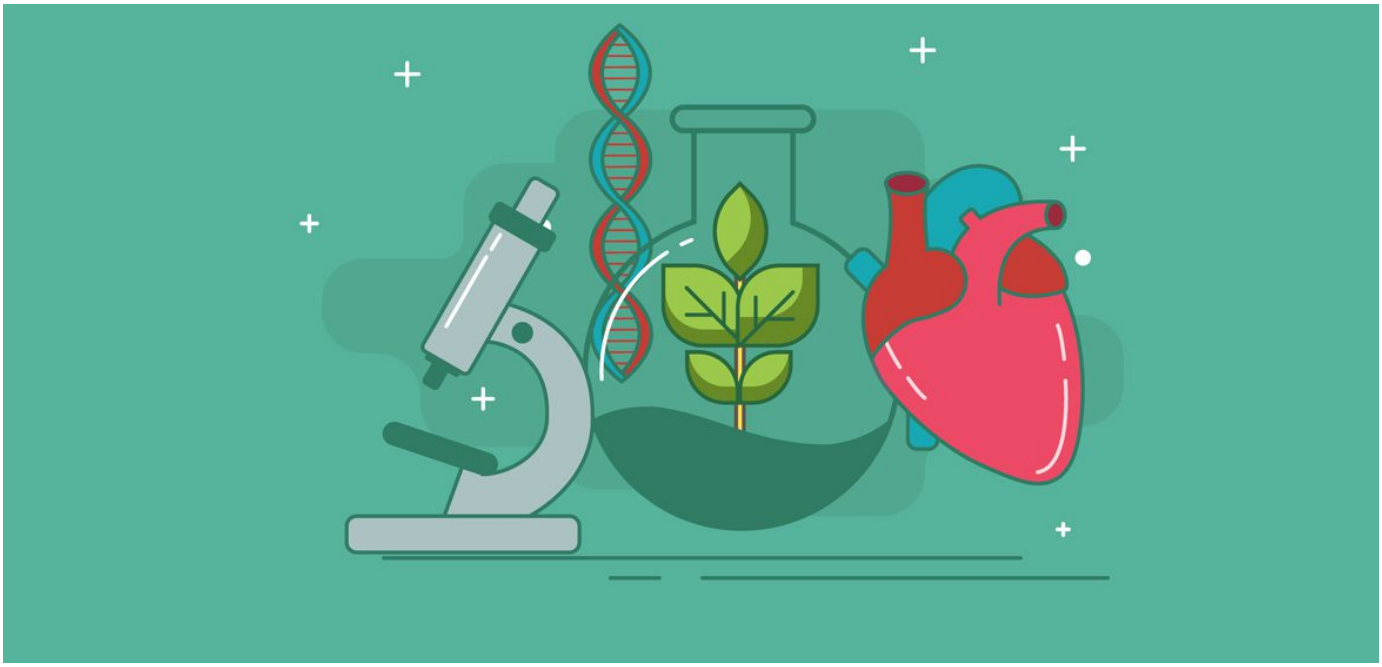
2020 HSC Study Day Series

AURORA COLLEGE

HSC Biology

Notes & student workbook



HSC 2020

NSW Department of Education

www.aurora.nsw.edu.au

2020 HSC Study Day Series

AURORA COLLEGE

Details

Date: Wednesday 1st July, 2020

Time: 8:50am – 3:10 pm

Location: Adobe Connect room https://connect.schools.nsw.edu.au/aurora-hsc-study2/

Materials: Available to download via this Dropbox link

Recordings: The sessions will be recorded and accessible for registered participants after the event via the same Dropbox link above. These recordings will be accessible until the HSC exam.

Program

Time	Session
8:50 – 9:00 am	**Welcome**
9:00 – 9:40 am	**Moving up a mark range / Exam tips** *Dr Silvia Rudmann, Gorokan HS & Aurora College*
9:45 – 10:45 am	**Module 5 – Heredity** *Tim Sloane, Head Teacher Science, Concord High School*
10:45 – 11:15 am	Morning tea break
11:15 – 12:15 pm	**Module 6 – Genetic Change** *Tim Sloane, Head Teacher Science, Concord High School*
12:20 – 1:20 pm	**Module 7 – Infectious Disease** *Dr Silvia Rudmann, Gorokan HS & Aurora College*
1:20 – 2:00 pm	Lunch break
2:00 – 3:00 pm	**Module 8 – Non-infection disease and disorders** *Dr Silvia Rudmann, Gorokan HS & Aurora College*
3:00 – 3:10 pm	**Conclusion**

Image on front cover attribution: Sourced from https://tinycards.duolingo.com/decks/MKXaiyRH/introduction-to-biology

Moving up to reach that Band 6

Successful exams? It is all in the preparation

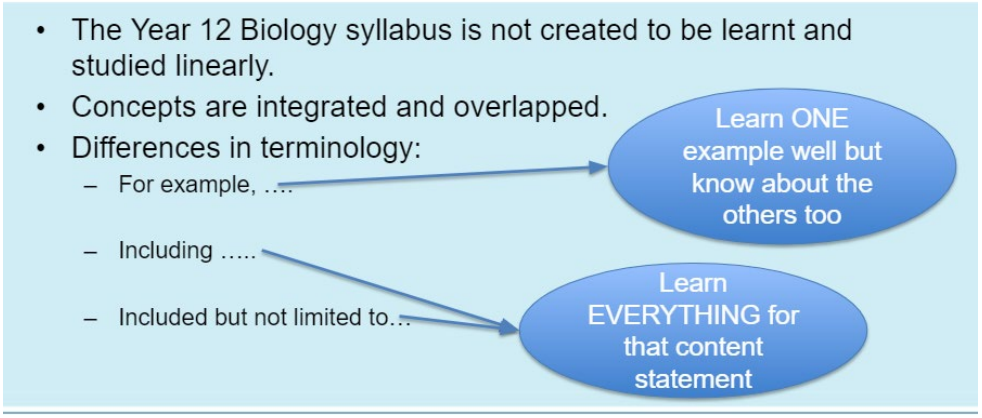
What? the syllabus?
The year 12 Biology course is based on a detailed syllabus which is what you have to learn for your exam.

Biology is the story of life. Learn the content of this subject as a story, building up from the simpler to the more complex

Your teacher has been teaching you the outcomes, content statements and skills explicitly indicated in the Biology syllabus. Therefore, become familiar with the Biology syllabus and create the habit to make detailed notes on every inquiry question, content statements and identify the skills that you need to address to answer them.
Textbooks do not always present the information in the same way as the syllabus. So use textbooks and other references to prepare your detailed notes.

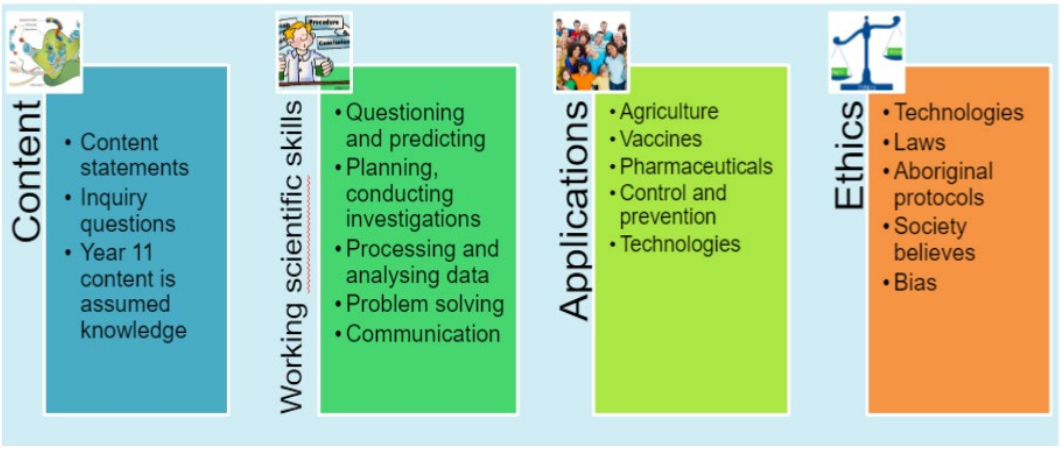
You can't learn the syllabus in a linear way, which means learning one concept isolated from the next. All concepts are interrelated and integrated. So, will be the questions in the exam.

Learning the verbs and the terminology of the syllabus will help you to address the inquiry questions properly.

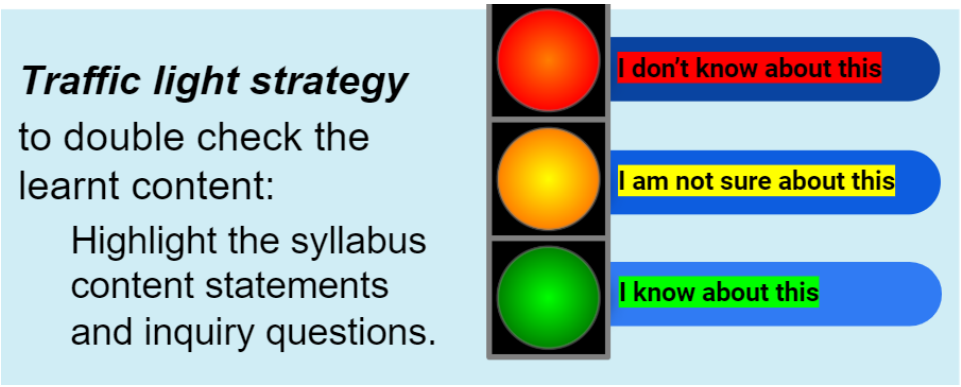


In your exam, the questions will require you to address the components of the syllabus:

- Inquiry questions
- Biology processes
- Applications of biology concepts that benefit society
- Ethical issues
- Technologies
- Demonstrates skills outcomes
- Integrate knowledge across modules (usually extended responses)



How much or how little do you know about HSC Biology?
One of the first steps to assess how much do you know of the syllabus content is to go through the entire HSC Biology course using the 'traffic light' strategy:

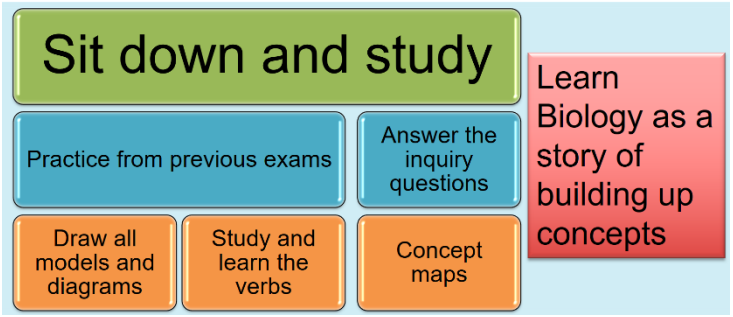


Once you have highlighted the content, you can get organised with your study and focus on topics that you need to work closely with your revision.

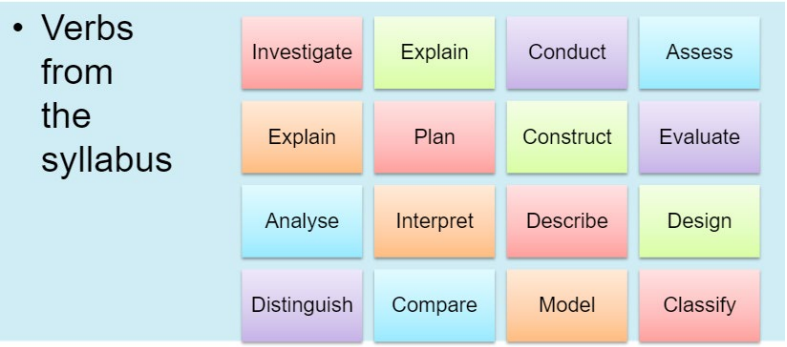
Get organised with your study and learning
Summarising the answers to the inquiry questions and content statements is one of the best ways to study.

As soon as you have finished each module

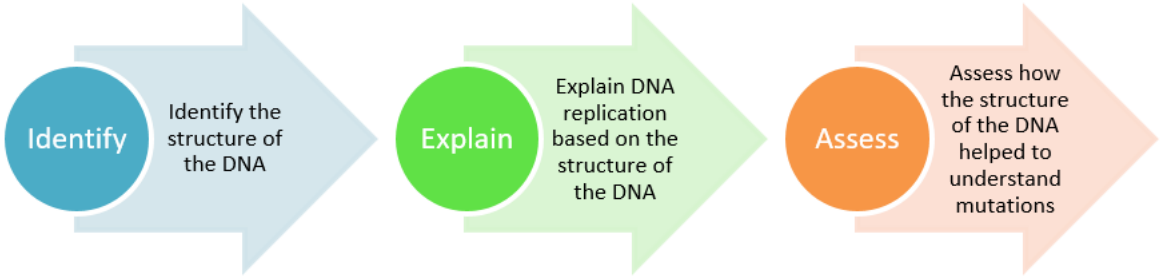
- create a concept map to link concepts, skills and investigations
- summarise an answer for each inquiry question
- summarise each content statement
- use tables and flow charts to link processes and content
- create an investigation scaffold for each investigation
- colour coded concepts, skills, investigations and verbs



Here is the list of the common verbs in the syllabus:

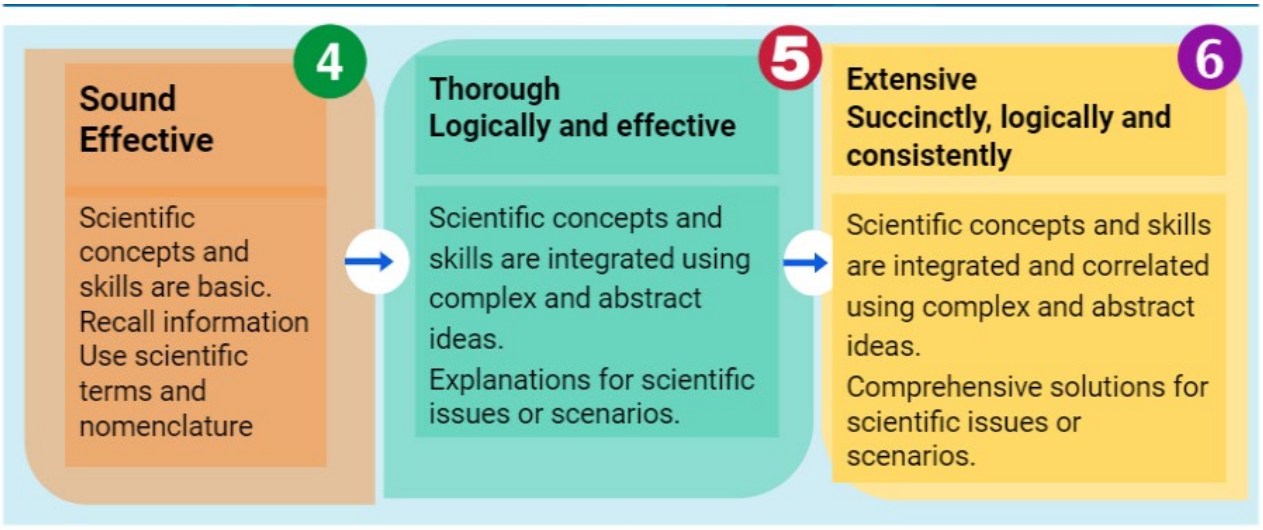


Learn to 'build up' the answer from a low level verb to a higher order. For example:



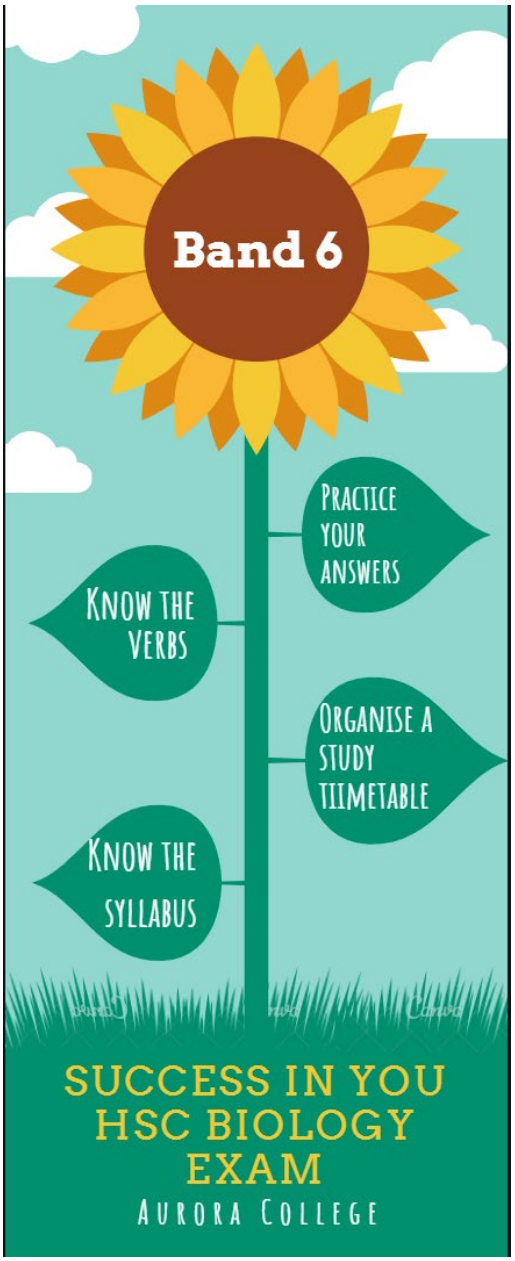
This will help you to build up on the biological concept and integrate content.

Reaching that band 6 by knowing the language of the band descriptors



Create a folder for each module. Using OneNote is a great method to keep your study organised. You can open OneNote on your mobile phone so you can revise before entering the exam (not during the exam!)

Create a study timetable, by now you know the dates of your exams. So, organizing your study days and time is crucial to avoid feeling overwhelmed. In the timetable include all the other extra activities that you should not stop doing because of the year 12 exams, such as sports, part-time work and friends.
Choose a study time that suits you. Some people prefer to study at night when it is quiet.



Practice from sample exams and previous exams
Doing sections of NESA sample papers and past papers allow you to become familiar with the structure of the exam and the type of questions asked. Do them regularly and then reward yourself with a healthy treat. Check answers and sample answers at the NESA' site.
The Biology exam is three hours long so you will need to learn to set time limits, usually you will have one minute per mark, so there is plenty of time to construct your questions. Once you become familiar with the exams, set up a stopwatch and timed yourself.
When you begin this process you will still be learning the content. So begin with your textbook open.

Exam structure
The exam is three hours long. It is divided into two main sections: multiple choices and extended responses.

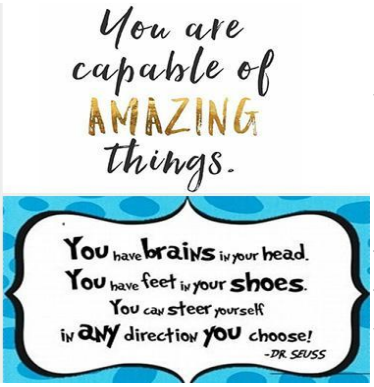
Multiple Choice Questions: they have four options and only one is correct, so a process of elimination may be helpful when answering multiple-choice questions.

Extended responses: they are based on content, skills, a combination of content and skills and the highest mark questions usually integrate content across modules, and sometimes assume knowledge from Year 11.

Give yourself a break and take care of your mind and body

Allow yourself to say study is tough, sometimes tedious and repetitive. Give yourself a day off, have short breaks during the day, go for a walk, listen to your favourite music and an audiobook every so often so you are revitalised.

Eat healthy, avoid too much sugar and fats that gives you only a short burst of energy and keep you well supplied with healthy food. Drink lots of water.



Others can help you, so ask

Parents, teachers and friends want you to do your best, and want you to be happy and healthy while you are doing the HSC. Exams are challenging and while a little stress can be a good thing, if you are feeling overwhelmed, talk to someone. Your school has a welfare team that can help you to understand that your feelings at this time of your life are common to many students and there is help to overcome them.

Biology Band Performance Descriptors

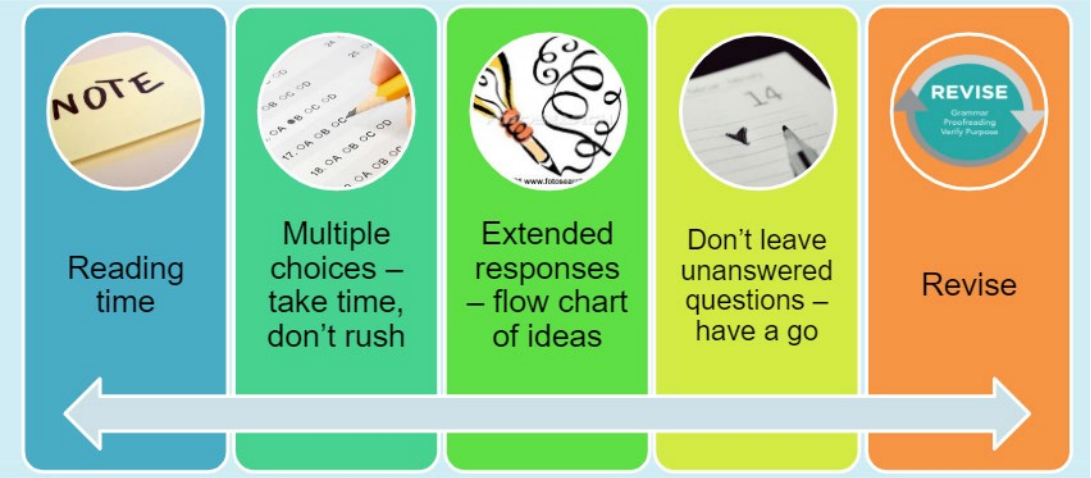
Each question in your exam will address the band descriptors and the marking criteria. It would be beneficial that you become familiar with them to understand the expectations that the marker will have to assess your answers.

Biology Band Descriptors

Band 6
demonstrates an extensive knowledge and understanding of scientific concepts, including complex and abstract ideas communicates scientific understanding succinctly, logically, and consistently using correct and precise scientific terms and application of nomenclature in a variety of formats and wide range of contexts designs and plans investigations to obtain accurate, reliable, valid and relevant primary and secondary data, evaluating risks, mitigating where applicable, and making modifications in response to new evidence selects, processes, and interprets accurate, reliable, valid, and relevant qualitative and quantitative, primary or secondary data, and represents it using a range of scientific formats to derive trends, show patterns and relationships, explain phenomena, and make predictions designs solutions to scientific problems, questions, or hypotheses using selected accurate, reliable, valid, and relevant primary and secondary data, and scientific evidence, by applying processes, modelling and formats applies knowledge and information to unfamiliar situations to propose comprehensive solutions or explanations for scientific issues or scenarios
Band 5
demonstrates thorough knowledge and understanding of scientific concepts, including complex and abstract ideas communicates scientific understanding, logically, and effectively using correct scientific terms and application of nomenclature in a variety of formats and wide range of contexts designs and plans investigations to obtain accurate, reliable, valid and relevant primary and secondary data, evaluating risks, mitigating where applicable, and making some modifications in response to new evidence selects, processes, and interprets accurate, reliable, valid, and relevant qualitative and quantitative, primary or secondary data, and represents it using a range of scientific formats to derive trends, show patterns and relationships designs solutions to scientific problems, questions, or hypotheses using selected accurate, reliable, and valid primary and secondary data, and scientific evidence, by applying processes, and formats applies knowledge and information to unfamiliar situations to propose explanations for scientific issues or scenarios
Band 4
demonstrates sound knowledge and understanding of scientific concepts communicates scientific understanding effectively using scientific terms and application of nomenclature designs and plans investigations to obtain primary and secondary data and evaluates risks processes and interprets primary and secondary data, and represents it using a range of scientific formats identifies scientific problems, questions, or hypotheses and applies processes, and formats to primary or secondary data applies knowledge and information relevant to scientific issues or scenarios
Band 3
demonstrates basic knowledge and understanding of scientific concepts communicates scientific understanding using basic scientific terms and application of nomenclature implements scientific processes to obtain primary and secondary data and identifies risks processes primary or secondary data, and represents it using scientific formats responds to scientific problems, questions, or hypotheses recalls scientific knowledge and information
Band 2
demonstrates limited knowledge and understanding of scientific concepts communicates scientific understanding using limited scientific terms partially outlines investigations to obtain data and information provides simple descriptions of scientific phenomena recalls basic scientific knowledge and information
Band 1

And the exam started!

Stay positive and take your time to answer the questions
Keep a positive thinking attitude throughout the test and try to stay relaxed. If you start to feel nervous take a few deep breaths.
Pace yourself, don't rush. Read the whole question and pay attention to all the details.
Keep an eye on the time… Consider about 1.5 minutes per mark… this will give you 30 minutes to spare to review or provide a buffer of time if you fall behind on some questions. Use the reading time to figure out the questions you will need to spend more time on.
Questions don't have to be attempted in order, use your reading time to plan a sequence of responses.

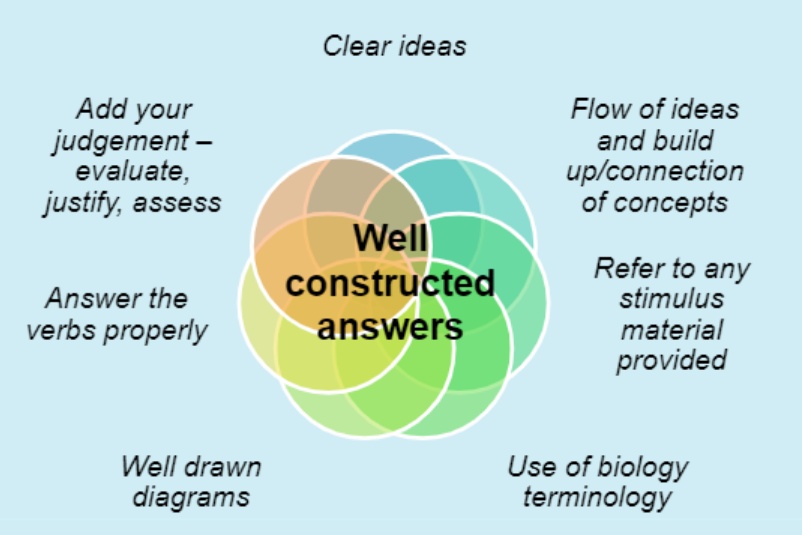


Read the questions properly and look for keywords
Read the questions a couple of times, look for the main verb, plurals and don't forget to give an example.
Look for keywords in every question to help you to understand and answer what is being asked of you. Highlight those keywords, creating a flow chart of ideas on the side of the question can help to organize your ideas to answer it. Read the question backwards so that keywords jump out of the page. – an old editors trick.

Write neatly in black pen and label/annotate all the diagrams
The marker will spend time on your paper to understand your diagrams, graphs and writing. The neater you do your work the easier will be for the marker to mark your question.
If you have to construct a graph pay attention to label both axis, write the appropriate units and scales.

Plan your response and show off your 'best biology knowledge'
Plan your written responses. Focus on the verb to identify if your response should be a description, explanation, analysis/discussion or evaluation/assessment. Take a few minutes to decide what you are going to write about and write down a few points beside the question or on the spare paper to keep yourself on track.
In Biology, almost all questions require any sort of explanation with an example and usually has to be aided with a diagram. Aim all your answers to achieve Band 6 descriptors that means, your answer

should have 'extensive biological knowledge' using proper biological terminology and vocabulary. Don't overthink the question, just answer what it is asked for. If you overthink, you will get confused and your answer won't make sense for the marker.



Answer ALL the questions, don't leave blanks
Give it a try! If you don't know the answer, don't worry. Just do your best to answer the question and at the very least, go with the answer that seems correct. Most responses score at least 1 for having relevant information related to the concept asked.

Review.
If you have time left when you have finished the assessment, look over it and make sure you haven't missed any questions. If you have time, redo the questions and check you have indicated the correct answers.

Stay focused
Don't worry if other students finish before you. Focus on what you are doing and what is in front of you.

Useful websites for resources to study and revise

Khan academy – https://www.khanacademy.org/science/biology

Khan academy app for android and iphone

Learn genetics – https://learn.genetics.utah.edu/

Biology corner – https://www.biologycorner.com/

HHMI Biointeractives - https://www.biointeractive.org/

World Health Organisation (WHO) – https://www.who.int/

Conquer Biology Notes - https://www.conquerhsc.com/hsc-biology-syllabus-notes/

NESA – Biology - https://educationstandards.nsw.edu.au/wps/portal/nesa/11-12/stage-6-learning-areas/stage-6-science/biology-2017

MODULE 5

HEREDITY

Tim Sloane

Head Teacher Science

Concord High School

This booklet will contain the following

- **inquiry questions with related dot points**
- **a guide/scaffold on how to address each IQ or dot point**
- **sample HSC style questions with sample responses provided by NESA**

INQUIRY QUESTION 1:
HOW DOES REPRODUCTION ENSURE THE CONTINUITY OF A SPECIES?

<u>Explain</u> the mechanisms of reproduction that ensure the continuity of a species, by analysing sexual and asexual methods of reproduction in a variety of organisms <u>including but not limited to</u>:

- Animals: advantages and disadvantages of external and internal fertilisation
- Plants: asexual and sexual reproduction
- Fungi: budding, spores
- Bacteria: binary fission
- Protists: binary fission, budding

IN ORDER TO ADDRESS THIS SECTION

- *Find the cause and effect relationship of each point under the heading*
- *Cause: Define the terms: sexual reproduction, asexual reproduction, internal fertilisation, external fertilisation, continuity of species etc*
- *Effect: give an explanation/how/why does each method of reproduction ensures continuity of species (must make clear links as to how genetic information is passed on and whether the offspring will be genetically identical or different to the parent)*
- *show advantages and disadvantages for each type of reproduction with reference to survival of species*

<u>Analyse</u> the features of fertilisation, implantation and hormonal control of pregnancy and birth in mammals

IN ORDER TO ADDRESS THIS SECTION

- *Define terms: fertilisation, implantation and hormone, pregnancy and birth*
- *Give characteristics of each process and the hormones involved*
- *Explain (give detailed reason) on how specific hormones regulate each stage*
- *Detail similarities and differences in the processes in types of mammals*

<u>Evaluate</u> the impact of scientific knowledge on the manipulation of plant <u>and</u> animal reproduction in agriculture

IN ORDER TO EVALUATE

- *Identify/name the technologies that you will be discussing*
- *Give definitions of the agriculture AND technologies that you will be discussing*
- *Give descriptions (features) of each type of technology*
- *Explain*
    - *how has each technology been used in agriculture in both plants and animals and WHY it is used*
    - *The scientific knowledge needed to enable these technologies to be developed (relate back to types of reproduction and the processes involved)*
- *Analyse- include arguments FOR and AGAINST the use of these technologies. Make sure it is related to biology (biodiversity, survival of species etc)*
- *Evaluate- (THIS IS CRUCIAL TO QUALIFY FOR A BAND 6 RESPONSE)*
    - *give a judgement on the use of these technologies in agriculture-are these effective/successful technologies.*
    - *Back up your judgement with evidence*

Module 5: IQ1 HSC style questions

Reproduction and continuity of the species

Mod 5 – Question 1

A strawberry plant will send out over the ground runners which will take root and grow a new plant as shown.

This method of growing a new plant is an example of

A. budding.

B. germination.

C. external fertilisation.

D. asexual reproduction.

19 A zebronkey hybrid is the result of crossing a male zebra which has 44 chromosomes with a female donkey which has 62 chromosomes.

How many chromosomes will the zebronkey have?

A. 53

B. 75

C. 84

D. 106

11 Which of the following is an example of *hybridisation*?

(A) The insertion of a bacterial gene for herbicide resistance into a cotton plant

(B) The culturing of a cell taken from the root of a carrot to form a small plant

(C) Artificial insemination of a domestic cat with wild cat semen to produce a Bengal cat

(D) A cutting taken from one variety of apple tree grafted onto the stem of a different variety of apple tree

5 The gamete plays an important role in sexual reproduction because it carries

(A) genetic information from both parents.

(B) half the genetic information of the parent.

(C) all of the genetic information of the parent.

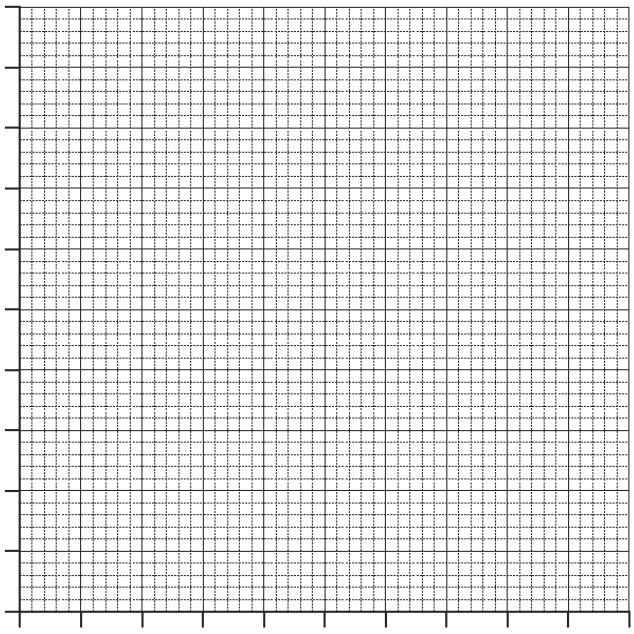
(D) double the genetic information of the parent.

Mod 5 – Question 11 (6 marks)

(a) The following data shows the average amount of Human Chorionic Gonadotropin (hCG) produced by pregnant women. **3**

Weeks of pregnancy	*hCG* (ng/mL)
0	0
4	85
8	185
12	185
16	80
20	65
24	60
28	65
32	75
36	65
40	35

Use the information provided to graph the levels of hCG in a normal pregnancy.



Question 11 (continued)

(b) Describe the role and changes in levels of a hormone in pregnancy. **3**

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Mod 5 – Question 12 (5 marks)

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

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Reproduction and continuity of the species
marking criteria and sample answers

Multiple Choice answers: Mod 5 Q1- D, Q19- A, Q11- C, Q5- B

Module 5 Q11

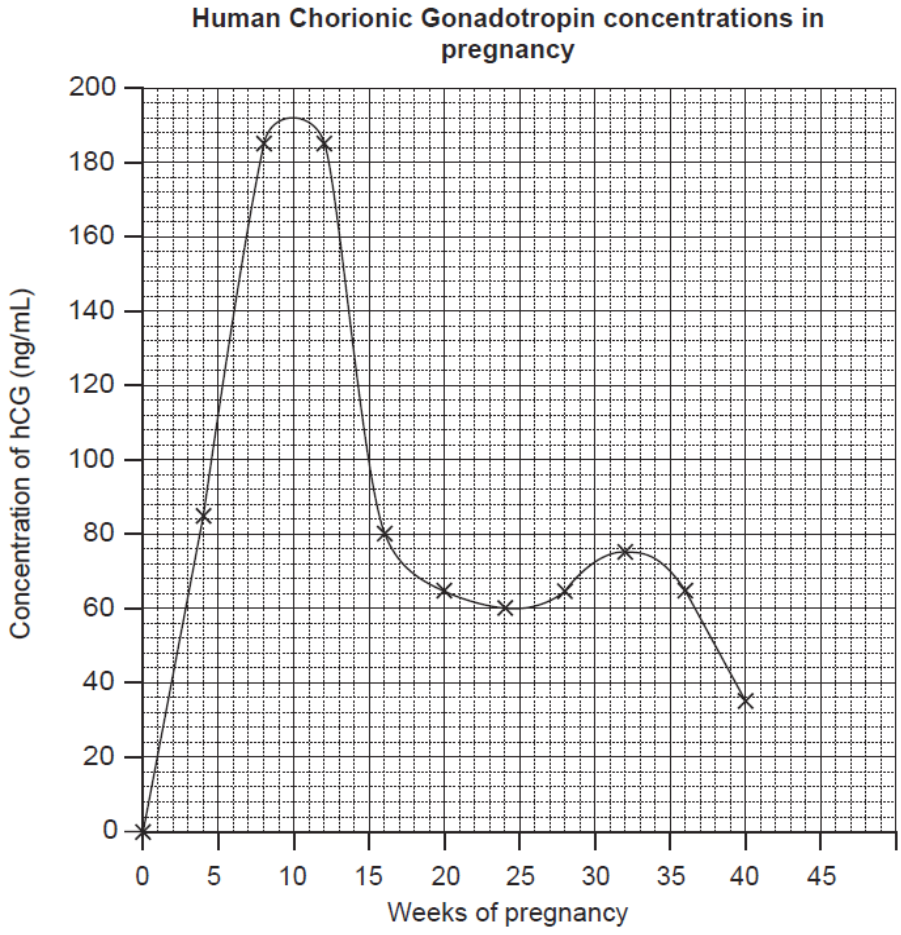
Mapping grid (a):

Content	Syllabus outcomes	Bands
Mod 5 Reproduction	BIO12–4, BIO12–12	2–4

Marking guidelines (a):

Criteria	Marks
• Labels axes correctly including units • Uses appropriate scale • Plots points correctly • Draws appropriate graph	3
• Provides some correct steps in completing the graph	2
• Provides some relevant information	1

Sample answer:



Mapping grid (b):

Content	Syllabus outcomes	Bands
Mod 5 Reproduction	BIO12–12	2–4

Marking guidelines (b):

Criteria	Marks
• Describes the role and changes in levels of a hormone in pregnancy	3
• Outlines the role and/or levels of a hormone in pregnancy	2
• Provides some relevant information	1

Sample answer:

A hormone that is important in pregnancy is progesterone. Progesterone is initially produced by the corpus luteum in the ovary and causes the endometrium to thicken, which helps to support and maintain the pregnancy in the first weeks when the placenta is still developing. The developed placenta then produces progesterone at significantly higher levels to maintain the pregnancy. Prior to birth progesterone levels drop significantly to facilitate labour.

Module 5 Q12

Mapping grid:

Content	Syllabus outcomes	Bands
Mod 5 Reproduction	BIO12–6, BIO12–12	2–6

Marking guidelines:

Criteria	Marks
• Provides a thorough justification • Shows a thorough understanding of both internal fertilisation and external fertilisation in terms of ensuring the continuity of a species • Shows clear understanding of the advantages of internal fertilisation over external fertilisation	5
• Shows a sound understanding of both internal fertilisation and external fertilisation • Links both to ensuring the continuity of a species • 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.

INQUIRY QUESTION 2:
How important is it for genetic material to be replicated exactly?

<u>Model</u> the processes involved in cell replication, <u>including but not limited to:</u>

a. **Mitosis and meiosis**
b. **DNA replication using the Watson and Crick DNA model, including nucleotide composition, pairing and bonding**

IN ORDER TO ADDRESS THIS SECTION

- *Create a model- this can be physical (construction, <u>diagrammatical</u>) , conceptual (principals, laws and theories), mathematical (equations and data)*
- *annotate models to explain each biological process. E.g. draw diagrams of each step of mitosis. include arrows between each diagram to show the correct sequence of events. Label each step and give a short description of what is occurring at each step (make direct reference to the changes in the shape and number of chromosomes)*

<u>Assess</u> the effect of cell replication processes on the continuity of species

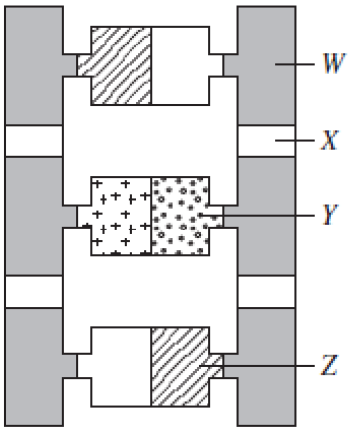
IN ORDER TO ADDRESS THIS SECTION

- *Identify processes involved in cell replication*
- *Define mitosis, meiosis and continuation of species*
- *Describe/give features of processes involved in cell replication*
- *Explain how processes of cell replication result in copying of genetic information AND the potential introduction of variation in offspring*
- *Explain the advantages and disadvantages of each type of cell replication for continuation of a species*
- *Give a judgement regarding the importance of cell replication for continuity of species*

Module 5: IQ2 HSC style questions

DNA Replication and Meiosis

10 A model of DNA is shown.



Which row of the table correctly identifies the different components of the model?

	W	*X*	*Y*	*Z*
(A)	Sugar	Phosphate	Adenine	Guanine
(B)	Phosphate	Sugar	Guanine	Cytosine
(C)	Sugar	Phosphate	Adenine	Thymine
(D)	Phosphate	Sugar	Guanine	Thymine

13 A section of DNA has the following nucleotide sequence.

AGG TCT CAG ATC

What is the nucleotide sequence of the newly-made strand following DNA replication?

A. AGG TCT CAG ATC

B. AGG UCU CAG AUC

C. UCC AGA GUC UAG

D. TCC AGA GTC TAG

17 Which feature of DNA was discovered as a result of Rosalind Franklin's work?

A. Double helix shape

B. Long stranded molecule

C. Sugar-phosphate backbone

D. Complementary nucleotides

13 Which of the following shows DNA replication in the correct order?

(A) Two DNA double helices → strands separate → matching bases pair up → DNA double helix

(B) DNA double helix → strands separate → matching bases pair up → two DNA double helices

(C) Strands separate → two DNA double helices → matching bases pair up → DNA double helix

(D) DNA double helix → strands separate → two DNA double helices → matching bases pair up

7 Thirty percent (30%) of the nucleotide bases in human DNA are adenine (A).

What is the percentage of guanine (G) bases in human DNA?

(A) 20%

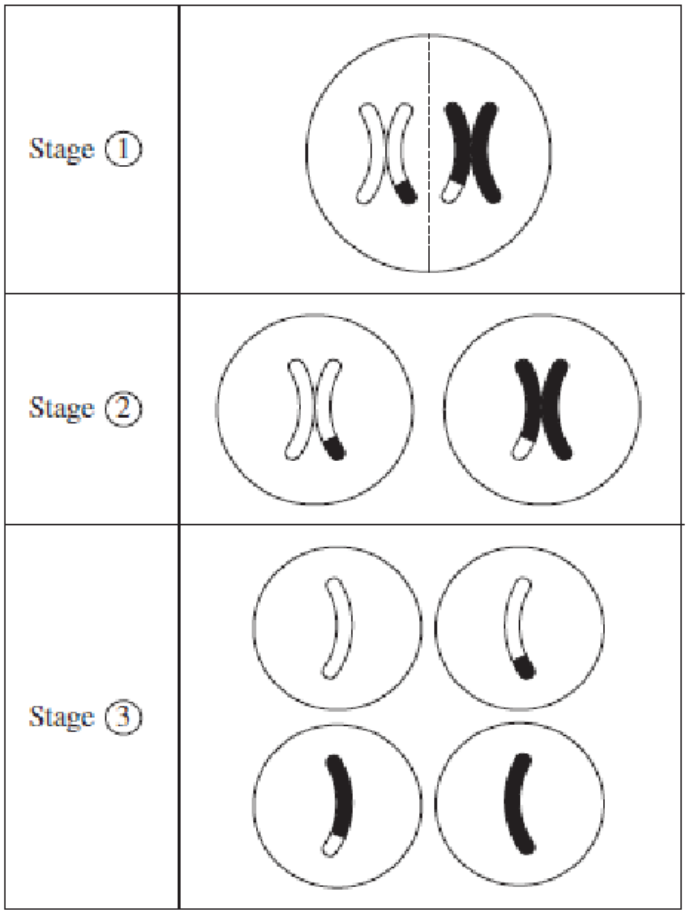
(B) 30%

(C) 40%

(D) 70%

Refer to the following information to answer Questions 13 and 14.

The diagram shows some chromosomes during some stages of meiosis.



13 When does the segregation of homologous chromosomes occur?

(A) Before stage ①

(B) Between stages ① and ②

(C) Between stages ② and ③

(D) Between stages ① and ② and again between stages ② and ③

14 The chromosomes shown carry

(A) different genes and different alleles.

(B) different genes and the same alleles.

(C) the same genes and different alleles.

(D) the same genes and the same alleles.

Mod 5 – Question 17 (4 marks)

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

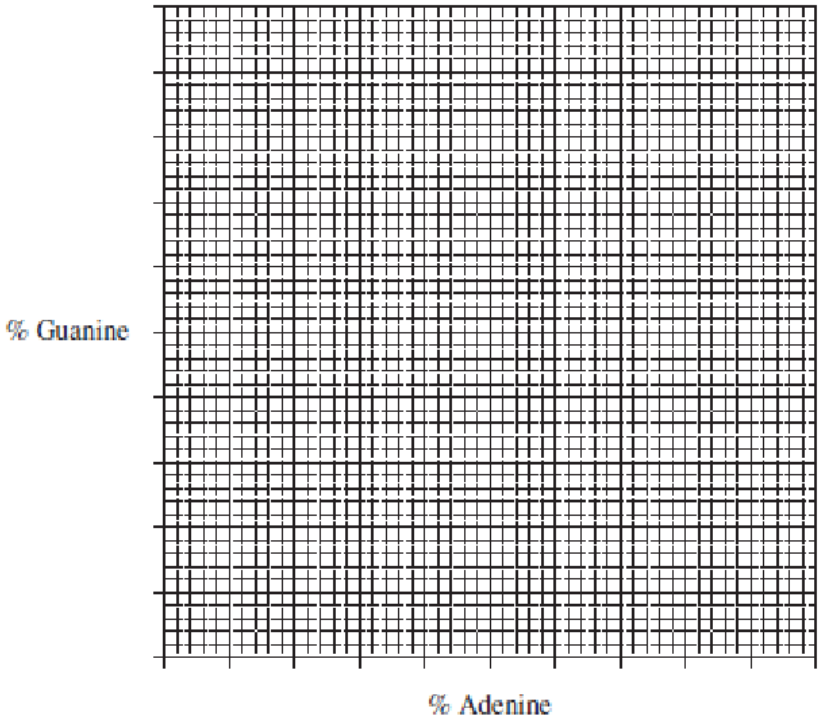
Question 26 (7 marks)

Students conducted preliminary experiments across different species to analyse their DNA base composition.

The table shows the experimental data collected.

Species	*% Adenine*	*% Guanine*
A	38	12
B	26	22
C	8	40
D	20	32
E	33	18

(a) On the grid below, plot the % Adenine vs % Guanine of the species analysed AND draw a suitable line of best fit. **3**



Question 26 (continued)

(b) Identify the relationship shown by the data. **1**

.....

.....

(c) Explain the relationship shown by the data. **3**

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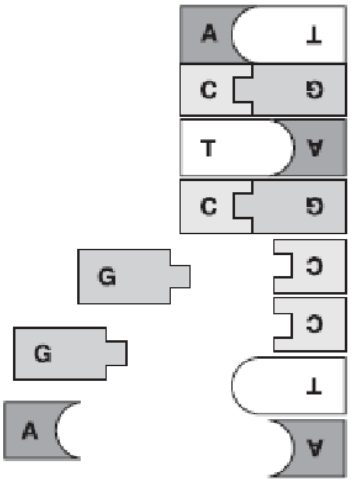
Question 23 (3 marks)

The diagram shows a model involving DNA.



(a) What process is being modelled? **1**

.....

(b) Identify TWO structural features of the DNA molecule which are NOT shown in this model. **2**

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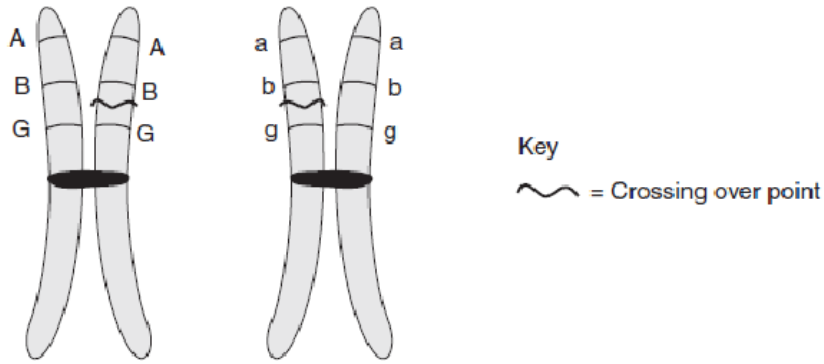
Question 24 (7 marks)

(a) Three genes are arranged along a homologous pair of chromosomes as shown.



(i) What is the individual's genotype before crossing over occurs? **1**

.....

(ii) Label, on the diagram below, the alleles after crossing over has occurred. **1**

(b) Explain the effect of independent assortment of chromosomes on the genotype of the offspring. **2**

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Question 24 continues on page 13

Question 29 (5 marks)

Scientists have tried to achieve a viable embryo by fusing two ova (eggs) from the same female. **5**

Explain whether the offspring produced using this process would be a clone of the female whose two ova were used. Use your knowledge of gamete formation and sexual reproduction to support your answer.

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Question 20 (6 marks)

(a) The table shows that 20% of the bases in a section of double-stranded DNA are adenine (*A*). **3**

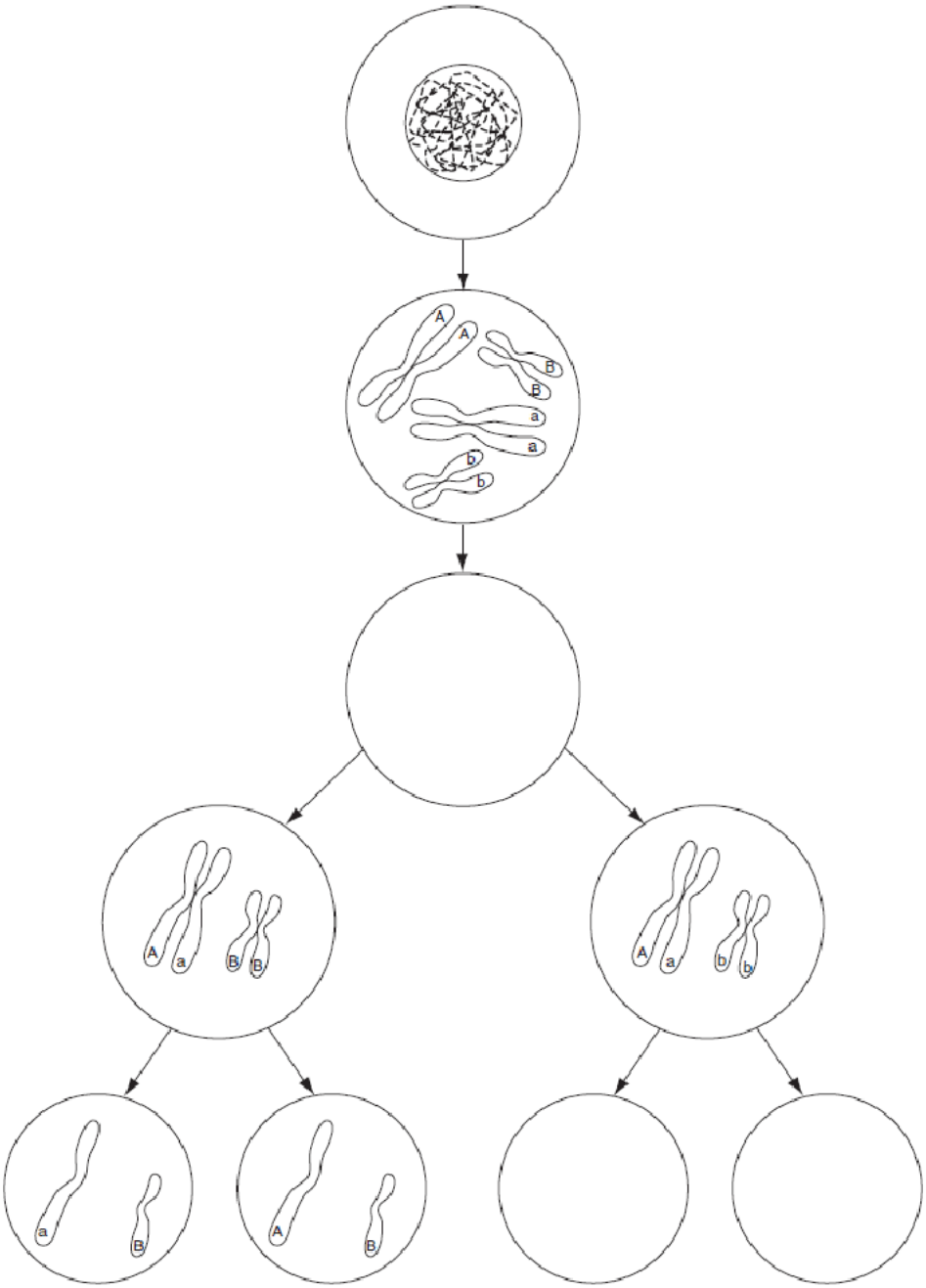
Complete the table below by identifying the other three base types and calculating the percentage of each base type in the section of double-stranded DNA.

Bases	*Percentage* (%)
A	20

(b) Construct a simple flowchart to describe the process of DNA replication. **3**

Question 29 (5 marks)

(a) Complete the following diagram to show the process by which gametes are formed. **3**



Question 29 continues on page 21

(b) How does the segregation of chromosomes during meiosis lead to a wide variety of gametes being produced? **2**

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Question 28 (6 marks)

(a) Explain how ONE named process that occurs during meiosis results in genetic variation. **3**

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(b) Why is genetic variation important in the survival of a species? **3**

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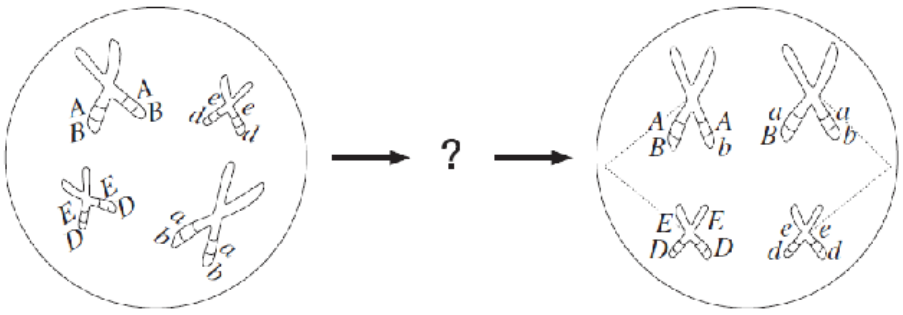
Question 22 (8 marks)

The diagram shows two steps of the process of meiosis occurring in a cell with four chromosomes.



(a) Describe the behaviour of the chromosomes between the steps shown. **2**

.....

.....

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.....

(b) List FOUR possible combinations of alleles that would be found in the gametes resulting from this process. **2**

.....

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(c) Explain ONE advantage of the process of meiosis to the species. **2**

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.....

(d) Distinguish between the terms *allele* and *gene*. **2**

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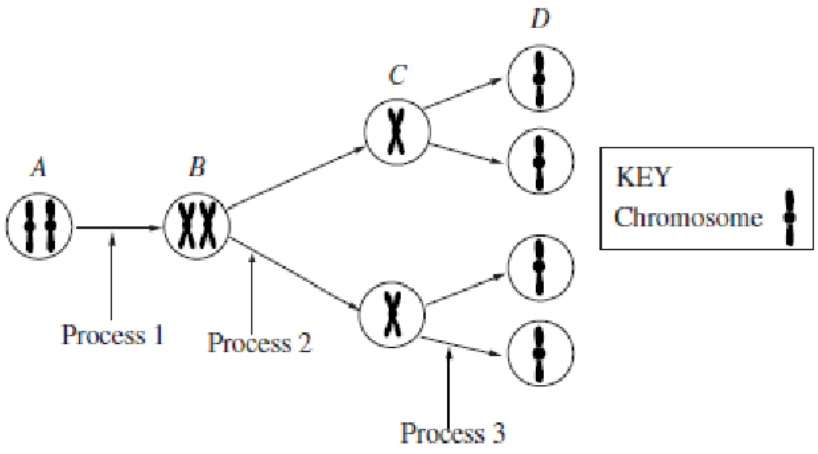
Question 23 (5 marks)

The flow diagram below is a representation of one pair of homologous chromosomes in a cell during meiosis.



(a) Identify ONE characteristic of the cells labelled *D*. 1

.....

(b) Identify what occurs in Process 1. 1

.....

(c) Identify where crossing over would occur, and explain how crossing over affects the inheritance of genes. 3

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DNA replication and Meiosis
marking criteria and sample answers

Multiple Choice answers: Q10 (DNA model)- A, Q13 (DNA)- D, Q17- A, Q13 (DNA replication)- B, Q7- A, Q13 (meiosis)- B, Q14- C.

Module 5 - Q17

Mapping grid:

Content	Syllabus outcomes	Bands
Mod 5 Genetic Variation	BIO12–4, BIO12–5, BIO12–6, BIO12–12	2–5

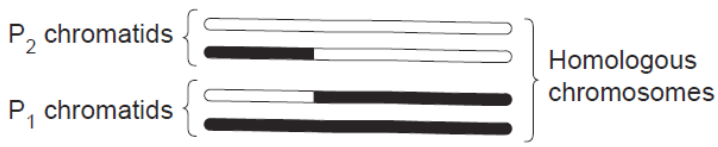
Marking guidelines:

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

Question 17 (continued)

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.

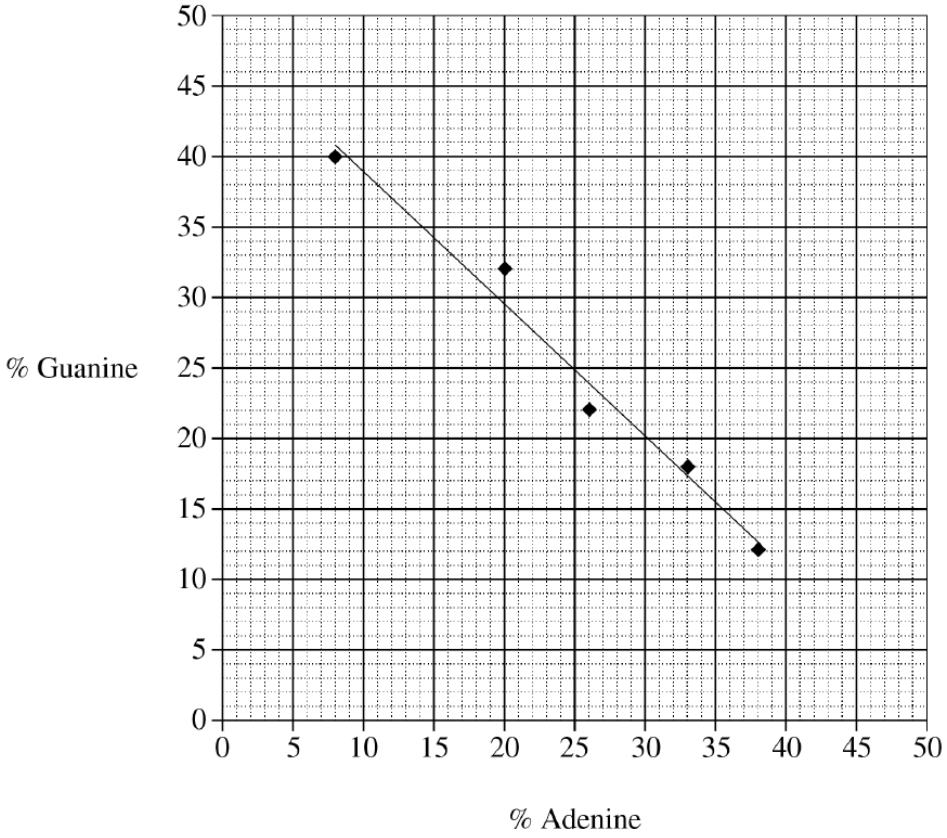


This means that when gametes are made, some will get unchanged parental chromosomes and some will get the chromatids that have undergone crossing over. This means that the range of gametes produced, and thus individuals produced through fertilisation, will show much greater variation.

Question 26 (a)

Criteria	Marks
• Scales axes correctly • Plots data correctly • Draws a suitable line of best fit	3
• Scales axes correctly • Plots most points correctly OR draws a suitable line of best fit	2
• Scales axes correctly OR plots most points correctly OR draws a suitable line of best fit	1

Sample answer:



Question 26 (b)

Criteria	Marks
• Identifies a correct relationship	1

Sample answer:

As the % of Adenine increases, the % of Guanine decreases.

Question 26 (c)

Criteria	Marks
• Identifies the amount of A = T and G = C • Explains A and T and G and C should = 100% • Relates increase of one nitrogenous base in the data to a decrease in another shown by the data	3
• Demonstrates some understanding of the relationship	2
• Provides relevant information about bases in DNA	1

Sample answer:

The percentage of A = T and the percentage of G = C due to the base pairing rule. This means as A goes up, T will also go up because A = T and A + T + C + G should equal 100%. Therefore as A increases, the amount of G should decrease as there is a smaller proportion available.

Module 5 – Q23

Question 23 (a)

Criteria	Marks
• Identifies the process	1

Sample answer:

DNA replication

Question 23 (b)

Criteria	Marks
• Identifies TWO structural features	2
• Identifies ONE structural feature	1

Sample answer:

- Sugar-phosphate backbone
- Double helix.

Question 24 (a) (i)

Criteria	Marks
• Provides correct genotype	1

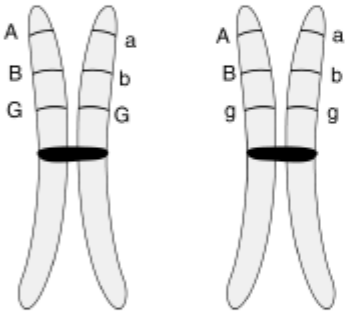
Sample answer:

Aa Bb Gg

Question 24 (a) (ii)

Criteria	Marks
• Provides correct sequence of alleles	1

Sample answer:



Question 24 (b)

Criteria	Marks
• Relates independent assortment to variation of offspring	2
• Provides some relevant information	1

Sample answer:

Independent assortment is the random alignment of homologous chromosomes during meiosis. This increases the number of possible combinations of chromosomes. Therefore, it increases the genetic variation of the offspring.

Question 29

Criteria	Marks
• Makes an appropriate assessment of whether offspring produced is a clone of the female on the basis of whether they are genetically identical • Clearly explains the relationship between the structure and behaviour of chromosomes during meiosis and the production of unique gametes (includes crossing over and independent assortment) • Explains the role of gametes and their combination in sexual reproduction to produce a unique genetic combination in each fertilisation • Links explanation to stimulus	5
• Makes an appropriate assessment of whether offspring produced is a clone of the female on the basis of whether they are genetically identical • Provides suitable explanations of the variability of the products of meiosis in gamete production (includes crossing over and independent assortment) OR explains the relationship between the structure and behaviour of chromosomes during meiosis and the production of unique gametes (includes crossing over or independent assortment) • Explains the role of gametes and their combination in sexual reproduction to produce a unique genetic combination in each fertilisation • Links explanation to stimulus	4
• Makes an appropriate assessment of whether offspring produced is a clone of the female • Provides relevant statement regarding the variability of the products of meiosis in gamete production • Refers to the combination of gametes in sexual reproduction to produce a unique genetic combination in each fertilisation	3
• Provides correct statements about cloning and/or sexual reproduction OR • Makes an appropriate assessment of whether offspring produced is a clone of the female on the basis of whether they are genetically identical	2
• Provides some relevant information about cloning or sexual reproduction	1

Sample answer:

The offspring would not be a clone of the female because the offspring and the female would not be genetically identical.

The offspring was produced using two ova. The nuclei of the two ova are different to each other and to the nuclei in the female's body cells. The ova were produced by meiosis of a body cell of the female.

During meiosis the processes of independent assortment of chromosomes and crossing over occur. In crossing over, segments of DNA swap positions on homologous chromosomes so new gene combinations are possible. Independent assortment results in different sorting of chromatids into ova. This results in genetically unique ova.

If these two genetically unique ova fuse there will be a new unique combination of genetic information in the offspring that is not identical to that of the female who produced the ova (eggs).

Question 20 (a)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Completes each row correctly	3
• Completes TWO rows correctly OR • Completes base column correctly • Provides correct % for T OR C/G	2
• Completes ONE row correctly OR • Completes base column correctly	1

a.

Bases	Percentage (%)
A	20
T	20
C	30
G	30

Question 20 (b)

Outcomes assessed: H9, H13

MARKING GUIDELINES

Criteria	Marks
• Provides a simple flowchart that provides features and characteristics of DNA replication in the correct sequence	3
• Provides a simple flowchart "or numbered sequence" that outlines DNA replication in the correct sequence	2
• Identifies the stages of DNA replication in the correct sequence with at least one step	1

DNA unwinds → DNA unzips → free nucleotides attach to matching bases on each DNA strand → new identical double strands are formed → double strands coil and twist into double helixes

Question 29 (a)

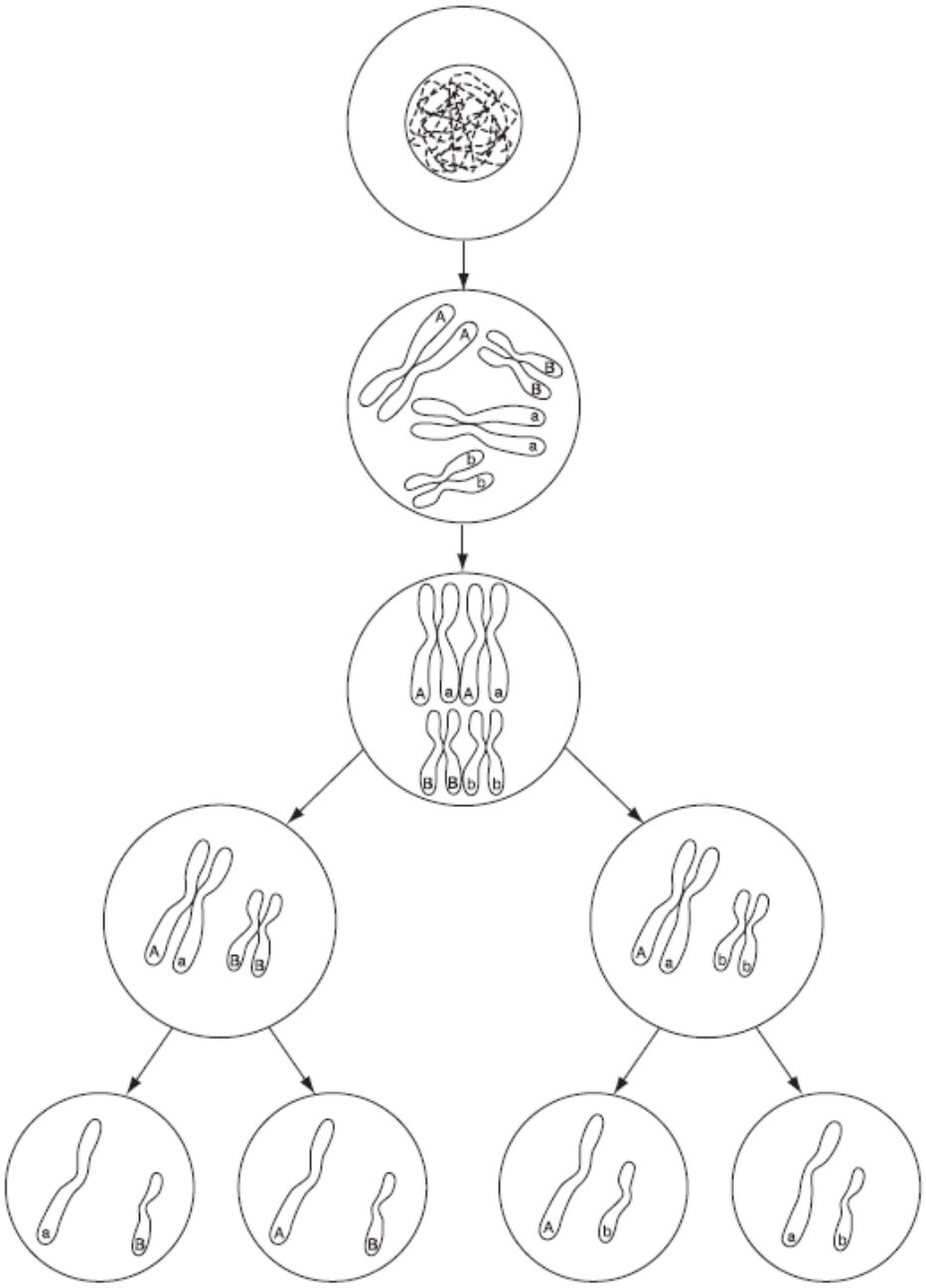
Criteria	Marks
• Diagram 1: tetrad line up correctly, alleles in correct position, homologous chromosomes paired and joined correctly and crossing over has occurred • Diagram 2: haploid, with appropriate chromosomes and alleles in both	3
• Diagram 1 as above OR • TWO elements of Diagram 1 and Diagram 2 as above	2
• Provides correct information about ONE element in correct cell	1

Question 29 (b)

Criteria	Marks
• Demonstrates a sound knowledge of independent assortment during gamete formation and relates to a range of gamete combinations	2
• Provides some information about independent assortment	1

Question 29 (a)

Sample answer:



Question 29 (b)

Sample answer:

In meiosis, there is a reduction division. Chromosome pairs line up together and one of each pair goes into the daughter cells. For each pair, this process is independent – hence a large number of combinations are possible.

Question 28 (a)

Outcomes assessed: H6, H9

MARKING GUIDELINES

Criteria	Marks
• Correctly relates cause and effect of ONE meiotic process leading to genetic variation	3
• Describes ONE meiotic process OR • Identifies ONE meiotic process and the effect it has on genetic variation	2
• Identifies ONE meiotic process	1

Sample answer:

Crossing over means that alleles on one chromatid can be exchanged with another chromatid. When the gametes are formed the chromosomes contain different combinations of alleles.

Question 28 (b)

Outcomes assessed: H10

MARKING GUIDELINES

Criteria	Marks
Demonstrates understanding by including these THREE ideas: - Change in environment occurs - Organisms with variations best suited to the environment survive - These organisms reproduce	3
• Includes TWO of the above ideas	2
• Includes ONE of the above ideas	1

Sample answer:

If there is a change in the environment, some organisms may be better suited to the new environment and can therefore survive and reproduce.

Question 22 (a)

Outcomes assessed: H9, H12

MARKING GUIDELINES

Criteria	Marks
• Provides the features of the behaviour of chromosomes between the steps by indicating the pairing of homologous chromosomes and crossing over	2
• Identifies a feature of the behaviour of chromosomes between the steps	1

Outcomes assessed: H9, H13

MARKING GUIDELINES

Criteria	Marks
• Provides four possible combinations	2
• Provides two or three possible combinations	1

Question 22 (c)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Shows how one result of the process is an advantage for a species	2
• Identifies either a result of the process or an advantage of the process	1

Question 22 (d)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Provides the difference between the terms allele and gene	2
• Provides an outline of either an allele OR a gene	1

sample answers

question 22

a. two visible behaviours of chromosomes are
    1. chromosomes line up along the equator and the centromeres are visible
    2. the chromosomes undergo crossing over (B and b)

b. possible combinations of alleles that would form in the gametes are: AE, BD, bD, Bd, bd

c. the advantage to the process of meiosis to a species is that it enables variation to occur. variation enables species to change over time, which is particularly advantageous to a species in a changing environment

d. A **gene** is the part of the DNA molecule that contains the instructions to make proteins and have specific locations on chromosomes. These determine particular characteristics e.g. height or eye colour. An **allele** is the variant or alternative form of this characteristic or gene e.g. tall/short or brown/blue

Question 23 (a)

Outcomes assessed: H9, H12

MARKING GUIDELINES

Criteria	Marks
• Correctly identifies characteristic	1

Question 23 (b)

Outcomes assessed: H9, H12

MARKING GUIDELINES

Criteria	Marks
• Identifies process	1

Question 23 (c)

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Identifies where crossing over occurs. Links cause and effect of crossing over	3
• Identifies crossing over AND describes crossing over OR the effect of crossing over OR • Describes crossing over AND the effect of crossing over	2
• Identifies where crossing over occurs OR • Describes crossing over OR • Describes the effect of crossing over	1

Question 23

a. cells labelled D are haploid
b. process 1 represents the duplication/copying of chromosomes
c. crossing over would occur during the first stage of meiosis (prophase), represented by diagram B, where homologous chromosomes pair/line up. If the chromosomes are twisted, breaks may occur at the twist point, resulting in the switching of genetic information from one strand to another. This creates a new chromosome with a new combination of genetic material, different from the original, being passed on to the offspring (new combination of alleles inherited together)

Module 5: IQ3 HSC style questions
Polypeptide synthesis

Construct appropriate representations to model and compare the forms in which DNA exists in eukaryotes and prokaryotes

IN ORDER TO ADDRESS THIS SECTION

- *Create a model- this can be physical (construction, diagrammatical) , conceptual (principals, laws and theories) , mathematical (equations and data) .*
- *annotate models to show the main features*
    - *shows similarities and differences between eukaryotic (nucleus should be evident) and prokaryotic cells (no nucleus evident)*
    - *shows **similarities** and **differences** in the **DNA** of eukaryotic and prokaryotic cells*

Model the process of polypeptide synthesis, including:

a. **transcription and translation**
b. **assessing the importance of mRNA and tRNA in transcription and translation**

IN ORDER TO ADDRESS THIS SECTION

- *Create a model- this can be physical (construction, diagrammatical), conceptual (principals, laws and theories), mathematical (equations and data)- could be a diagrammatical flowchart showing steps of polypeptide synthesis (remember flow charts must contain more than 2 arrows/3 stages)*
- *annotate models to to describe the main steps of transcription and translation*
- define the terms mRNA and tRNA
- describe the structure and function of mRNA and tRNA (use annotated diagrams)
- outline how preRNA differs from mature RNA
- clearly explain the roles of
    - mRNA during transcription
    - tRNA during translation
- give an explicit judgement regarding the importance of correct functioning of tRNA and mRNA in the production of polypeptides (band 6)

Analysing the function and importance of polypeptide synthesis

IN ORDER TO ADDRESS THIS SECTION

- *Identify the main steps involved in polypeptide synthesis and the location of each step*
- *Define AND describe the steps involved in polypeptide synthesis (transcription and translation)- can be done in a flowchart*
- *Explain the function of polypeptide synthesis*
- *Explain the importance of polypeptide synthesis*
- *Discuss, with examples, the effects of mistakes that may occur during polypeptide synthesis (mutations) - positive and negative effects*

Assessing how genes and environment affect phenotypic expression

IN ORDER TO ADDRESS THIS SECTION

- *Define terms gene, gene expression, phenotype, transcription, translation*
- *Describe the process by which polypeptides are made*
- *Describe the factors that control gene expression in eukaryotic cells*
- *Use examples to show how genes can control the expression of proteins*
    - *Use specific examples to show how the environment can affect the expression of proteins*

Investigate the structure and function of proteins in living things

IN ORDER TO ADDRESS THIS SECTION

- *describe the structure of proteins*
    - *you may use models/diagrams to support this. Ensure that you refer to polypeptides*
- *describe the functions of proteins*
- *relate the structure of specific proteins to their functions*
    - *e.g. haemoglobin - comprised of 4 polypeptide chains (2 alpha and 2 beta chains). Include all main features. Relate these features to their function.*
    - *extension of this could have you relate mutations to the altered structure and function of specific proteins such as haemoglobin (sickle cell anaemia) - link to IQ in module 6*

14 The table shows the base triplets in mRNA for amino acids.

From the table, the amino acid Serine (Ser) can be coded for by the base triplet UCG.

Base triplets found in messenger RNA

First base	Second base U	Second base C	Second base A	Second base G	Third base
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Phe	Ser	Stop	Stop	A
	Phe	Ser	Stop	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

Which base triplet could code for the amino acid Tyrosine (Tyr)?

(A) CCU

(B) CAU

(C) UAA

(D) UAC

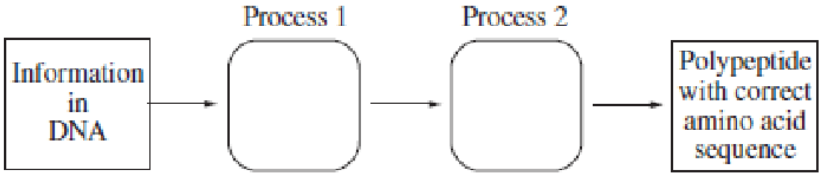
Mod 5 – Question 15 (3 marks)

There are some significant differences in the form that DNA has in prokaryotic and eukaryotic cells. **3**

In the space provided draw a labelled diagram demonstrating the difference in the form of DNA between prokaryotic and eukaryotic cells.

Question 18 (4 marks)

This flow chart represents a model of polypeptide production. **4**



In the table below, name and outline what occurs in Processes 1 and 2.

Name of process (word or phrase)	*Outline of process*
Process 1	.....
Process 2	.....

Polypeptide synthesis
marking criteria and sample answers

Multiple Choice answers: Q14- D

Module 5 Q15

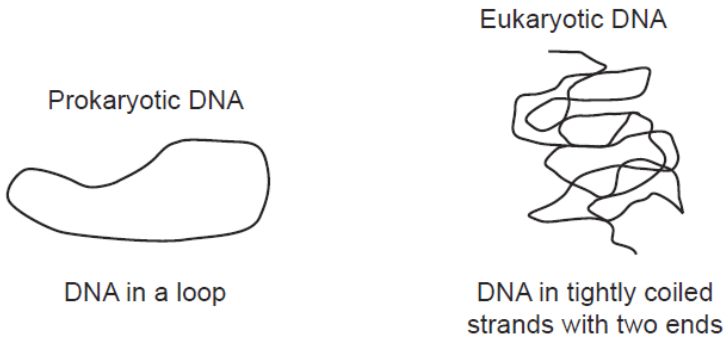
Mapping grid:

Content	Syllabus outcomes	Bands
Mod 5 DNA and Protein Synthesis	BIO12–7, BIO12–12	2–4

Marking guidelines:

Criteria	Marks
• Draws prokaryotic DNA form as loop and eukaryotic DNA form as a strand with distinct ends • Provides relevant labels that convey understanding of DNA forms	3
• Draws prokaryotic DNA form as loop and eukaryotic DNA as a strand with distinct ends OR • Draws and labels EITHER prokaryotic DNA form or eukaryotic DNA form	2
• Provides some relevant information	1

Sample answer:



Question 18

Outcomes assessed: H6, H13

MARKING GUIDELINES

Criteria	Marks
• Names TWO processes correctly and indicates main features of the processes	4
• Names TWO processes correctly and indicates main feature of ONE process OR • Indicates main features of BOTH processes without naming	3
• Names ONE process correctly and indicates main feature of named process OR • ONE correct name and ONE correct function (not linked) OR • TWO correct outlines with correct names but in wrong position OR • TWO processes correctly named or outlined	2
• ONE process correctly named OR • ONE correct outline with correct name but in wrong position	1

sample answer

Name of process (word or phrase)	outline the process
Process 1: unzipping/transcription	double strand DNA unwinds. RNA moves along the strand linking complementary nucleotides together to form mRNA. The mRNA then moves from the nucleus into the cytoplasm
Process 2: translation (polypeptide synthesis	mRNA strand binds onto the ribosome. tRNA binds to mRNA within the ribosome. the ribosome moves along the strand linking the amino acids, forming a polypeptide chain. When a stop codon is reached, the chain is released into the cytoplasm

Module 5: IQ4 HSC style questions
Genetic similarities and differences

Conduct practical investigations to predict variations in genotypes of offspring by modelling meiosis, including crossing over of homologous chromosomes, fertilisation and mutation

IN ORDER TO ADDRESS THIS SECTION

- *determine an aim, hypothesis and method for an investigation into the listed processes*
- *create a model (physical and mathematical -punnett squares will need to be used) to show how each process occurs - model must include genotypes of parents (e.g. AA x aa) -good to incorporate linked genes here to show a greater understanding of the effect crossing over has on variation in offspring*
- *annotate the models to give clear steps*
- *show the outcomes (results) in genotypes of offspring*
- *discuss the importance of each process in ensuring continuity of species- make sure you refer to VARIATION (creating new combinations of alleles in daughter cells)*

Model the formation of new combinations of genotypes produced during meiosis, including but not limited to:

a. interpreting examples of autosomal, sex-linkage, co-dominance, incomplete dominance and multiple alleles
   - *i. distinguish between genes, alleles, dominant and recessive alleles*
   - *ii. distinguish between different patterns of inheritance (identify unique characteristics of each types of inheritance pattern)*
   - *iii. construct/draw punnett squares to show predict genotypes of offspring or parents*

b. constructing and interpreting information and data from pedigrees and Punnett squares
   - *i. define pedigree*
   - *ii. outline the importance of using pedigrees to show new combinations of trait inherited over generations within a family tree (human and animal pedigrees)*
   - *iii. construct pedigrees with correct*
     1. *key to identify males and females*
     2. *key to identify affected vs non affected individuals*
     3. *correct lines to show marriage/partnerships (line across and offspring (branching)*
   - *iv. give reasoning/justification for identified pattern of inheritance (autosomal recessive because unaffected parents produce affected offspring, no sex bias)*
     1. *use punnett squares for justification*

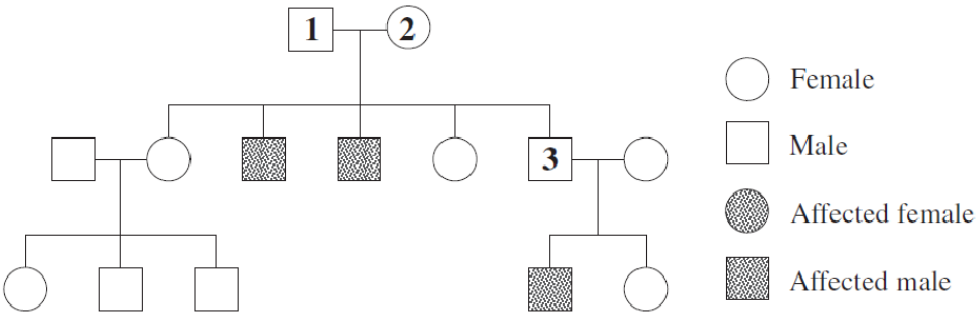
Collect, record and present data to represent frequencies of characteristics in a population, in order to identify trends, patterns, relationships and limitations in data, for example:

a. **examining frequency data**
b. **analysing single nucleotide polymorphism (SNP)**

IN ORDER TO ADDRESS THIS SECTION

- *research or extract data from secondary source*
- *tabulate and graph data*
- *identify trends in data (what is being shown/what is the correlation between dependent and independent variables)*
- *describe similarities or differences (relationships) in different sets of data and give reasons for these differences (relate to selective pressures and evolution)*
- *identify limitations in data and give suggestions of additional data needed to validate information and conclusions*

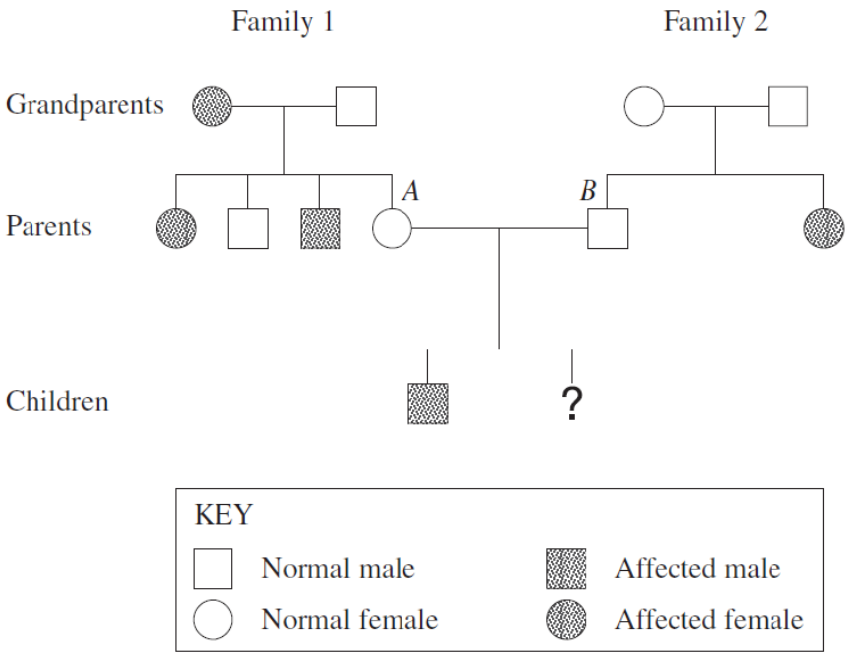
15 In a particular sex-linked disease, progressive weakening of the muscles and loss of coordination lead to death before the age of five.



Using this pedigree, what is the genotype of the individuals numbered **1**, **2** and **3**?

	Individual 1	*Individual 2*	*Individual 3*
(A)	Normal	Normal	Normal
(B)	Carrier	Normal	Carrier
(C)	Normal	Carrier	Normal
(D)	Normal	Carrier	Carrier

11 The family tree shows the inheritance of a genetic characteristic.



What is the probability that a daughter of parents *A* and *B* would be affected?

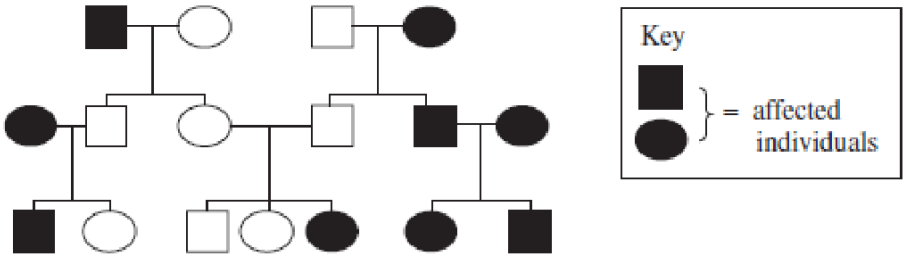
(A) 0%

(B) 25%

(C) 50%

(D) 100%

8 The pedigree shows the inheritance of a characteristic.



What pattern of inheritance is shown?

(A) Dominant and sex-linked

(B) Recessive and sex-linked

(C) Dominant and not sex-linked

(D) Recessive and not sex-linked

15 In a certain plant species, individual plants have either yellow, red or orange flowers.

Two plants, each with a different flower colour, were crossed in a breeding experiment like those carried out by Mendel. The F2 results were: 6 red, 11 orange and 5 yellow flowered plants.

What were the genotypes of the original parent plants?

(A) RY and RY

(B) RR and rr

(C) RR and YY

(D) Rr and RY

10 Why do co-dominant alleles NOT produce simple Mendelian ratios?

(A) Both alleles are expressed in the phenotype.

(B) Neither allele is expressed in the phenotype.

(C) The recessive allele is only expressed in the homozygous genotype.

(D) The expression of the dominant allele is affected by the recessive allele.

15 Goltz Syndrome is a condition in humans that adversely affects the skin. It is inherited as a dominant gene carried on the X chromosome.

A man with Goltz Syndrome and a woman who does NOT have the trait have two children, a boy and a girl.

Which of the following is correct about the inheritance of Goltz Syndrome in these children?

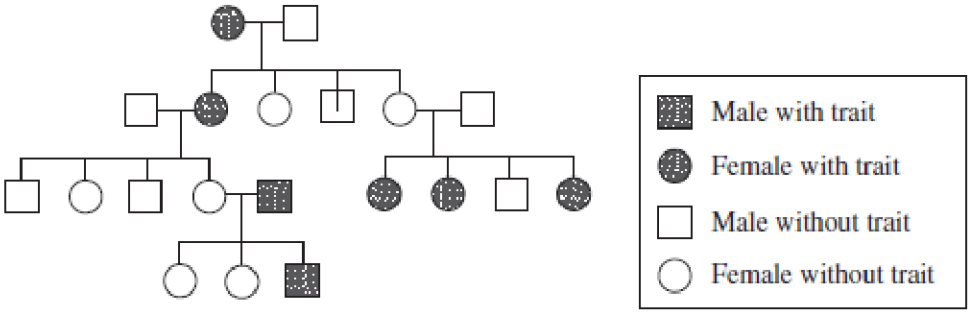
(A) Both children have the syndrome.

(B) The girl has the syndrome and the boy does not.

(C) The girl has the syndrome and the boy is a carrier.

(D) The girl has a 50% chance of having the syndrome and the boy has a 0% chance.

18 A family tree is shown.



What is represented by this family tree?

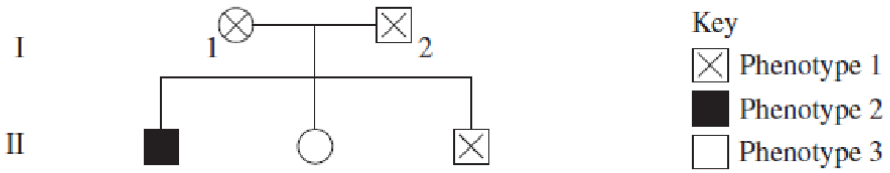
(A) Sex-linked inheritance

(B) Co-dominant inheritance

(C) Inheritance of a recessive trait

(D) Inheritance of a dominant trait

17 The pedigree shows the inheritance of a trait controlled by a pair of alleles.



Which Punnett square correctly represents the cross between the parents in generation I?

(A)

	B	b
A	AB	Ab
a	aB	ab

(B)

	B	B
A	AB	AB
A	AB	AB

(C)

	B	b
B	BB	Bb
b	Bb	bb

(D)

	A	B
A	AA	AB
B	AB	BB

5 The presence of freckles is a dominant characteristic. A child's mother has no freckles and its father is heterozygous for freckles.

What is the probability that this child will have freckles?

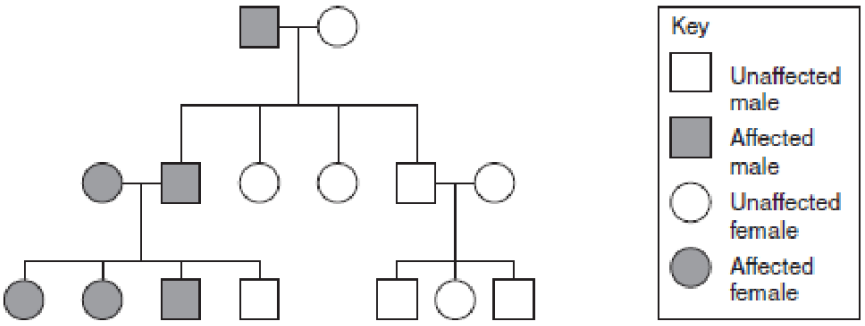
(A) 25%

(B) 50%

(C) 75%

(D) 100%

14 A pedigree is shown.



What type of inheritance is shown in the pedigree?

(A) Sex-linked recessive

(B) Sex-linked dominant

(C) Non sex-linked recessive

(D) Non sex-linked dominant

8 In humans, brown eye colour is dominant and blue eye colour is recessive. A brown-eyed boy and a blue-eyed girl have a blue-eyed mother.

What eye colour does the father have and why?

(A) Brown, because the gene for brown eye colour is sex linked.

(B) Brown, because at least one of the parents must have brown eyes.

(C) Blue, because at least two other members of the family have blue eyes.

(D) Blue, because at least one of the parents must be heterozygous for eye colour.

Question 21 (2 marks)

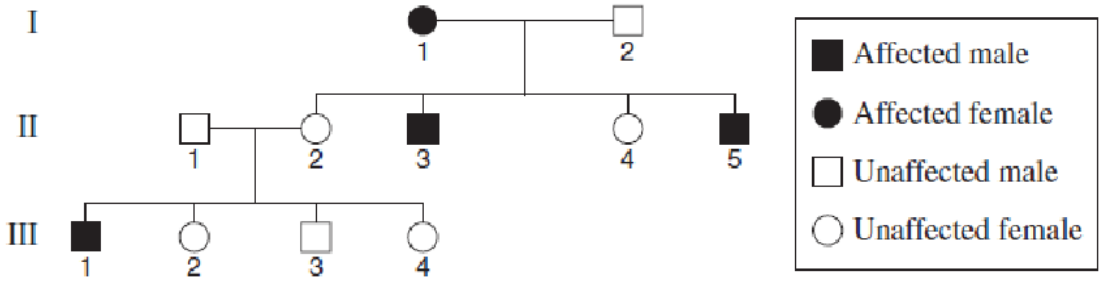
Gregor Mendel and Thomas Morgan both used breeding experiments to deduce fundamental principles of genetics.

Complete the four blank boxes in the table. 2

	Mendel's Monohybrid Cross	Morgan's Fruit Fly Experiments
First Cross Parents Phenotype	tall × short	red eyed female × white eyed male
First Cross (F_1) Parents Genotype		$X^R X^R \times X^r Y$
First Cross Punnet Square	t t T Tt Tt T Tt Tt	
F_1 Phenotype		

Question 28 (3 marks)

A pedigree chart of an inherited characteristic is shown. **3**



Subsequent genetic analysis showed I-2 does not have the recessive allele.

Explain the inheritance of this characteristic.

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Question 16 (3 marks)

A plant species may have red or white flowers. Two red-flowered plants were crossed. Most of the offspring had red flowers, but some had white flowers. **3**

Explain the presence of both red- and white-flowered offspring.

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Question 22 (3 marks)

Outline the work done by Morgan that has led to our understanding of sex linkage. 3

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Question 30 (8 marks)

Explain how our knowledge of chromosome structure has led to reproductive technologies that have the potential to alter the path of evolution. **8**

Question 17 (6 marks)

As part of an independent research project, a student studied a genetic condition suffered by members of his family. The student wrote the following summary:

- I am male and I have the condition.
- My mother does not have the condition.
- My father and his brother have the condition.
- My father's sister and my father's mother do not have the condition.
- My father's father has the condition.

(a) Construct a pedigree of this family. **3**

(b) Why are diagrams, such as pedigrees, useful in analysing data? **1**

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(c) The student made the following conclusion from his study. **2**

"As only males have the condition, it must be a sex-linked genetic condition."

Assess the validity of the student's conclusion, and provide support for your assessment.

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Question 24 (6 marks)

Nick's wife Maria has a history of red-green colour blindness in her family. Jack, their two-year old son, may be red-green colour blind. Maria's brothers, Vincent and Paul, are colour blind but her brother, James, is not. Maria's mother Anne, is a carrier of red-green colour blindness. Her father, John, is unaffected.

(a) Construct a family pedigree to show the inheritance of this sex-linked genetic disorder. **4**

(b) Predict whether Jack will be colour blind. Justify your answer. **2**

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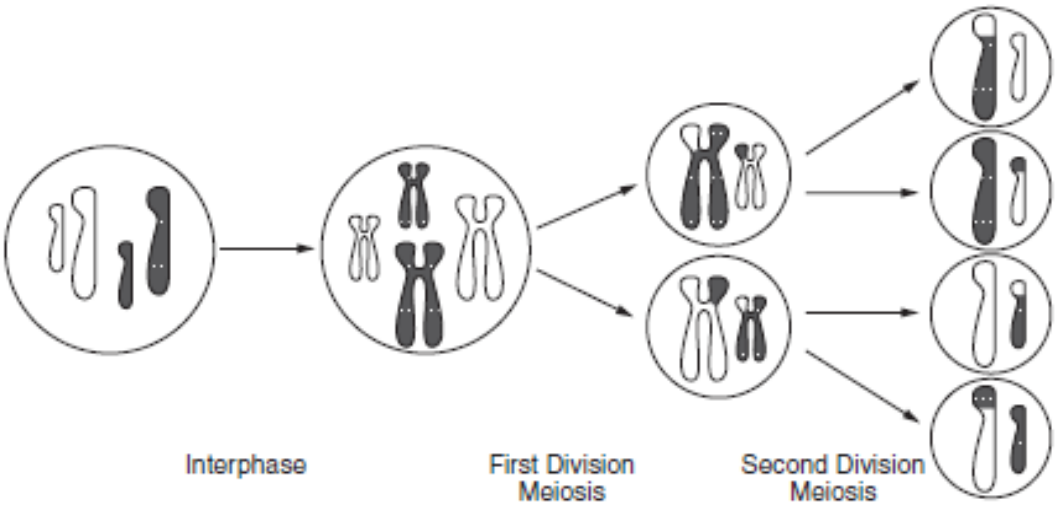
Question 29 (7 marks)

The diagram models the process of meiosis.



NCBI

(a) Describe the process that accounts for the changes shown in the model during interphase. **2**

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Question 29 continues on page 23

(b) Explain the structure and behaviour of chromosomes in the first division of meiosis. Include detailed reference to the model. **5**

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End of Question 29

Question 34 (continued)

Answer parts (d) and (e) of the question on pages 6–8 of the Section II Writing Booklet. Start each part of the question on a new page.

(d) The offspring as a result of a dihybrid cross are shown.

RRTT	RRTt	RrTT	RrTt
RRTt	RRtt	RrTt	Rrtt
RrTT	RrTt	rrTT	rrTt
RrTt	Rrtt	rrTt	rrtt

Key
R = red flowers
r = yellow flowers
T = tall plant
t = dwarf plant

(i) Identify the genotype and the phenotype of the parents. **2**

(ii) Explain how the phenotypic ratio would be different depending on whether two genes are carried on the same chromosome or on two different chromosomes. **3**

Genetic similarities and differences
marking criteria and sample answers

Multiple Choice answers: Q15- C, Q11- B, Q8- D, Q15- C, Q10- A, Q15- B, Q18- C, Q17- D, Q5- B. Q14- D, Q8- B.

Question 28

Criteria	Marks
• Identifies the inherited characteristic and relates the genetic analysis to the pedigree chart	3
• Identifies one feature of the characteristic with reference to the pedigree chart	2
• Provides some relevant information	1

Sample answer:

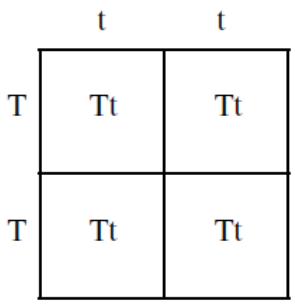
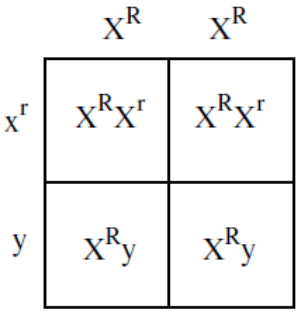
The condition is recessive because III-1 has the condition but neither of the parents have the condition. The condition is sex linked because I-2 does not have the recessive allele and therefore the genotype of I-2 is X^AY. If I-2 was autosomal AA then it would not be possible for II-3 and II-5 to have the condition.

Question 21

Criteria	Marks
• Correctly completes the F_1 parent genotype, punnet square and phenotype of both offspring	2
• Correctly completes TWO or THREE of the boxes provided	1

Question 21

Sample answer:

	Mendel's Monohybrid Cross	*Mendel's Fruit Fly Experiments*
First Cross Parents Phenotype	tall × short	red eyed female × white eyed female
First Cross Parents Phenotype	TT × tt	$X^RX^R \times X^rY$
First Cross Punnet Square		
F_1 Phenotype	100% Tall	100% Red eye

Question 16

Outcomes assessed: H9

MARKING GUIDELINES

Criteria	Marks
• Correctly uses genotypes in answer to explain phenotypes of BOTH generations	3
• Correctly uses genotypes to explain phenotype of ONE generation	2
• Correctly links a genotype and phenotype	1

Sample answer:

The parents were heterozygous (Rr) and carried a recessive gene for white flowers. Thus, the offspring are mostly red (RR) but some have the double recessive making them white (rr).

Question 22

Criteria	Marks
• Sketches in general terms the sex-linked inheritance experiments conducted by Morgan • Notes the different frequencies of occurrence of the sex-linked trait in males and females	3
• Indicates some of the features of Morgan's work with fruit fly AND • Notes the difference in ratios between males and females of a trait that includes sex linkage OR identifies that the trait showed non-Mendelian ratios	2
• Provides some relevant information concerning Morgan's work with fruit flies	1

Sample answer:

Morgan bred fruit flies and observed that the eye colour was not inherited in normal Mendelian ratios. The white eye colour was common in males and rare in females.

Question 30

Criteria	Marks
• Demonstrates thorough knowledge of the structure of chromosomes • Clearly states the relationship between chromosome structure and inheritance • Links appropriate reproduction technologies to the nature of inheritance and chromosomes • Relates using these technologies to possible impacts on evolution	8
• Provides some information about chromosome structure • Clearly states the relationship between chromosome structure and inheritance • Outlines a reproductive technology • Relates this technology to possible impact on evolution	6–7
• Provides some information about chromosomes • States a relationship between chromosomes and inheritance AND • Outlines a reproductive technology OR links chromosomes to evolution	4–5
• Provides some information about chromosome structure OR • Shows a relationship between chromosomes and inheritance OR • Outlines a reproductive technology OR • Relates chromosomes to evolution	2–3
• Provides some information about chromosomes or evolution OR • Identifies a reproductive technology	1

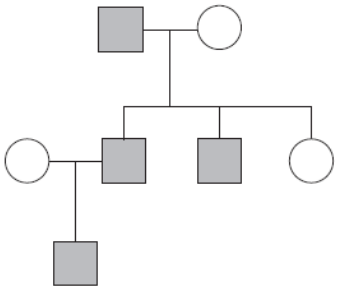
Sample answer:

Chromosomes contain DNA that provides the genetic code for an organism. Genes in this DNA code for proteins and eventually phenotypes. In sexual reproduction pairs of homologous chromosomes are separated during meiosis into gametes. These pairs are then brought back together during fertilisation, with genetic information from both parents. Some of the characteristics will be dominant, and revealed in the phenotypes and others will be recessive, not revealed unless both of the chromosome pair are recessive. Knowing the sperm have the characteristics of the father artificial insemination can be used from one father to fertilise many females, such as is done in racehorses. If this is done then genetic variation will be limited and so limiting variations in the population and hence controlling evolution. Cloning techniques have also been developed where the chromosomes of a normal cell are placed in an egg, or parts of a plant are grown into a new plant. These then develop into copies of the parent organism and there is no variation because all the chromosomes and genetic information is the same as the parent. This would lead to a population with no genetic variation, hence stopping evolution.

please keep in mind that this is a sample response and not necessarily an 8 mark response

Question 17 (a)

Sample answer:



Question 17 (b)

Sample answer:

Showing written information in the form of a diagram allows relationships to be easily seen.

Question 17 (c)

Sample answer:

The student's conclusion might not be valid.

The pattern shown by the pedigree could occur if the condition was a dominant condition and affected individuals were heterozygous for the condition.

Question 24 (a)

Outcomes assessed: H13, H14

MARKING GUIDELINES

Criteria	Marks
• Constructs pedigree correctly showing affected and unaffected members. Anne identified as a carrier • Correct key included	4
• Constructs pedigree with some errors • Key incomplete	2–3
• Constructs the framework of the pedigree • No key	1

Question 24 (b)

Outcomes assessed: H14

MARKING GUIDELINES

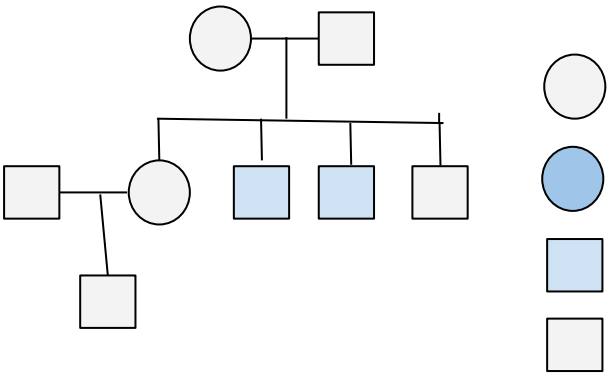
Criteria	Marks
• Makes a prediction based on pedigree in part (a) • Supports prediction with logical argument	2
• Makes a correct statement from pedigree drawn	1

question 24

Key:

Unaffected female

a.



b. Jack may or may not be colour blind. Maria has a 50% chance of being a carrier as her mother was a carrier; hence she has two colour blind brothers. Jack has a 50% chance of being colour blind, depending on whether Maria is a carrier or not.
If Maria is a carrier, Jack has a 50% chance of being colour blind
If Maria is not a carrier, Jack will not be colourblind

Question 29 (a)

Criteria	Marks
• Provides main features of DNA replication	2
• Provides some relevant information	1

Sample answer:

DNA replication involves separating DNA strands and adding complementary nucleotides to each strand.

Question 29 (b)

Criteria	Marks
• Demonstrates a thorough understanding of the structure and behaviour of chromosomes in first division of meiosis and links a feature to the model • Links features of meiosis I to variation	5
• Demonstrates a sound understanding of the structure and behaviour of chromosomes in first division of meiosis and links a feature of the model • Links a feature of meiosis I to variation	4
• Describes the structure and behaviour of chromosomes during first division of meiosis • Links information provided to features of the model	3
• Outlines relevant information about structure and/or behaviour of chromosomes during first division of meiosis OR • Links information about structure or behaviour of chromosomes to the model	2
• Provides some relevant information	1

Sample answer:

The model represents homologous pairs of chromosomes as being the same size and identifies the paternal or maternal origin with different shading.

In the first division of meiosis individual chromosomes form homologous pairs. These carry the same genes but not identical alleles. When paired, crossing over occurs as genetic material is exchanged between non-sister chromatids resulting in new combinations of genetic material as shown by the shading.

The two daughter cells formed after this division have half the number of chromosomes (haploid cells), one from each homologous pair assigned at random. This increases variation in the daughter cells, as shown after the first division.

Question 34 (d) (i)

Criteria	Marks
• Identifies genotype and phenotype of both parents	2
• Provides some relevant information	1

Sample answer:

Both parents are RrTt and are tall and have red flowers.

Question 34 (d) (ii)

Criteria	Marks
• States the phenotypic ratio for both cases • Relates the difference in ratios to independent assortment	3
• States the phenotypic ratio for both cases	2
• Provides some relevant information	1

Sample answer:

If the genes are on separate chromosomes the ratio of the phenotypes is 9 : 3 : 3 : 1. This occurs due to independent assortment. The phenotypic ratio would be 3:1 if the genes RT and rt were on the same chromosome as they are linked.

Module 5: IQ5 HSC style questions
Predicting population genetics

Investigate the use of technologies to determine inheritance patterns in a population using, for example:

a. **DNA sequencing and profiling**

IN ORDER TO ADDRESS THIS SECTION

- identify technologies used to determine inheritance patterns (DNA sequencing and profiling
- describe the steps involved in the use of each technology
- describe the uses of each technology in determining inheritance patterns in a population

Investigate the use of data analysis from a large-scale collaborative project to identify trends, patterns and relationships, for example:

b. **the use of population genetics data in conservation management**
c. **population genetics studies used to determine the inheritance of a disease or disorder**
d. **population genetics relating to human evolution**

IN ORDER TO ADDRESS THIS SECTION

- *Define population genetics*
- *research or extract data from secondary source*
- *tabulate and graph data*
- *identify trends in data (what is being shown/what is the correlation between dependent and independent variables)*
- *describe similarities or differences (relationships) in different sets of data and give reasons for these differences (relate to selective pressures and evolution)*
- *Explains how changes in allele frequencies arise and how these changes lead to microevolution (changes over short periods of time)*
- *Use of quantitative data to to determine frequencies of alleles in populations and how these change over generations with relation to a specific disease or disorder*

Mod 5 – Question 18 (6 marks)

A student plans to investigate whether the development of insulin has affected the prevalence of Type 1 diabetes in the human population and subsequently influenced human evolution. She has access to data on Australians with diabetes extending back to 1973.

(a) Propose a suitable hypothesis for this investigation. **2**

(b) Identify TWO variables that need to be controlled for this investigation and **4**

Mapping grid (a):

Content	Syllabus outcomes	Bands
Mod 5 Inheritance Patterns in a Population	BIO12–1, BIO12–12	4–5

Marking guidelines (a):

Criteria	Marks
• Proposes a suitable hypothesis	2
• Provides some relevant information	1

Sample answer:

The use of insulin, by people who have Type 1 diabetes, has increased the prevalence of Type 1 diabetes in the human population.

Mapping grid (b):

Content	Syllabus outcomes	Bands
Mod 5 Inheritance Patterns in a Population	BIO12–2, BIO12–12	3–6

Marking guidelines (b):

Criteria	Marks
• Identifies TWO variables that could affect findings and explains their importance	4
• Identifies TWO variables that could affect findings and outlines their importance	3
• Identifies ONE variable that could affect findings and outlines its importance	2
• Provides some relevant information	1

Sample answer:

One variable the student will need to control for is the increase in the Australian population since 1973. Just counting the increase in numbers without taking into account population increases will give a biased result as even without an increase in prevalence it would be expected that the total numbers will increase as the population increases. The prevalence will need to be measured using a rate such as number of people with Type 1 diabetes per 100 000 people.

Another variable that may affect results, and therefore reduce the validity of the data, is the length of time the subject has used insulin or since diagnosis. This data may also be useful if determining whether the prevalence of Type 1 diabetes is caused by more people being diagnosed or more people surviving for a longer time.

MODULE 6

GENETIC CHANGE

Module 6: IQ1 HSC style questions
Mutations and new alleles

Explain how a range of mutagens operate, including but not limited to:

- **electromagnetic radiation sources**
- **chemicals**
- **naturally occurring mutagens**

IN ORDER TO ADDRESS THIS SECTION

- *HOW = EXPLAIN = CAUSE (DEFINE/DESCRIBE) AND EFFECT (WHAT IS THE EFFECT OF THE CAUSATION)*
- *<u>CAUSE:</u>*
  - *define mutation*
  - *define allele*
  - *identify and describe different types of mutations and how they occur*
- *<u>EFFECT:</u> how does each type of mutation introduce new alleles into the population*
- *MAKE LINK TO POLYPEPTIDE SYNTHESIS AND PRODUCTION OF PROTEINS*

Compare the causes, processes and effects of different types of mutation, including but not limited to:

- **point mutation**
- **chromosomal mutation**

IN ORDER TO ADDRESS THIS SECTION

- show similarities and differences between the
  - causes of point and chromosomal mutations
    - chemical mutagens, radiation, mistakes during DNA replication and meiosis
- the processes of point and chromosomal mutations
- how these changes occur and the effect on gene sequences (point and chromosomal) and the chromosomal structure (chromosomal mutations)
  - types of point and chromosomal mutations
  - give examples of specific types of point and chromosomal mutations
- when comparing, it often helps to draw a table to show direct comparisons or clearly show similarities and differences

Distinguish between somatic mutations and germ-line mutations and their effect on an organism

IN ORDER TO ADDRESS THIS SECTION

- *Define mutation*
- *Define somatic and germline*
- *Show differences between somatic and germline mutations in terms of*
    - *Cells they affect*
    - *Effect on individuals*
    - *Effect on populations*

Assess the significance of 'coding' and 'non-coding' DNA segments in the process of mutation

IN ORDER TO ADDRESS THIS SECTION

- *Define mutation*
- *Describe (give features of) coding and non-coding DNA segments*
- *Explain effect of mutation in coding AND non-coding DNA segments*
    - *Relate to DNA replication and polypeptide synthesis*
    - *Effect on populations*
    - *Advantages/disadvantages of this type of mutation*
    - *Use examples to justify the effect*
- *GIve a judgement about the significance of coding and non-coding DNA segments in process of mutation*
    - *judgement must be explicit- e.g. a frameshift mutation in the non-coding segment of DNA would have a significant effect on the polypeptide produced because……..*

Investigate the causes of genetic variation relating to the processes of fertilisation, meiosis and mutation

IN ORDER TO ADDRESS THIS SECTION

- *Include an aim, hypothesis and method to describe the steps taken to investigate/demonstrate the effects of these processes on variation*
- *define fertilisation*
  - *describe the process of fertilisation*
  - *relate the process to its role in variation (must show how variation can come about due to the random nature of fertilisation and the genetic differences that appear in gametes)*
  - *useful to use diagrams to demonstrate this*
- *define mutation*
  - *describe processes of mutation (at a gene level or chromosomal level) that result in changes in genotype and phenotype of offspring*
  - *relate to polypeptide synthesis and the resulting changes in amino acid sequences (useful to use a flowchart here showing 2 processes: polypeptide occurring normally AND polypeptide occurring with a mutation)*
    - *ensure that you indicate where the mutation is in the DNA, codons and amino acids produced → LINK TO NEW polypeptide → changed expression of a protein*
- *define meiosis*
  - *describe the steps in meiosis that lead to variation*
    - *crossing over*
    - *random assortment and segregation*
    - *ENSURE THAT YOU LINK VARIATION TO NEW COMBINATIONS OF ALLELES INHERITED TOGETHER IN THE RESULTING DAUGHTER CELLS*
    - *using a diagram here could be helpful*

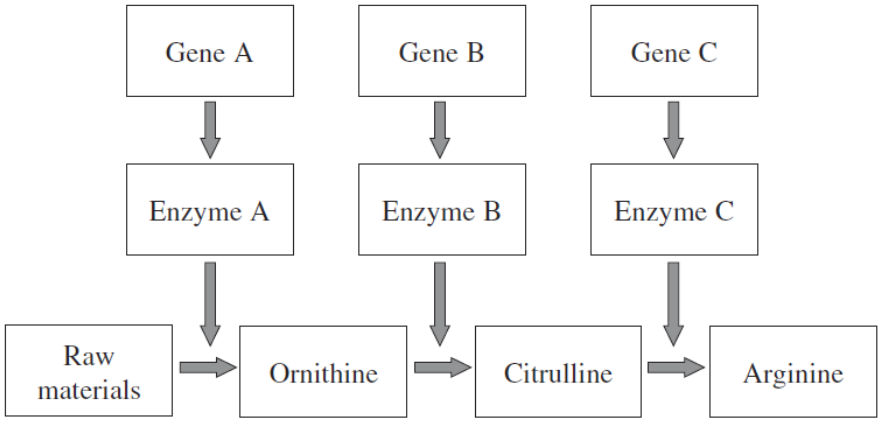
Evaluate the effects of mutation, gene flow and genetic drift on the gene pool of populations

IN ORDER TO ADDRESS THIS SECTION

- *Define mutation, gene flow, genetic drift and gene pool*
- *Describe how mutations change DNA sequences and polypeptides/proteins/characteristics*
- *Relate changes/mutations to natural selection - relate advantages and disadvantages of mutations to the gene pool of populations*
- *Explain how genetic drift affects the gene pool of populations*
  - *What are the advantages/disadvantages*
- *Explain how gene flow affects the gene pool of populations*
  - *What are the advantages/disadvantages*
- *Give a judgement (needs to be explicit) relating to the effect of these changes in populations*
  - *Provide evidence for your judgement*

Mod 6 – Question 1

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.

Mod 6 – Question 3

The following events occur after DNA is subjected to radiation. The events are listed in no specific order.

P: Mutation
Q: Change in cell activity
R: Change in protein structure
S: Change in polypeptide sequence

What is the correct sequence of steps?

A. P, Q, R, S

B. S, Q, P, R

C. S, R, Q, P

D. P, S, R, Q

Mod 6 – Question 4

Which of the following is true of a mutation that produces an allele that is dominant?

A. It would be expected to cause death.

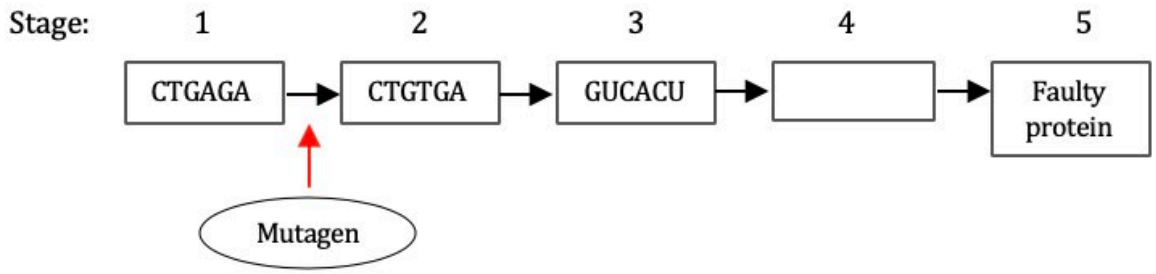
B. It could give an observable phenotype in a heterozygous genotype.

C. It could give an observable phenotype only in a homozygous genotype.

D. It would be expected to spread more quickly through a population than a recessive mutation.

Mod 6 – Question 8 (8 marks)

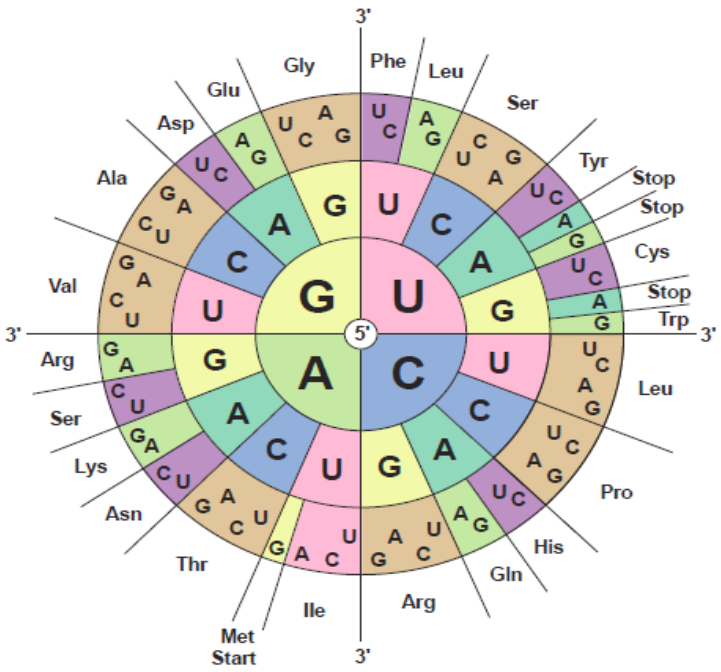
The flow chart illustrates the effect of a point mutation on an organism.



(a) Outline the series of events from stages 2 to 4 that resulted in the faulty protein. **3**

(b) Describe how a type of mutagen may have caused the changes observed in stage 2. **2**

(c) Given the information in the chart shown, describe the effect caused by the mutation in stage 4 and the effect this would have on the organism. **3**



Mod 6 – Question 9 (8 marks)

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

Question 26 (6 marks)

(a) Compare proteins and polypeptides. **2**

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(b) Antidiuretic hormone (ADH) is a protein produced by cells in the hypothalamus. The AVP gene codes for the production of ADH.

(i) Outline the steps to show how a mutation in the AVP gene could result in changes in the ADH protein. **3**

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(ii) Identify ONE possible effect of the AVP mutation on kidney function. **1**

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(b) The coding strand of some DNA is shown. It is part of a sequence that codes for a polypeptide. **4**

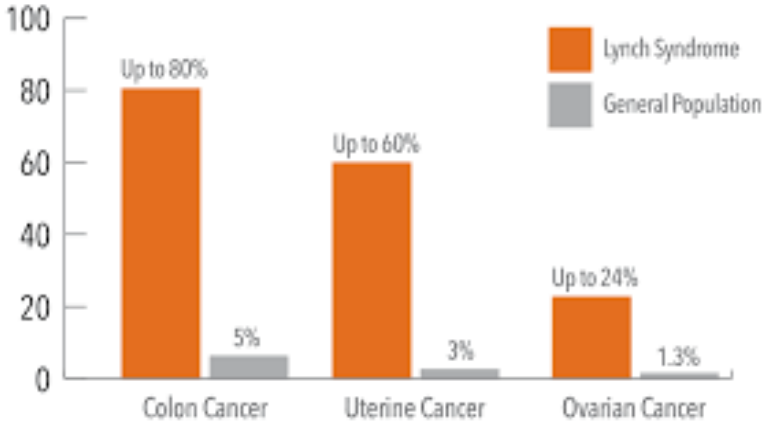
A T C A G T C G T A C G A T C G C A T A

Contrast the effect of a frameshift mutation with the effect of a base substitution mutation on the polypeptide produced from this sequence.

Question 33 (continued)

(c) Lynch syndrome is a condition that is the result of a mutation.

(i) The graph shows data comparing the lifetime risk of cancer in people with Lynch syndrome to that in the general population. **2**



Outline TWO trends shown in the graph for people with Lynch syndrome.

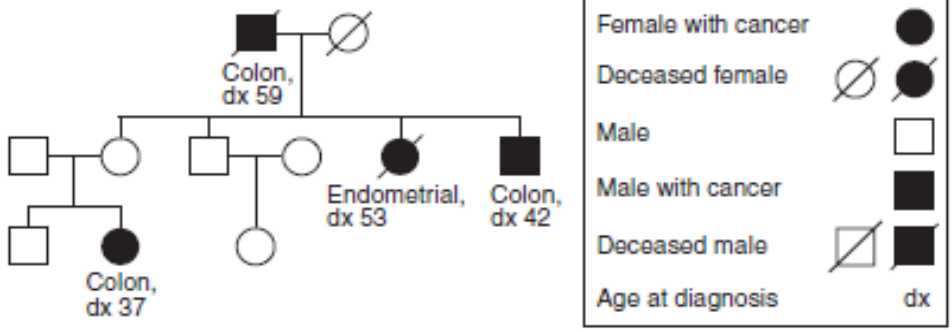
Question 33 continues on page 37

Question 33 (continued)

(ii) Lynch syndrome is an autosomal dominant condition that is the result of a mutation of a DNA repair gene. This mutation interferes with the ability of DNA to repair itself. **3**

The incidence of cancer in a family with Lynch syndrome is shown in the pedigree.

Incidence of cancer in a family with Lynch syndrome



'Lynch Syndrome Pedigree', 14 November 2014, from Genetics of Colorectal Cancers, 14 June 2018. Available at https://www.ncbi.nlm.nih.gov/books/NBK126744/figure/CDR0000062863_2756/
© National Cancer Institute

Analyse the disease pattern shown in the pedigree.

Answer parts (d) and (e) of the question on pages 6–8 of the Section II Writing Booklet. Start each part of the question on a new page.

Mutations and new alleles
marking criteria and sample answers

Question 8 (continued)

Mapping grid (a):

Content	Syllabus outcomes	Bands
Mod 6 Mutation	BIO12–4, BIO12–13	2–5

Marking guidelines (a):

Criteria	Marks
• Outlines the series of events from stages 2 to 4	3
• Outlines some events from stages 2 to 4	2
• Provides some relevant information	1

Sample answer:

Stage 2 represents the mutation that occurred in the DNA.

Stage 3 represents the transcription of the mutated DNA into RNA.

Stage 4 represents the translation of the RNA into a polypeptide chain that cannot be made into a functional protein.

Mapping grid (b):

Content	Syllabus outcomes	Bands
Mod 6 Mutation	BIO12–6, BIO12–13	2–4

Marking guidelines (b):

Criteria	Marks
• Describes how a type of mutagen may have caused the change in DNA	2
• Provides some relevant information	1

Sample answer:

A mutagen that may have caused the mutation in stage 2 is UV radiation. It has high energy photons that can cause the misalignment or change in the DNA when it is undergoing replication. In this case the mutation resulted in a substitution change, switching an adenine base for a thymine base.

Mapping grid (c):

Content	Syllabus outcomes	Bands
Mod 6 Mutation	BIO12–4, BIO12–6, BIO12–7, BIO12–13	2–5

Marking guidelines (c):

Criteria	Marks
• Describes the effect of the mutation on the polypeptide • Describes the effect that this change will have on the organism	3
• Outlines the effect of the mutation on the polypeptide and/or the effect that this change will have on the organism	2
• Provides some relevant information	1

Sample answer:

Stage 4 would have the Leu (Leucine) amino acid and a Stop codon. The original DNA strand had a Leu (Leucine) and an Arg (Arginine) amino acid. The Arg (Arginine) has been replaced with a STOP as a result of the mutation. This will cause the translation process to end, causing the polypeptide chain to terminate prematurely. This will result in an incomplete chain that cannot be made into a functional protein. The non-functioning protein has implications for the health of the organism.

Module 6 Question 9

Mapping grid:

Content	Syllabus outcomes	Bands
Mod 6 Mutation	BIO12–4, BIO12–6, BIO12–13	2–6

Marking guidelines:

Criteria	Marks
• Provides a comprehensive comparison • Shows a thorough understanding of the processes and effects of point mutations and chromosomal mutations • 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 • Includes examples of point mutations and/or chromosomal mutations	6–7
• Outlines some processes and/or effects of point mutations and chromosomal mutations • 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 make changes to DNA. They occur in 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.

Question 9 (continued)

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.

End of Question 9

Question 26 (a)

Criteria	Marks
• Provides similarities of and/or differences between proteins and polypeptides OR • Provides a similarity of and a difference between proteins and polypeptides	2
• Provides some relevant information	1

Sample answer:

Both proteins and polypeptides are composed of amino acids. Polypeptides, however, are single amino acid chains, whereas proteins are made up of one or more polypeptides.

Question 26 (b) (i)

Criteria	Marks
• Uses sequential steps to outline polypeptide synthesis • Relates mutation of AVP gene to change in ADH protein	3
• Outlines some aspects of polypeptide synthesis or mutation • Links mutation to change in ADH protein	2
• Provides some relevant information	1

Sample answer:

1. The base sequence of the AVP gene is altered.
2. The mRNA strand produced during transcription would not be correct.
3. At translation, incorrect amino acids would be delivered to the ribosome by tRNA.
4. An incorrect/dysfunctional/different polypeptide chain is produced.
5. The ADH protein is altered.

Question 26 (b) (ii)

Criteria	Marks
• Identifies an effect of AVP mutation on kidney function	1

Sample answer:

Less reabsorption of water (due to malfunction of ADH)

Question 33 (b)

Criteria	Marks
• Demonstrates an understanding of both types of mutation using the sequence provided • Contrasts the effect of each mutation on the polypeptide produced	4
• Demonstrates an understanding of both types of mutation using a specific sequence • Refers to polypeptide produced	3
• Outlines both types of mutation OR • Demonstrates an understanding of one type of mutation and its effect on the polypeptide produced	2
• Provides some relevant information	1

Sample answer:

Codons initially read as ATC, AGT, CGT, ACG, ATC, GCA.

A frameshift mutation could remove or insert one or more bases, leading to all codons after this point being altered.

Eg delete T (2nd from left)

Will now read ACA, GTC, GTA, CGA, TCG, CAT.

This would result in all amino acids being incorrectly coded for, resulting in a different polypeptide.

In contrast, a base mutation replaces just one base in 1 codon. One amino acid may be coded incorrectly. However, the rest of the amino acids in the polypeptide will remain correct.

Question 33 (c) (i)

Criteria	Marks
• Outlines TWO trends	2
• Provides some relevant information	1

Sample answer:

People with Lynch syndrome have an increased risk of developing every type of cancer compared to the general population.

The graph shows Lynch syndrome sufferers have the greatest difference in risk for colon and endometrial cancer compared to the general population.

Question 33 (c) (ii)

Criteria	Marks
• Analyses information to provide a detailed explanation of the disease pattern in the family	3
• Explains the disease pattern in the family	2
• Provides some relevant information	1

Sample answer:

People with Lynch syndrome have faulty DNA repair enzymes. Therefore they may not be able to repair random mutations leading to increased risk of cancer. The faulty allele is dominant, however, cancer may not develop. People inherit the allele that increases the risk of cancer eg individual colon dx 37 is likely to have the dominant allele and even though her mother does not show evidence for it, the allele may be present.

Module 6: IQ2 HSC style questions

Effect of genetic techniques on biodiversity

Investigate the uses and applications of biotechnology (past, present and future), including:

a. **analysing social implications and ethical uses of biotechnology, including plant and animal examples**
b. **researching future directions of the use of biotechnology**
c. **evaluating the potential benefits for society of research using genetic technologies**
d. **evaluating the changes to the Earth's biodiversity due to genetic techniques**

IN ORDER TO ADDRESS THIS SECTION

- *Define biotechnology*
- *Identify and describe applications of biotechnology (give plant and animal examples)*
    - *past e.g. selective breeding (corn, chicken), antimalarial drugs (cinchona plant) aquaculture (use by aboriginal people) , artificial pollination, bacterial fermentation of food (rice wine)*
    - *present - aquaculture, antibiotics (penicillin), bacterial fermentation on an industrial scale (alcoholic beverages) , genetic engineering (transgenic species-plant and animal examples) , biofabrication, stem cells*
    - *future - CRISPR (medicine and designer babies), 3D printing (larger scale)*
- *Define the term ethics*
- *Discuss (give points for and against) the use of biotechnology in plants and animals.*
- *Justify arguments for the use of biotechnologies in plants and animals*
- *Justify the arguments against the use of biotechnologies*
- *Justify (explain and give reasons for) the benefits to society for the continued research into genetic technologies*
    - *medical purposes (clinical trials for diseases such as cystic fibrosis, deletion of faulty genes)*
    - *effects on economy*
    - *effects on health care systems*
    - *effects on families living with genetic disorders*
- *discuss how biotechnologies have resulted in changes in the genomes of species*
    - *has it increased or decreased biodiversity?*
    - *effects in the short term and long term*
    - *give an explicit judgement as to the benefit or detriment of using biotechnologies to Earth's biodiversity- make sure to justify your judgement (support with evidence)*

Question 29 (6 marks)

'The application of modern reproductive techniques in plant and animal breeding limits genetic diversity.' **6**

Discuss this statement.

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Question 29

Criteria	Marks
• Describes a reproductive technique used in plant breeding • Describes a reproductive technique used in animal breeding • Provides arguments that these techniques limit genetic diversity • Provides an argument that these techniques do not limit genetic diversity	6
• Outlines a reproductive technique used in plant breeding and one used in animal breeding OR outlines one technique and identifies the other • Provides arguments that these techniques limit genetic diversity AND/OR provides an argument that these techniques do not limit genetic diversity	4–5
• Identifies a reproductive technique used in plant breeding AND/OR one used in animal breeding • Provides an argument that this technique limits genetic diversity AND/OR provides an argument that this technique does not limit genetic diversity	2–3
• Provides some information relevant to the question	1

Sample answer:

Artificial pollination is the transfer of pollen from the anther of one plant to the stigma of another. Artificial insemination is the collection of semen and its delivery into the reproductive system of a female, using equipment.

Both techniques can be used to increase the number of offspring that can be generated by one parent and therefore can result in decreased genetic diversity in the population. Other individuals in the population do not contribute to the next generation. For example semen from the same bull can be used to impregnate hundreds of cows, or pollen from one male flower is more likely to be transferred to a female flower.

However the reproductive techniques can both overcome geographical barriers and therefore allow genes to be spread more widely across the world. These techniques could increase genetic diversity by allowing interbreeding between geographically separated organisms, and generating new hybrids.

Answers could include:

Banks of sperm and pollen can be created to preserve endangered genes and allow them to be more prevalent in subsequent generations. This helps to prevent the loss of genetic diversity.

Module 6: IQ3 HSC style questions
Artificial manipulation of DNA and its effect on populations

Investigate the uses and advantages of current genetic technologies that induce genetic change

IN ORDER TO ADDRESS THIS SECTION

- *Include an aim, hypothesis and method for the investigation*
- *Name current genetic technologies (e.g. recombinant DNA technology, CRISPR)*
- *describe how each technology induces genetic change- what are the mechanisms involved in changing the DNA sequence of the select organisms*
- *describe the uses of each technology- for what purposes are these technologies used (beneficial to include several uses where possible)*
- *discuss the advantages of each technology*
    - *how does each technology benefit the organism/populations that it is changing?*

Compare the processes and outcomes of reproductive technologies, including but not limited to:

a. **artificial insemination**
b. **artificial pollination**

IN ORDER TO ADDRESS THIS SECTION

- *Draw a table (ideal)*
- *identify and outline features of processes of artificial insemination and artificial pollination (types of gametes, reproductive organs, method of transfer of gametes etc) (can be done on vertical or horizontal axis of graph)*
- *identify and outline outcomes of reproductive technologies (effects on gamete production, variation etc)*
- *identify specific examples of organisms used for these processes and for what reason*
- *show similarities and differences between the processes and outcomes of these technologies*

Investigate and assess the effectiveness of cloning, including but not limited to:

a. **whole organism cloning**
b. **gene cloning**

IN ORDER TO ADDRESS THIS SECTION

- *define the term cloning*
- *describe the process of whole organism cloning (in animals and plants)*
    - *Somatic cell nuclear transfer (dolly the sheep)*
    - *embryo splitting*
    - *tissue culture propagation in plants (wollemi pine)*
- *describe the effect of cloning of the genetic makeup of populations (short term and long term) - refer to biodiversity*
- *discuss the advantages and disadvantages of whole organism cloning in plants and animals -justify your arguments*
- *describe the processes involved in gene cloning (PCR, restriction enzymes, ligases etc)*
- *describe the effects of gene cloning of genetic makeup up of populations (short term and long term) - refer to biodiversity*
- *discuss the advantages and disadvantages of gene cloning in plants and animals-justify your arguments*
- *give an explicit judgement as to the effectiveness of cloning- is cloning a beneficial - JUSTIFY your judgement with evidence*

Describe techniques and applications used in recombinant DNA technology, for example:

- **the development of transgenic organisms in agricultural and medical applications**

IN ORDER TO ADDRESS THIS SECTION:

- *define recombinant DNA*
- *describe steps involved in producing transgenic species*
  - *ensure that you include terms such as restriction enzymes, sticky ends, ligases, plasmids, insertion techniques (gene guns, microinjection)*
- *give detailed examples of transgenic species used in agriculture*
  - *use plant and animal examples here (Bt corn and cotton, Aqua-advantage salmon etc)*
  - *describe the benefits of producing these organisms in agriculture*
- *give detailed examples of recombinant DNA technologies used in medical applications*
  - *gene therapy is good to use here (insertion of normal copies of genes into DNA of cells of individuals with genetic disorders e.g. cystic fibrosis), production of insulin for diabetics*

Evaluate the benefits of using genetic technologies in agricultural, medical and industrial applications

IN ORDER TO ADDRESS THIS SECTION

- *define biotechnology*
- *Identify and describe applications of genetic technologies used in agriculture (give plant and animal examples)*
    - *e.g. transgenic species (Bt corn and cotton, Aqua-advantage salmon)*
        - *describe the processes used to produce transgenic species*
        - *what are the BENEFITS of using these technologies in agriculture?*
- *include several benefits (to farmer, economy. environment etc)*
- *Identify and describe applications of genetic technologies used in medicine*
    - *e.g gene therapy, genetic screening (for cancers, genetic diseases etc), stem cell therapy, gene probes*
        - *describe the processes used in the application of these technologies*
        - *what are the BENEFITS of using these technologies in medicine (to individuals and their families, society, healthcare sectors etc)*
- *Identify and describe applications of genetic technologies used in industry*
    - *e.g biofuels, biopesticides, biomaterials (such as artificial valves, stents, joint replacements), biofabrication (printing of 3D organs and tissues)*
    - *describe the processes used in the application of these technologies*
        - *what are the BENEFITS of using these technologies in industry (to individuals and their families, society, healthcare sectors, government bodies etc)*
- *GIVE a JUDGEMENT regarding their benefits* ***(this is essential for a band 6 response)***
    - *this needs to be explicit- for example: the use of biofabrication in the production of tissues and organs using 3D printing is extremely beneficial in the medical industry as it helps to meet the needs of donated organs without the risks involved with tissue rejection*

Evaluate the effect on biodiversity of using biotechnology in agriculture

IN ORDER TO ADDRESS THIS SECTION

- *Define biotechnology, agriculture and biodiversity*
- *Give examples of biotechnology used in agriculture*
  - *Use plant and animal examples (recombinant DNA technologies, selective breeding, cloning)*
  - *describe the processes involved in the techniques described AND the resulting offspring*
    - *are they similar or different to the wild type?*
- *Discuss the benefits and limitations of the use of this biotechnology in agriculture?*
- *Explain the effect that these biotechnologies have on biodiversity*
  - *should refer to the short term (in most cases increases biodiversity) effects AS WELL AS the long term (reduces biodiversity) effects on biodiversity*
- *Give a judgement (needs to be explicit) regarding the use of biotechnology on biodiversity- Support your judgement with evidence.*

Interpret a range of secondary sources to assess the influence of social, economic and cultural contexts on a range of biotechnologies

IN ORDER TO ADDRESS THIS SECTION

- *relate knowledge and understanding to secondary sources - important to use information from data presented in order to access BAND 6 response*
- *define biotechnology*
- *describe detailed examples of biotechnologies used for a variety of purposes (agriculture, medicinal)*
- *justify the social influences of uses of specific biotechnologies*
    - *specific needs of society (is it really targeted in this way?)*
    - *choices made by government*
    - *SES of individuals*
    - *SES of country*
    - *cohorts used for clinical trials (are these biased?)*
- *justify the economic influences of uses of specific biotechnologies*
    - *patents on technologies (control of access and costs)*
    - *unequal access (SES)*
    - *cost to consumers (agriculture-access to food)*
- *justify the cultural contexts of uses of specific biotechnologies*
    - *religious beliefs and uses of technologies*
    - *moral beliefs (vegans, vegetarians)*
    - *educational background (accept or reject use of biotechnologies)*

Question 33

(c) Explain why the domestication of species for agriculture is described as a biotechnology. In your answer, refer to ONE specific domesticated organism. **4**

Question 33 (c)

Criteria	Marks
• Demonstrates a thorough understanding of biotechnology • Explains the process of domestication of species for agriculture • Describes the specific traits selected for an identified domesticated plant or animal used in agriculture • Relates the processes of domestication to aspects of biotechnology	4
• Demonstrates an understanding of biotechnology • Describes the process of domestication of species for agriculture • Describes a specific improved characteristic in the domesticated species OR • Demonstrates a thorough understanding of biotechnology • Describes the process of domestication of species for agriculture • Relates the process of domestication to aspects of biotechnology	3
• Outlines the process of domestication of species and identifies a specific improved characteristic in the domesticated species OR • Demonstrates an understanding of biotechnology and identifies a specific improved characteristic in the domesticated species OR • Demonstrates a thorough understanding of biotechnology and explains the process of domestication of species for agriculture	2
• Provides some information relevant to the question	1

Sample answer:

Biotechnology is the use of biological processes, organisms or systems to manufacture useful products to improve the quality of human life.

Domestication of species for agriculture was achieved by selective breeding (a biological process) of organisms to achieve favourable traits in offspring (useful product). Organisms with unfavourable traits were culled. In general terms this increased farm yields and reduced hunger within human populations (quality of life).

For example artificial selection of wild grasses (organisms) for non-brittle seed heads allowed for larger crop yields. Seeds were not lost from the plant during harvesting. Selection of plants with larger seeds also increased the food value of each grain harvested. These two new traits made the now domesticated grasses (wheats) useful and abundant food products.

Question 33

(e) 'Science is used to solve problems for the benefit of society.' **7**

Justify this statement with reference to the scientific knowledge behind DNA technology, using ONE example from medicine and ONE from forensics.

Question 33 (e)

Criteria	Marks
• Demonstrates a thorough understanding of DNA technology • Identifies a medical condition which can be solved with a DNA/medical technology • Describes the scientific knowledge behind this named technology • Explains a benefit to society of using the technology in this medical setting • Describes a forensic setting in which a DNA technology can be used to solve a problem • Describes the scientific knowledge behind this named technology • Explains the benefits to society of using the technology in this forensic setting	7
• Demonstrates a sound understanding of DNA technology • Identifies a medical condition which can be solved with a DNA/medical technology • Describes the scientific knowledge behind this named technology • Identifies a benefit to society or an individual of using the technology in this medical setting • Describes a forensic setting in which a DNA technology can be used to solve a problem • Describes the scientific knowledge behind this named technology • Identifies a benefit to society or an individual of using the technology in this forensic setting	5–6
• Demonstrates some understanding of DNA technology AND • Identifies a medical condition which can be solved with a DNA/medical technology • Describes the scientific knowledge behind this technology • Identifies a benefit of using the technology in this medical setting OR • Describes a forensic setting in which a DNA technology can be used to solve a problem • Describes the scientific knowledge behind this technology • Identifies a benefit of using the technology in this forensic setting	3–4
• Identifies a medical condition which can be solved with a DNA/medical technology • Outlines the scientific knowledge behind this technology • Identifies a benefit OR • Identifies a forensic setting in which a DNA technology can be used to solve a problem • Outlines the scientific knowledge behind this technology • Identifies a benefit	2

OR • Identifies a medical AND a forensic setting which can be solved with a DNA/medical technology • Identifies a benefit	
• Provides information relevant to the question	1

Sample answer:

DNA technologies: Manipulation of DNA for useful purposes

Examples

Medicine

The treatment of diabetics with mass-produced insulin. This insulin is produced using genetic engineering and large-scale fermentation.

Forensics

DNA fingerprinting can be used to compare genetic samples gathered from crime scene and suspects. In this way police can both eliminate suspects and confirm criminals.

Science behind the technologies

Medicine

Normal genes for insulin are isolated from cells of a healthy individual using restriction enzymes. These genes are spliced into bacterial DNA using DNA ligase, and the hybrid bacteria are mass cultured to produce insulin.

Forensics

Restriction enzymes are used to cut gene sequences from crime scene samples. They are loaded onto gel electrophoresis equipment, along with the same genes from other samples. The genes traverse the gel at different rates providing a pattern of bands. Matching bands between samples can prove they are from the same source.

Solving problems of benefits to society

Medicine

A cheap and safe treatment for diabetics allows them to fully participate in society and in the workplace.

Forensics

This prevents innocent people from being wrongly incarcerated and allows them to participate fully in society. It also allows some crimes to be solved which were previously unsolved.

Mod 6 – Question 10 (6 marks)

'The application of reproductive technologies in plant and animal breeding limits genetic diversity.' **6**

To what extent is this statement correct?

Mapping grid:

Content	Syllabus outcomes	Bands
Mod 6 Biotechnology Mod 6 Genetic Technologies	BIO12–6, BIO12–7, BIO12–13	2–6

Marking guidelines:

Criteria	Marks
• Makes an informed judgement about the correctness of the statement • Shows comprehensive understanding of genetic diversity and the application of reproductive technologies in plant and animal breeding • Shows a clear connection between genetic diversity and the application of reproductive technologies in plant and animal breeding	6
• Makes a judgement about the correctness of the statement • Shows thorough understanding of genetic diversity and the application of reproductive technologies in plant and animal breeding • Shows a connection between genetic diversity and the application of reproductive technologies in plant and animal breeding	5
• Shows a sound understanding of genetic diversity and the application of reproductive technologies in plant and animal breeding • Makes a link between genetic diversity and the application of reproductive technologies in plant and animal breeding	4
• Shows some understanding of genetic diversity and/or reproductive technologies	2–3
• Provides some relevant information	1

Sample answer:

Artificial pollination is the transfer of pollen from the anther of one plant to the stigma of another. Artificial insemination is the collection of semen and its delivery into the reproductive system of a female, using equipment.

Both technologies can be used to increase the number of offspring with the desired characteristics that can be generated by one parent and therefore can result in decreased genetic diversity in the population. Other individuals in the population do not contribute to the next generation. For example semen from the same bull can be used to impregnate hundreds of cows, or pollen from one male flower is more likely to be transferred to a female flower.

However, reproductive technologies can overcome geographical barriers and therefore allow genes to be spread more widely across the world. These techniques could increase genetic diversity by allowing interbreeding between geographically separated organisms, and generating new hybrids.

Answers could include:

Banks of sperm and pollen can be created to preserve endangered genes and allow them to be more prevalent in subsequent generations. This helps to prevent the loss of genetic diversity.

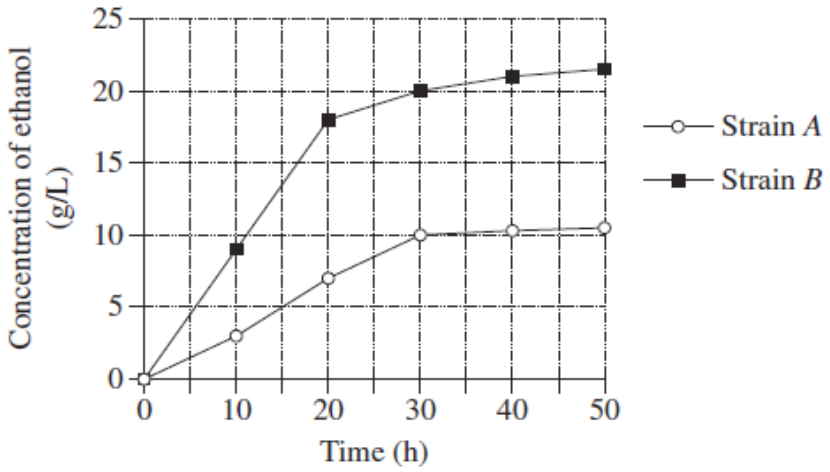
Mod 6 – Question 11 (5 marks)

The yeast *Saccharomyces cerevisiae* cannot naturally ferment the sugar xylose. Low value biomass, such as straw and wood fibres, contains up to 20% xylose. *S. cerevisiae* was modified to enable it to produce ethanol from xylose. Information on the two species involved in making the modified *S. cerevisiae* is shown in the table.

Type of organism	*Species*	*Relevant reaction*	*End product*
Bacteria	*Burkholderia cenocepacia*	Utilises xylose in metabolism	Fructose
Yeast	*Saccharomyces cerevisiae*	Utilises fructose in metabolism	Ethanol

(a) Explain why biotechnology was needed to modify *S. cerevisiae*. **2**

(b) Two strains of genetically modified *S. cerevisiae* were produced. The two strains were compared under the same conditions. The results are shown. **3**



Justify which of these two strains would be better to use to produce commercial quantities of ethanol using low value biomass. In your answer, refer to information from the graph.

Question 11 continues on page 46

Question 11 (continued)

Mapping grid (a):

Content	Syllabus outcomes	Bands
Mod 6 Biotechnology Mod 6 Genetic Technologies	BIO12–5, BIO12–6, BIO12–13	4–6

Marking guidelines (a):

Criteria	Marks
• Relates the use of biotechnology to crossing the species barrier	2
• Provides some relevant information	1

Sample answer:

The organisms are from different genera so genetic material is not usually transferred between them. The desired genetic material is cut out from the bacteria and inserted into the yeast genome.

Mapping grid (b):

Content	Syllabus outcomes	Bands
Mod 6 Genetic Technologies	BIO12–5, BIO12–6, BIO12–7, BIO12–13	3–6

Marking guidelines (b):

Criteria	Marks
• Justifies why one of the strains is more suitable to use, with reference to information from the graph • Links the justification to commercial operation	3
• Identifies the strain more suited • Outlines why the strain chosen is preferred, based on information from the graph	2
• Provides some relevant information	1

Sample answer:

Strain *B* would be the better strain to use. Strain *B* has a higher rate of ethanol production than Strain *A*. The graph shows that Strain *B* consistently produced significantly more ethanol than Strain *A*. For example, at time 30 hours, Strain A produced 10 g/L concentration of ethanol and Strain B produced 20 g/L concentration of ethanol. This means the strain is more efficient and, for the production of commercial quantities, more ethanol will be produced within a given time frame.

Mod 6 – Question 13 (4 marks)

Draw a flow chart showing the sequence of events that results in the formation of recombinant DNA. **4**

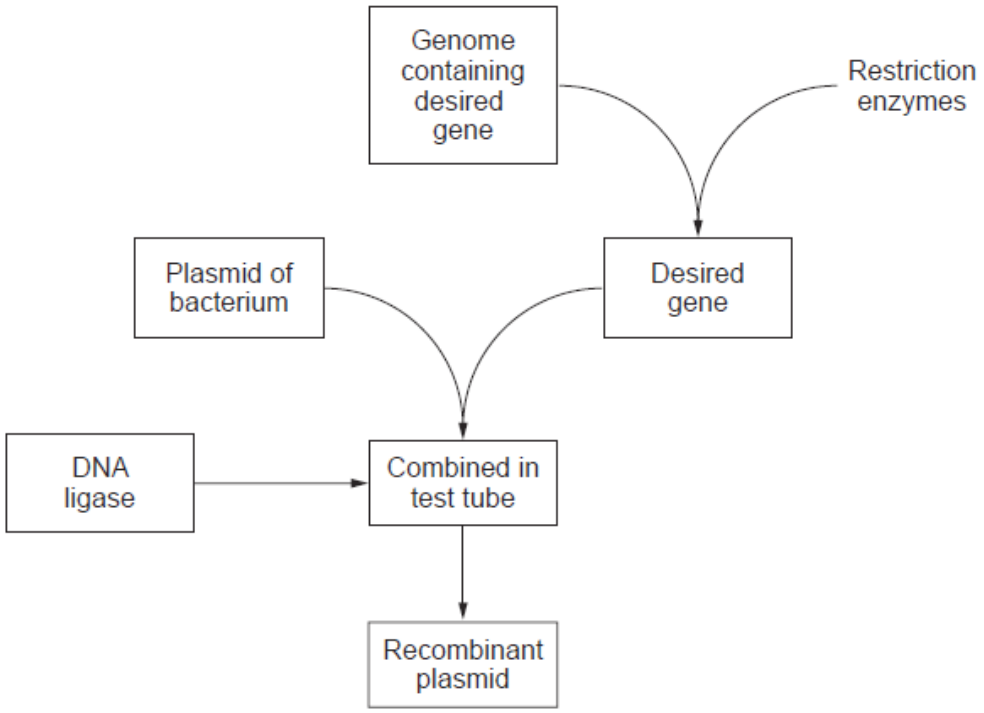
Mapping grid:

Content	Syllabus outcomes	Bands
Mod 6 Genetic Technologies	BIO12–4, BIO12–5, BIO12–7, BIO12–13	2–6

Marking guidelines:

Criteria	Marks
• Draws a flow chart that clearly shows the sequence of events in the formation of recombinant DNA	4
• Draws a substantially correct flow chart	3
• Shows some steps in the formation of recombinant DNA	2
• Provides some relevant information	1

Sample answer:



Mod 6 – Question 14 (7 marks)

Describe how technological developments led to the advancement of our knowledge and understanding of inheritance. Support your answer with examples. **7**

Mapping grid:

Content	Syllabus outcomes	Bands
Mod 5 Heredity Mod 6 Genetic Technologies	BIO12–5, BIO12–6, BIO12–7, BIO12–12, BIO12–13	2–6

Marking guidelines:

Criteria	Marks
• Shows a comprehensive understanding of how technological developments led to the advancement of knowledge and understanding of inheritance • Supports answer with examples	7
• Identifies relevant technological developments • Describes their contributions to knowledge and understanding of inheritance • Shows a sound understanding of the knowledge and understanding before and after the technological developments • Supports answer with examples	6
• Identifies relevant technological developments • Outlines their contributions to knowledge/understanding of inheritance • Shows some understanding of the knowledge/understanding before and after the technological developments • Supports answer with an example	4–5
• Identifies a technological development • Outlines its contribution(s) to knowledge/understanding of inheritance	2–3
• Provides some relevant information	1

Answers could include:

- Artificial pollination – Mendel's Laws
- Microscopy and staining – behaviour of chromosomes – work of Sutton and Boveri
- X-ray crystallography – structure of DNA – work of Rosalind Franklin
- Use of isotopes – show semi-conservative DNA replication – work of Meselson and Stahl
- Radiation – one gene, one polypeptide – work of Beadle and Tatum
- Gene manipulation
- Gene editing – CRISPR.

Mod 6 – Question 12 (5 marks)

A woman recently conceived a baby guaranteed to be free from hereditary breast cancer. Doctors screened for an embryo that was free from a gene that can cause breast cancer.

The screening was performed due to the long history of this form of cancer in the family and the fact that any daughter born with the gene would have a 50–80% chance of developing breast cancer.

(a) Explain the possible impact of this reproductive technology on the genetic composition of the population. **2**

(b) Discuss the use of this genetic technology in the treatment of medical conditions. **3**

Mapping grid (a):

Content	Syllabus outcomes	Bands
Mod 6 Biotechnology	BIO12–5, BIO12–6, BIO12–13	4–6

Marking guidelines (a):

Criteria	Marks
• Correctly relates use of the reproductive technology to changes in the genetic composition of the population	2
• States ONE possible impact of the reproductive technology on the genetic composition of the population	1

Sample answer:

In the long term, the gene which has a higher chance of developing breast cancer will become less common in the population, as the gene is selected against. So, fewer people will suffer breast cancer and because fewer people will have the gene, their offspring are also more likely not to have the gene.

Question 12 (continued)

Mapping grid (b):

Content	Syllabus outcomes	Bands
Mod 6 Genetic Technologies	BIO12–5, BIO12–6, BIO12–7, BIO12–13	3–6

Marking guidelines (b):

Criteria	Marks
• Identifies issues associated with the use of the genetic technology • Provides points for and/or against the use of the genetic technology	3
• Outlines issue(s) associated with the use of the genetic technology	2
• Provides some relevant information	1

Sample answer:

Genetic technologies may reduce the number of people suffering from certain medical conditions, enable them to increase their contribution to society and reduce the medical costs of treatment. This technology may also have some undesired effects.

If pre-fertilisation genetic manipulation were to become more widespread, it would affect human evolution, as genomes could be chosen and manipulated. Insurance companies may insist on genetic screening before they would insure and vary insurance conditions according to the results of the screening.

Ethical guidelines concerning genetic manipulation must be made clear and adhered to so that personal choice and liberties are not compromised by government or corporations, for this type of genetic manipulation to result in real positive outcomes.

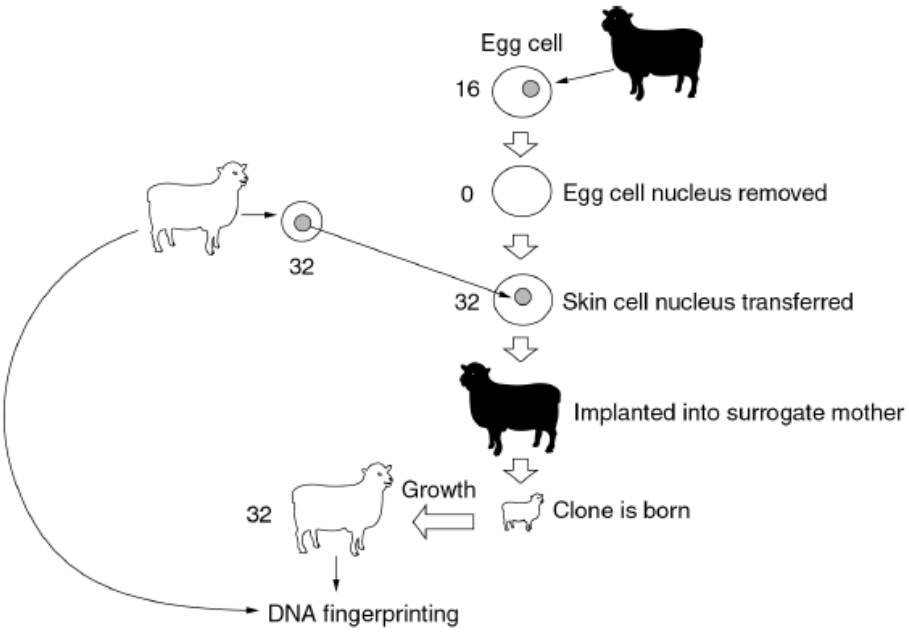
End of Question 12

(d) Construct a flow chart to show how an animal with a diploid number of 32 chromosomes can be cloned and how the clone can be verified. Include reference to chromosome number in each step. **5**

Question 33 (d)

Criteria	Marks
• Constructs a clear flow chart that includes the key steps in animal cloning and suitable method of verification • Includes chromosome number at each step	5
• Constructs a clear flow chart that includes most of the steps in animal cloning • Includes chromosome number at each step • Provides a suitable method of verification	4
• Constructs a clear flow chart that includes some suitable steps in animal cloning • Attempt to provide a suitable method of verification	3
• Provides some steps in animal cloning	2
• Provides relevant information	1

Sample answer:



(e) Transgenic mice can be used as models to study human diseases such as muscular dystrophy, a condition caused by sex-linked mutation. These mice have been genetically modified and cloned, resulting in a population with the disease.

7

Explain how developments in our understanding of genes and gene technologies have led to the use of such models to study human disease.

Question 33 (e)

Criteria	Marks
• Demonstrates a thorough knowledge of genes and genetic manipulation • Relates an understanding of genes, mutations and developments in gene technologies to the production and use of mouse models • Demonstrates coherence and logical progression of ideas	7
• Demonstrates a sound knowledge of genes and genetic manipulation • Links an understanding of genes, mutations and developments in gene technologies to the production and use of mouse models	6
• Demonstrates a sound knowledge of genes and genetic manipulation • Links an understanding of developments in gene technologies to the production and/or use of mouse models	4–5
• Demonstrates some knowledge of genes and gene technologies AND/OR • Links an understanding of gene technologies to the use of mouse models	2–3
• Provides some relevant information	1

Sample answer:

Our knowledge of mutations and their effect on cell function was developed by Beadle and Tatum with experiments on bread mould showing that particular genes code for particular polypeptides. This has led to an increased understanding of the effect of mutation eg muscular dystrophy (MD) on human health.

The search for mutations that caused diseases led to the development of the HGP. It aimed to establish the sequence of the human genome and the identification and the location of all of the genes. Thus scientists could identify the MD gene and cut it out of the human genome and insert it into bacterial plasmids using DNA recombinant technology and thus producing multiple copies. Without identifying the location and size of the genes in the HGP this process of genetic engineering to produce transgenic species would not be possible.

Transgenic mice are created by inserting the MD gene into the mouse genome. This allows the crossing of the species barrier incorporating the human gene into the mouse genome. The mouse can then be cloned and the population will contain this MD gene. This allows the MD mutation to be expressed in the mouse which provides a useful model for the study of characteristics and potential treatments of the disease.

By using the mouse model, scientists could see the effect of the gene for MD in mice and then look for potential ways of treating the disease by such measures as gene therapy or medical research. This may allow scientists to insert a gene into a patient's cells instead of using drugs or surgery.

Module 7

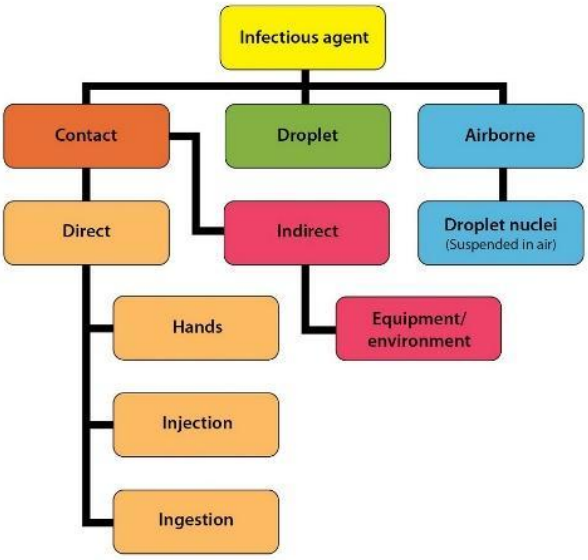
Outcomes

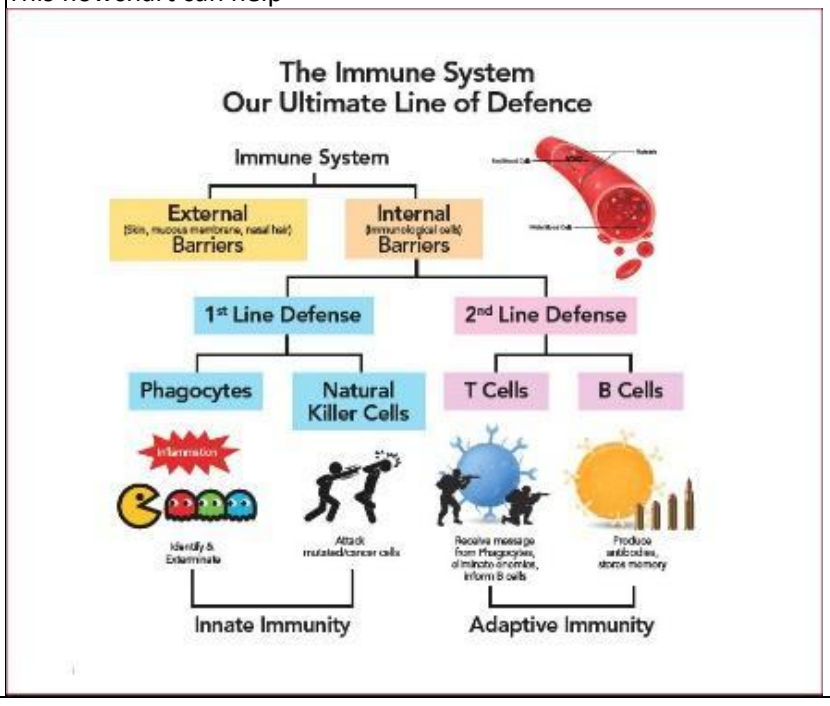
A student:

- develops and evaluates questions and hypotheses for scientific investigation BIO11/12-1
- designs and evaluates investigations in order to obtain primary and secondary data and information BIO11/12-2
- conducts investigations to collect valid and reliable primary and secondary data and information BIO11/12-3
- selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media BIO11/12-4
- analyses infectious disease in terms of cause, transmission, management and the organism's response, including the human immune system BIO12-14

Module concept map

Content

Causes of Infectious Disease	*How to address the inquiry question and content statements*
Inquiry question: How are diseases transmitted?	Define disease – condition that impairs normal function of an organisms Define infectious disease – they are caused by a pathogen and can be transmitted from one host to another Explain transmission – direct and indirect contact between host and pathogen
● describe a variety of infectious diseases caused by pathogens, including microorganisms, macroorganisms and non-cellular pathogens, and collect primary and secondary-sourced data and information relating to disease transmission, including: (ACSBL097, ACSBL098, ACSBL116, ACSBL117)	Create a table with this statement using this headings: Pathogen/description of pathogen/infection to plant or animals/transmission/examples
– classifying different pathogens that cause disease in plants and animals (ACSBL117)	Create a table with this statement
– investigating the transmission of a disease during an epidemic	Choose ONE disease: e.g flu, smallpox. Define epidemic as the rapid spread of an infectious disease to a large number of people in a particular area in a very short period of time Define pandemic – epidemic that spread outside the boundaries of the original epidemic area and to other areas. Factors: Presence of continual source of the disease and ease spread of the pathogen (high virulent rate)
– design and conduct a practical investigation relating to the microbial testing of water or food samples	Follow the plan scaffold in the appendix of this booklet: Write the inquiry question, aim, hypothesis, materials, risk assessment, procedure, results, discussion and conclusion.
– investigate modes of transmission of infectious diseases, including direct contact, indirect contact and vector transmission	Create a flow chart For example: 
● investigate the work of Robert Koch and Louis Pasteur, to explain the causes and transmission of infectious diseases, including:	Focus on the verb investigate and follow the scaffold in the appendix to complete the investigation using secondary or primary data collection

– Koch's postulates	Koch investigation – hypothesis, design, plan, results, conclusions Current applications Koch put together a set of steps to follow to identify that a particular organism is the cause of a particular disease.
– Pasteur's experiments on microbial contamination	Pasteur investigation – hypothesis, design, plan, results, conclusions Pasteur explained that bacteria and mould can cause contamination and consequently disease.
• assess the causes and effects of diseases on agricultural production, including but not limited to:	Focus on the verb assess, learn more than one disease for plants and animals in agriculture
– plant diseases	Causes – fungus, bacteria and virus, usually bacteria and virus are transmitted to plants by vectors (insects), insect infestations Effects: loss of crop yields, financial loses, reduce sales locally and internationally, expenses to control and treatment of the disease Learn an example/case study
– animal diseases	Causes – fungus, bacteria and virus Effects: loss of livestock, financial losses, reduced exports, expenses to control and treatment of diseases. Learn an example/case study
• compare the adaptations of different pathogens that facilitate their entry into and transmission between hosts (ACSBL118)	Create a table with pathogens and compare the entry to plant and animals: e.g. adaptations of virus to entry in plants and animals
Responses to Pathogens	
Inquiry question: How does a plant or animal respond to infection?	Define innate and acquired immune response. This flowchart can help 

• investigate the response of a named Australian plant to a named pathogen through practical and/or secondary-source investigation, for example:	Focus on the verb investigate and follow the scaffold in the appendix to complete the secondary source investigation for this content statement. Plants have an innate response to pathogens, they have co-evolved with vectors (usually insects and animals) to avoid the entry of pathogens, e.g. spikes, thick epidermis, 'fury' leaves. Plants have developed chemical innate barriers such as toxic oils for vectors and animals. Plants have an induced response too, called hypersensitive response in which the formation of chemicals are triggered or the formation of barriers zones to isolate the affected area to be in contact with the vascular system. Choose ONE from below, viral or fungus.
– fungal pathogens	Choose an Australian plant and a fungus
– viral pathogens	Choose an Australian plant and a virus – e.g. banana
• analyse responses of animals to pathogens by assessing the physical or chemical changes that occur in the cells and tissues of animals in the presence of pathogens (ACSBL119, ACSBL120, ACSBL121, ACSBL122)	Focus on the verb assess to answer this content statement. Explain all the physical and chemical changes to pathogens: first and second line of defence and then assess those responses to destroy the pathogen and avoid further infection in the animal.
Immunity	
Inquiry question: How does the human immune system respond to exposure to a pathogen?	Define innate and acquired immune response. Explain in detail the three lines of defence and the interaction between T and B cells in the humoral and cellular response. It will be practical to create a flowchart with this content statement.
• investigate and model the innate and adaptive immune systems in the human body (ACSBL119)	It does not matter what model you did in class, the importance is that you follow the investigation steps and you assess the model for validity.
• explain how the immune system responds after primary exposure to a pathogen, including innate and acquired immunity	This refers to a cause and effect: Cause – pathogen invasion Effect – trigger the immune response, innate and acquired Explain all the features and processes for the response for both innate and acquired immunity There are really good flow charts and interactive websites about this on the internet. Identify that acquired immunity can be created artificially by the use of vaccines.
Prevention, Treatment and Control	
Inquiry question: How can the spread of infectious diseases be controlled?	Explain all the measurements that are used to control the spread of diseases: hygiene practices, quarantine, use of pesticides, educational programs, vaccination programs, use of pharmaceuticals, genetic engineering.
• investigate and analyse the wide range of interrelated factors involved in limiting local, regional and global spread of a named infectious disease	Learn ONE infectious disease to answer this content statement as a case study, e.g. Factors are: Mode of transmission, pathogen reproductive/replication cycle, setting in which the disease is (socio-economic areas, animal husbandry practices, place ecology), population susceptibility, transmission patterns. To limit the spread of the disease at different levels:

	Local – hygiene practices, potable water, public health responses Regional – quarantine procedures and surveillance Global – trade and travel restrictions to infected areas, public awareness campaigns.
• investigate procedures that can be employed to prevent the spread of disease, including but not limited to: (ACSBL124)	Create a table with ALL of the procedures listed. The verb is investigate, so plan a secondary research investigation and draw conclusions for each of the procedures on how to avoid the spread of disease

– hygiene practices	Describe the hygiene practices, e.g wash hands, drink potable water
– quarantine	Restrictions to travel to infected areas or Isolation of infected individuals, e.g. equine flu (Hendra virus)
– vaccination, including passive and active immunity (ACSBL100, ACSBL123)	e.g. vaccination programs across the entire population since people are born and systematically done until adolescence vaccination campaigns vaccines in the case of travelling overseas
– public health campaigns	Health promotion information, vaccination advertising, e.g. current flu vaccine
– use of pesticides	Control of vectors and insects infestations in animals and plants.g. Malaria control using insecticides to kill sources of mosquitos
– genetic engineering	Engineer the genes of vectors, e.g. Malaria
• investigate and assess the effectiveness of pharmaceuticals as treatment strategies for the control of infectious disease, for example:	Focus on the verb investigate and assess the effectiveness, this means how well those pharmaceuticals work to treat and control the spread of diseases. Effectiveness refer to how well those strategies control disease by reducing morbidity (new cases) and mortality (deaths) Explain resistant to the drugs. Learn well ONE of the following
– antivirals	Flu vaccines, treatment of HIV
– antibiotics	Penicillin and similar antibiotics
• investigate and evaluate environmental management and quarantine methods used to control an epidemic or pandemic	Focus on the verb evaluate to make a judgement to determine how effective the management and control was based on criteria. First step is to quickly identify, contain and control the source of the disease. Follow quarantine protocols of isolation or limited contact, some extreme measurements would destroy all the diseased animals and plants. Spray areas with pesticides and vaccinate all the population in the affected area.
• interpret data relating to the incidence and prevalence of infectious disease in populations, for example:	Define incidence (number of new cases) and prevalence (number of cases at a given time) of a disease Use a data set to reach conclusions, analyse graphs and tables. Learn ONE example below.
– mobility of individuals and the portion that are immune or immunised (ACSBL124, ACSBL125)	Mobility influences the incidence and prevalence of disease by being in contact with other individuals and spreading the disease. Today, humans and livestock has a high level of movement across areas
– Malaria or Dengue Fever in South East Asia	Malaria - a protozoan disease Dengue - a viral disease Data source for those diseases: World Health Organisation, Australian Bureau of Statistics, Malaria, ourworldindata.org
• evaluate historical, culturally diverse and current strategies to predict and control the spread of disease (ACSBL125)	Focus on the verb evaluate to make judgements about models and systems and how well those help to predict and control the spread of disease. Create a timeline with the strategies from ancient cultures to today. Compare different cultural practices to control disease. Current strategies are simulation models, education campaign, surveillance systems in country borders, data analysis and storage
• investigate the contemporary application of Aboriginal protocols in the development of	Focus on intellectual property and the protection and protocols followed to develop medicines (Be aware of bias websites)

particular medicines and biological materials in Australia and how recognition and protection of Indigenous cultural and intellectual property is important, for example:	Aboriginal traditional knowledge about medicines and biological materials to control and treat disease is based in distinct systems of knowledge, innovation and trial and error practices. Protocols refer to ways of behaving, communicating and showing respect for Aboriginal culture and knowledge of Country and Place. There are established partnerships with some Aboriginal communities and industries to the production of pharmaceuticals based on medicinal plants. Good source of information: Australian Institute of Aboriginal and Torres Strait Island Studies https://aiatsis.gov.au/ Learn well ONE of the examples below
– bush medicine	This is an ABC site related to bush medicine and indigenous protocols https://www.abc.net.au/illawarra/topics/community-and-society/indigenous-aboriginal-and-torres-strait-islander/indigenous-protocols/
– smoke bush in Western Australia	https://www.researchgate.net/publication/324082590_From_Smokebush_to_Spinifex_Indigenous_traditional_knowledge_and_the_commercialisation_of_plants

Exam questions related to Module 7

Multiple choice questions

Exam paper 2019

1 Which of the following is an example of a non-infectious disease?

A. Polio caused by a virus
B. Cholera caused by a bacterium
C. Wheat rust caused by a fungus
D. Haemophilia caused by a gene mutation

2 What does the body produce in response to a vaccine?

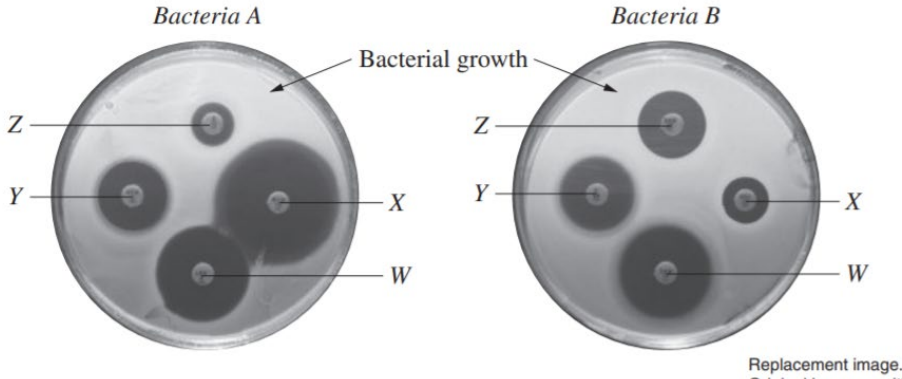
A. Antigens
B. Antibiotics
C. Antibodies
D. Activated toxins

5 Which of the following is part of the innate immune response?

A. Antibodies
B. Phagocytes
C. Stomach acid
D. B lymphocytes

7 Two types of bacteria were isolated from a patient's throat swab and grown in pure culture on separate agar plates. On each plate there were FOUR different antibiotic discs, *W*, *X*, *Y* and *Z*.

The photograph shows the plates seven days later.



Replacement image.
Original image awaiting copyright.
http://www.bacteriainphotos.com/disk%20diffusion%20testing.html

Which antibiotic should be used to treat the patient?

A. *W*
B. *X*
C. *Y*
D. *Z*

10 A group of islands are separated from each other by large stretches of water. Each island has its own policy on quarantine.

A nearby country is experiencing an outbreak of an infectious disease in its cattle.

An investigation is to be designed to find which of the quarantine policies operating on the islands is the most effective.

Which of the following would be a suitable design feature of the investigation?

A. The control is the smallest island.
B. The control is the number of infected cattle.
C. The independent variable is quarantine policy.
D. The independent variable is the number of infected cattle.

Previous exams - sample paper

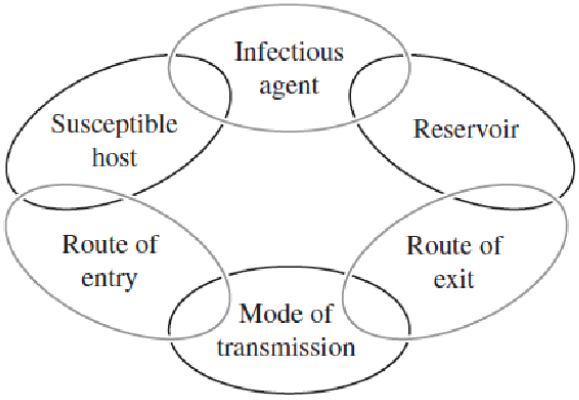
Mod 7 – Question 1

All pathogens can be described as

A. infectious.
B. macroscopic.
C. microscopic.
D. viral.

Mod 7 – Question 2

The diagram shows a model of disease transmission.



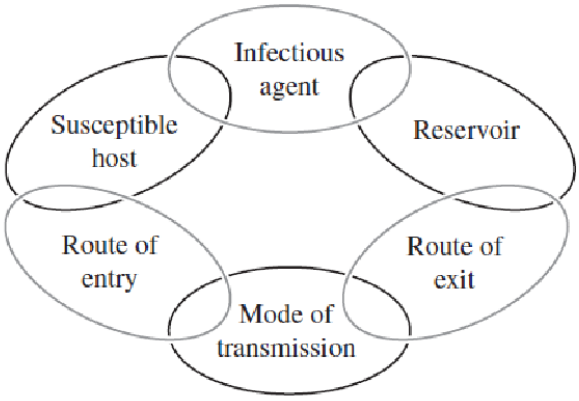
A pathogen was identified as being unadapted to dry conditions and as having the gastrointestinal tract as the 'route of entry' and the 'route of exit'.

Using this information, what is the most likely mode of transmission?

A. Skin to skin contact
B. Coughing or sneezing
C. Contaminated water supplies
D. Transmission of infected blood products

Mod 7 – Question 3

The diagram shows a model of disease transmission.



An epidemiologist suspected that bats were acting as a reservoir for an infectious disease in humans.

Which condition would need to be met to confirm the epidemiologist's suspicion?

A. The infectious agent would need to have a mode of entry into humans.

B. The infectious agent would need a mode of transmission from bats to humans.

C. The bats would have to be able to transmit the infectious agent between each other.

D. The susceptible human host must be able to transmit the infectious agent to the reservoir of bats.

Mod 7 – Question 4

The runny nose and coughing that is symptomatic of having a cold is an example of the body's response to a pathogen.

How does this response protect the body?

A. By heating the body to try to kill the virus

B. By trying to spread the virus to other people

C. By preventing the virus from entering the body

D. By attempting to rapidly expel the virus from the airways

Mod 7 – Question 5

When a foreign body breaches the first line of defence the mast cells produce histamines in response.

What is the role of histamines in the defence of the body?

A. To attack the invading pathogen

B. To activate B and T lymphocytes of the specific immune response

C. To activate the inflammation response and increase blood flow to the affected area

D. To retain information on a pathogen's antigen so that the immune system can respond quickly to any subsequent infection

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.

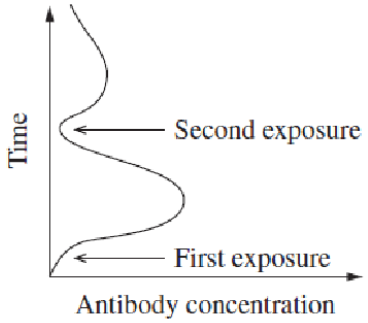
D. Use bacteria from the blood of affected animals to inoculate healthy animals. If these healthy animals develop the symptoms, attempt to isolate the same bacterium from their blood.

Mod 7 – Question 6

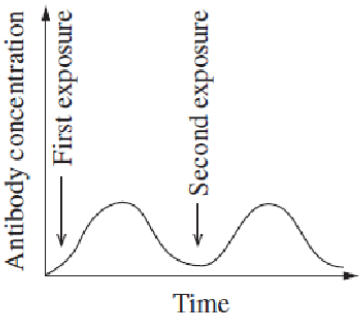
A student was vaccinated for rubella when they were 13. Three years later, they were exposed to the active rubella virus.

Which graph best represents the student's production of antibodies over time?

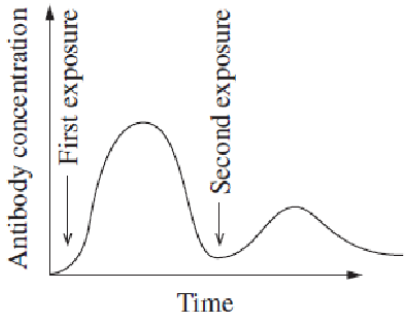
A.



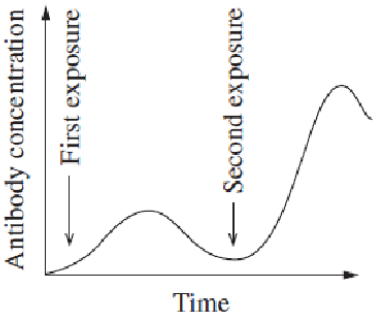
B.



C.



D.



Mod 7 – Question 7

Melanomas are characterised by uncontrolled cell division caused by mutations that continue to occur once the tumour has developed. Scientists have discovered that vaccines produced using antigens extracted from the patient's own melanoma cells can be useful in treating melanoma. When injected, the vaccines stimulate an immune response.

What can be inferred from the scientists' discovery?

A. Cancer cells carry unique antigens.

B. Self-antigens are not present on cancer cells.

C. The melanoma patient has a dysfunctional immune system.

D. The body cannot mount an immune response against cancer cells.

Mod 7 – Question 8

Melanomas are characterised by uncontrolled cell division caused by mutations that continue to occur once the tumour has developed. Scientists have discovered that vaccines produced using antigens extracted from the patient's own melanoma cells can be useful in treating melanoma. When injected, the vaccines stimulate an immune response.

The effect of the melanoma vaccine is to stimulate

A. T cells which produce antibodies.

B. cytotoxic T cells which activate B cells.

C. cell division to produce more lymphocytes.

D. production of B cells which destroy melanoma cells.

Mod 7 – Question 9

The map shown was drawn by Dr John Snow during the 1854 London cholera epidemic.

The dots indicate people who died from cholera and the crosses indicate the location of water pumps.

Which of the following is the most likely hypothesis for which Dr John Snow was gathering evidence?

A. That the outbreak of cholera was caused by people living near each other

B. That the people who died from cholera drank water from the Broad Street pump

C. That cholera was caused by an infectious agent that can be found and transmitted in water

D. That the cause of a disease can be determined by mapping the location of infected patients

Mod 7 – Question 10

How do vaccinations prevent disease?

A. They increase the inflammation process.

B. They enable the infected cells to seal off the pathogen.

C. They increase the number of antibodies against the pathogen.

D. They decrease the number of antigens that trigger the immune response.

Mod 7 – Question 11

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 the 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.

3 Which defence adaptation in the table is correctly matched with one of its features?

	Defence adaptation	*Feature*
A.	Inflammation	Constriction of blood vessels
B.	Phagocytosis	Production of antibodies by white blood cells
C.	Lymph system	Transportation of blood to help fight pathogens
D.	Cell death	Formation of a barrier around the pathogen

8 An organism suspected of causing a disease is described as being unicellular, having a cell wall and lacking a nucleus.

How is this organism classified?

A. A bacterium

B. A fungus

C. A protozoan

D. A virus

16 How do helper T cells assist in raising a specific immune response to a pathogen?

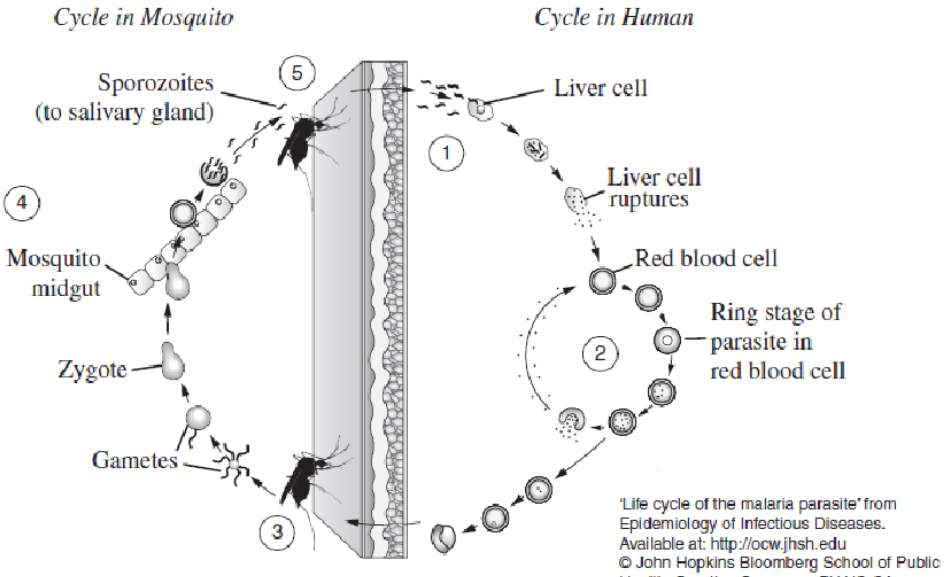
A. They mass produce specific antibodies.

B. They stimulate the cloning of specific T cells.

C. They are cloned and differentiate to become specific cytotoxic T cells.

D. They produce cytokines that stimulate the cloning of specific phagocytes.

17 The diagram shows the life cycle of the malaria parasite, *Plasmodium* sp. Five stages in this life cycle are numbered on the diagram.



'Life cycle of the malaria parasite' from Epidemiology of Infectious Diseases. Available at: http://ocw.jhsh.edu

To prevent malaria, the following four strategies have been used:

- taking anti-malarial drugs
- spraying swamps with insecticides
- using mosquito nets over beds
- administering a malaria vaccine.

Which row in the table shows the stage in the life cycle in which each of these strategies would be most effective?

	Taking anti-malarial drugs	*Spraying swamps with insecticides*	*Using mosquito nets over beds*	*Administering a malaria vaccine*
A.	5	1	3	2
B.	2	5	1	3
C.	1	4	2	5
D.	2	3	5	1

Extended responses

Exam paper 2019

Question 31 (5 marks)

(a) Outline ONE adaptation of a specific pathogen that facilitates its entry into a host. **2**

(b) Explain how the mode of transmission of pathogens influences the spread of diseases. **3**

Question 31 (a)

Criteria	Marks
• Outlines one adaptation that facilitates entry of a specific pathogen into its host	2
• Provides some relevant information	1

Sample answer:

The bacterium *Helicobacter pylori* causes stomach ulcers in humans. It has a flagellum that allows it to move and penetrate the mucus lining/barrier of the stomach wall.

Question 31 (b)

Criteria	Marks
• Explains how the mode of transmission of pathogens affects the spread of diseases	3
• Outlines how one mode of transmission of a pathogen affects the spread a disease OR • Identifies modes of transmission of pathogens	2
• Provides some relevant information	1

Sample answer:

Some diseases are spread easily by the pathogen passing between people in droplets in the air, eg influenza virus, and therefore the rates of infection are high in populated areas.

Question 32 (10 marks)

Use the following data to answer parts (a) and (b).

Dengue fever and malaria are examples of infectious diseases transmitted between humans by mosquitoes. Dengue fever is caused by a virus transmitted by mosquitoes of the genus *Aedes*. Malaria is caused by a single-celled organism transmitted by mosquitoes of the genus *Anopheles*.

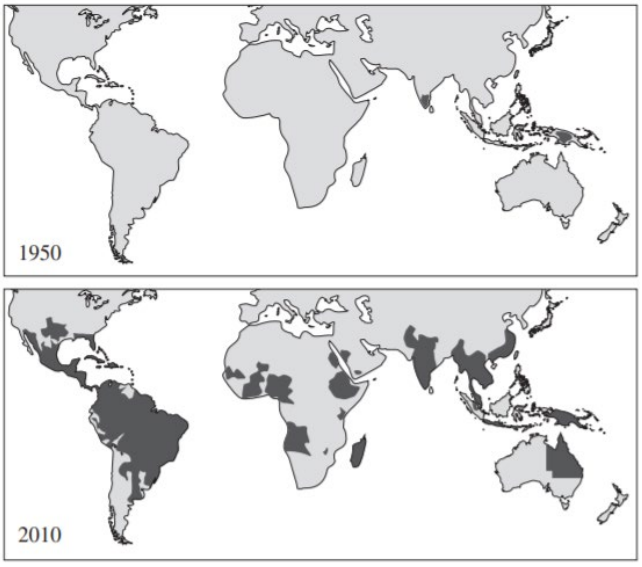
The following data provide information about the global incidence of these two diseases over time.

Global malaria data for selected years from 1900 to 2010

Year	*Global population* ($\times 10^9$)	*Number of countries with reported cases*	*Population at risk*	
			($\times 10^9$)	(%)
1900	1.2	140	0.9	75
1946	2.4	130	1.6	67
1965	3.4	103	1.9	65
1975	4.1	91	2.1	51
1992	5.4	88	2.6	48
1994	5.6	87	2.6	46
2002	6.2	88	3.0	48
2010	6.8	88	3.4	50

S I Hay, C A Guerra, A J Tatem, A M Noor and R W Snow (2004). 'The global distribution and population at risk of malaria: past, present and future', *The Lancet Infectious Diseases*, 4(6): 327–336. Reproduced with permission.

Distribution of reported cases of dengue fever in 1950 and 2010



KEY Reported cases of the viral disease dengue fever

Max Roser and Hannah Ritchie (2018) – Dengue fever distribution maps in 1950 and 2010. Published online at OurWorldInData.org. Retrieved from https://ourworldindata.org/malaria

(a) Based on the data provided, identify trends in the global disease burden for both malaria and dengue fever. **3**

Question 32 (a)

Criteria	Marks
• Identifies relevant global trends in malaria and dengue fever, based on the data provided	3
• Identifies trends in the incidence of malaria and dengue fever	2
• Provides a relevant trend	1

Sample answer:

The distribution of dengue fever appears to have increased markedly since 1950. There are many more parts of the world such as South America and Africa that are now affected. The number of countries with reported cases of malaria has decreased significantly. However, there is a growing number of people at risk, but representing a smaller percentage of the global population.

Question 32 (continued)

(b) Analyse factors that could have contributed to the change in global distribution of both dengue fever and malaria over the last 100 years. Support your answer with reference to the data provided. **7**

Question 32 (b)

Criteria	Marks
• Provides a thorough analysis of factors that could have affected the global distribution over time of both malaria and dengue fever • Relates analysis to data provided	7
• Provides a sound analysis of factors that could have affected the global distribution over time of both malaria and dengue fever • Refers to data provided	6
• Explains factors that could have affected global distribution over time of malaria and/or dengue fever • Refers to data provided	4–5
• Outlines factors that could have affected the distribution of malaria and/or dengue fever	2–3
• Provides some relevant information	1

Sample answer:

The global distribution of both dengue fever and malaria is likely to be associated with mosquito vectors. Airline travel has increased markedly over the last century offering opportunities for both infected people and the mosquito vectors to be transported around the world. In addition, world population has increased as shown in the table, which will increase the density of potential hosts of both diseases. With increasing urbanisation of a larger population, new urban habitats for the mosquitoes could have emerged. It could be argued that these factors have led to the increased distribution of dengue fever and the increased population at risk of malaria, but the number of countries, ie the distribution of malaria, has shrunk. This suggests that the mosquito vector for malaria has been contained within known areas. This could have been achieved by the use of pesticide spraying on water bodies to kill the mosquitoes, or by strict quarantine regulations whereby mosquitoes are eliminated before they can establish populations in new areas. To prevent spread of these diseases both the vector and the hosts need to be contained if possible.

Medical advances have the capacity to prevent or control these diseases, for example development of vaccines, especially for a viral disease such as dengue fever. From the data it would seem that medicines have had a greater effect in containing malaria than dengue fever. It may be that application of a vaccine in remote areas can limit the spread as the higher the proportion of the population vaccinated, the more effective the control of the disease. Also, antiviral drugs may assist in treatment of the disease. However, the evidence suggests that there are no suitable vaccines or drugs for dengue fever or that these have not been widely applied. It is possible too that the virus evolves quickly, rendering vaccines ineffective after a short period of time. Vaccines and pharmaceuticals, such as antibiotics and antimalarial drugs, appear to have been more effective for malaria than for dengue fever.

Previous and sample papers

Mod 7 – Question 12 (3 marks)

Complete the following table to show the distinguishing characteristic of each pathogen and a disease caused by each. **3**

Pathogen	*Distinguishing characteristic of the pathogen*	*Disease caused by the pathogen*
Bacteria		
Fungi		
Protozoans		

Marking guidelines:

Criteria	Marks
• Provides a correct distinguishing characteristic for each pathogen • Provides a correct disease caused by each pathogen	3
• Provides a correct distinguishing characteristic for TWO pathogens • Provides a correct disease caused by TWO pathogens	2
• Provides some relevant information	1

Sample answer:

Pathogen	*Distinguishing characteristic of the pathogen*	*Disease caused by the pathogen*
Bacteria	DNA not enclosed by a nuclear membrane	Whooping cough
Fungi	Have a cell wall but never contain chlorophyll	Tinea
Protozoans	Single cell, eukaryotic organism	Malaria

Mod 7 – Question 13 (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*

Marking guidelines:

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 35°C, so microbes dangerous to humans will not grow
Infection	Wear protective clothing, eg gloves, masks, lab coat

Mod 7 – Question 14 (5 marks)

Scientific advances have resulted in new methods of managing plant diseases and insect pests. **5**

Describe how **TWO** of these methods have changed the management of plant diseases and/or insect pests.

Marking guidelines:

Criteria	Marks
• Names TWO relevant methods • Describes how the TWO methods have changed the management of plant diseases and/or insect pests	5
• Names TWO relevant methods • Desribes how ONE method has changed the management of plant diseases and/or insect pests and outlines how the other method is used	4
• Identifies TWO relevant methods and outlines how one of these methods is used	3
• Identifies TWO relevant methods OR • Outlines how a relevant method is used	2
• Provides some relevant information	1

Answers could include:

Genetic engineering of plants with particular characteristics: The finding that a combination of certain genetic characteristics can provide insect-resistant crops has led to the insertion of genes for desirable characteristics into plants to produce insect-resistant plants. This has resulted in less need for insecticides.

Quarantine restrictions: Based on our understanding of disease transmission, the isolation of diseased plants has prevented the spread of plant diseases into and around Australia. This has led to a change from the treatment of diseased plants to preventing the spread of disease.

Mod 7 – Question 15 (6 marks)

The image shows a lemon-scented gum tree, *Corymbia citriodora*, which has been attacked by a fungal stem canker. Fungal cankers are opportunistic plant pathogens that gain access to the inner layers of the stem as a result of damage to the protective outer layer of bark. The inner layers provide suitable conditions for the fungus to grow. Once established it destroys the bark cells that protect the tree. The tree responds to the presence of the canker under its bark by producing an excess of resinous sap at the wound site.

(a) Using the information provided, suggest a hypothesis to explain how the tree is responding to the presence of the canker. **2**

(b) Consider another plant with a different response to a specific pathogen. **4**

Compare the necessity and limitations of this plant's response with the response of the lemon-scented gum tree described above.

Marking guidelines (a):

Criteria	Marks
• Provides a suitable hypothesis	2
• Provides some relevant information	1

Sample answer:

Hypothesis: That excess sap production alters the conditions where the canker is, thus making it difficult for the canker to survive. Sap may increase the osmotic pressure gradient and the quantity of chemicals that may be toxic to the canker.

Marking guidelines (b):

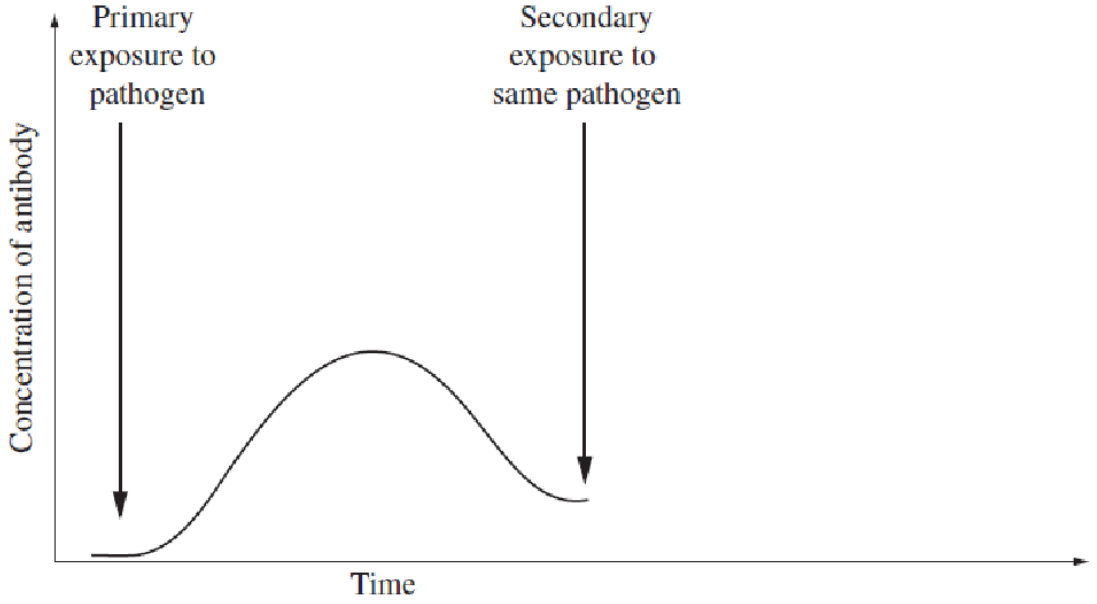
Criteria	Marks
• Shows a thorough understanding of another plant's response to a specific pathogen • Shows how the necessity and limitations of the two responses are similar and/or different	4
• Shows a sound understanding of another plant's response to a specific pathogen • Shows sound understanding of the necessity and limitations of the two responses	3
• Shows some understanding of another plant's response to a specific pathogen • Shows some understanding of the necessity and/or limitations of the response(s)	2
• Provides some relevant information	1

Sample answer:

The river red gum can most effectively rid itself of the halo leaf spot canker by dropping its leaves, though this means new leaves will have to be made. The halo leaf spot will prevent the river red gum from being able to photosynthesise if too many leaves are infected and this would kill the tree. The fungal canker stem affects the ability of the lemon-scented gum to effectively transport material via the xylem and phloem, thus weakening the tree. As the canker affects the lemon-scented gum's stem it is not possible to eliminate or 'drop' that part of the tree, though if it was on a branch this response could be possible. The lemon-scented gum must use a method that will isolate the infected area as much as possible, however, it may not be possible to kill the canker completely.

Mod 7 – Question 16 (6 marks)

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



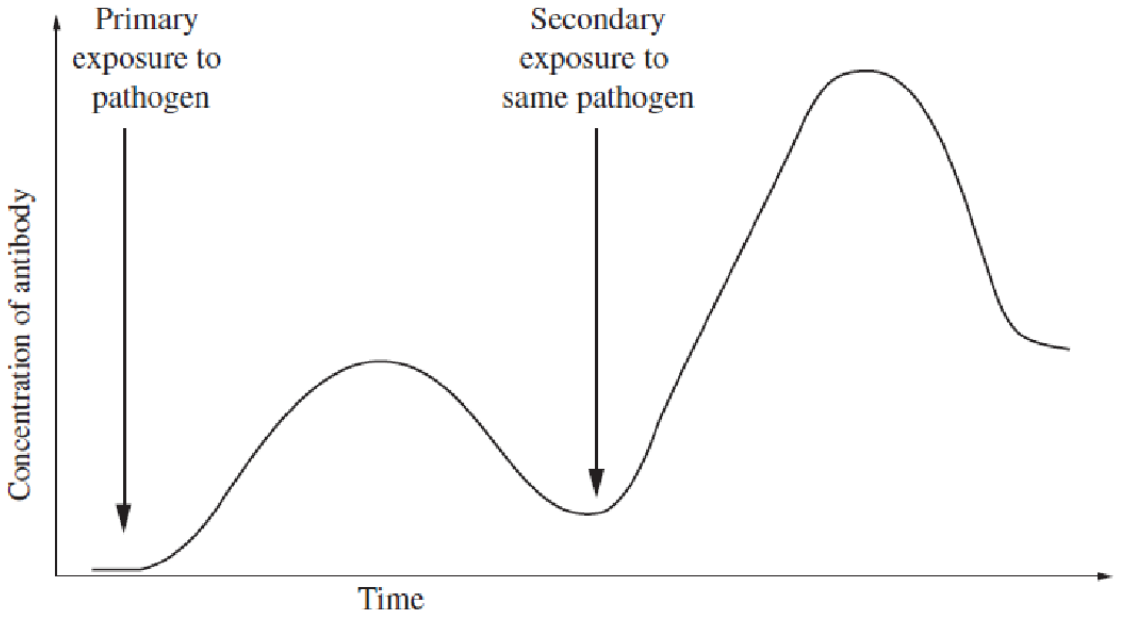
(a) On the diagram, continue the graph to show the immune response upon secondary exposure to the same pathogen. **2**

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

Marking guidelines (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

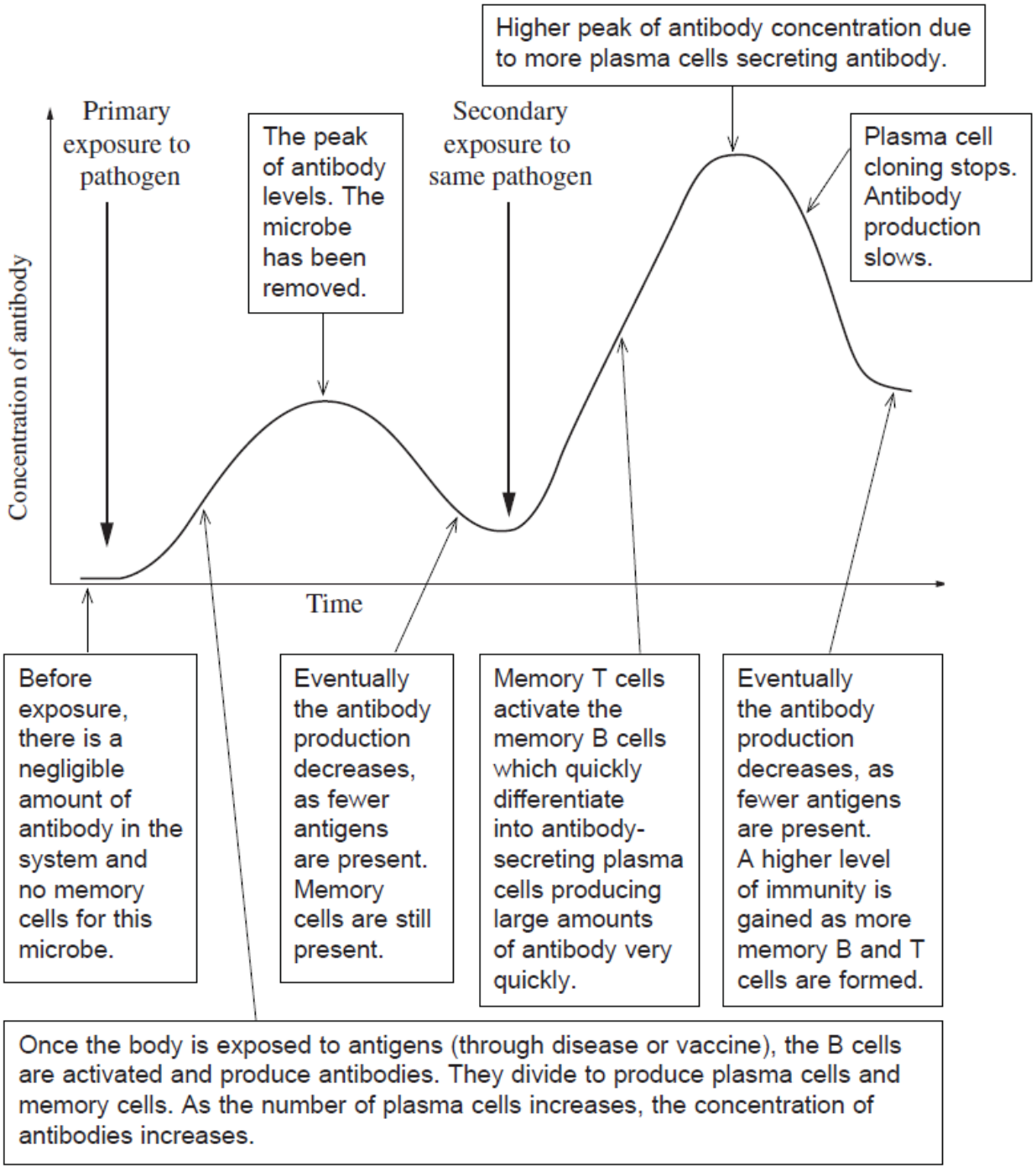
Sample answer:



Marking guidelines (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

Sample answer:



Mod 7 – Question 17 (6 marks)

The immune system's primary role is to defend against pathogens. For this to be effective the immune system must be able to recognise cells that belong to the body and cells that do not.

(a) Describe the mechanism that the immune system uses to distinguish between body cells and potential pathogens. Support your answer with an example. **3**

(b) Explain why this mechanism means that patients who receive an organ donation require immune suppression drugs. **3**

Marking guidelines (a):

Criteria	Marks
• Describes antigens as markers on the surface of a cell that the immune system can classify as self or foreign • Outlines that the immune system learns which antigens are self • Provides an example of an antigen the immune system will recognise as either self or foreign	3
• Describes antigens as markers on the surface of a cell that the immune system can recognise • Provides an example of an antigen	2
• Provides some relevant information	1

Sample answer:

The body's immune system recognises its own cells by the presence of particular antigens on the surface of the cell. All cells have these antigens which act as markers or flags. The immune system has 'learned', during embryonic development, which antigens belong to the body and which do not. An example of antigens that the immune system can recognise as belonging to the body are the antigens displayed on the surface of red blood cells. These cells are typically classified as A and/or B blood types, or O blood type if no antigens are present. Substances or cells that enter the body that do not have antigens recognised as belonging to the body, such as the wrong blood type or bacterial cells, are attacked by the immune system.

Marking guidelines (b):

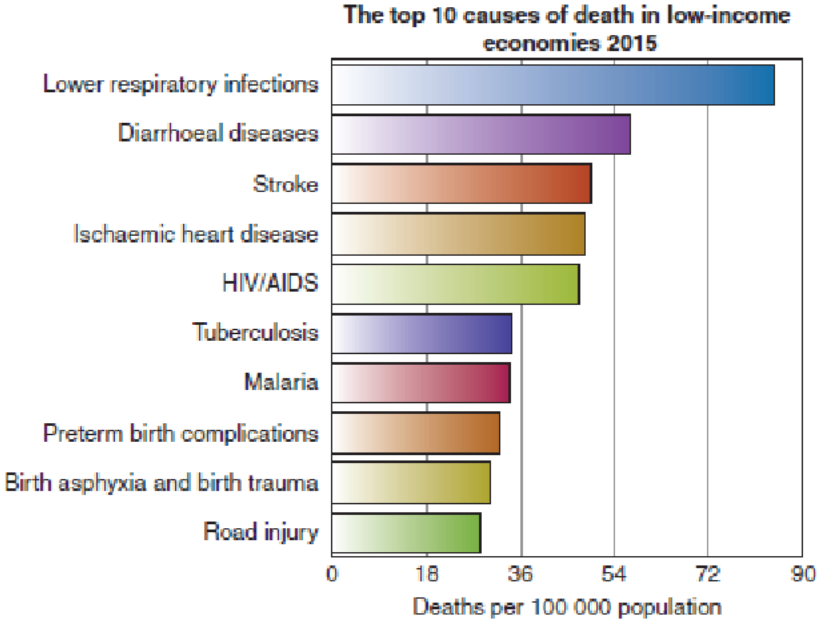
Criteria	Marks
• Identifies that the donated organ's antigens and the recipient's antigens are different • Explains that the difference in antigens will result in the recipient's immune system attacking the donated organ	3
• Shows some understanding that the difference in antigens will result in the recipient's immune system attacking the donated organ	2
• Provides some relevant information	1

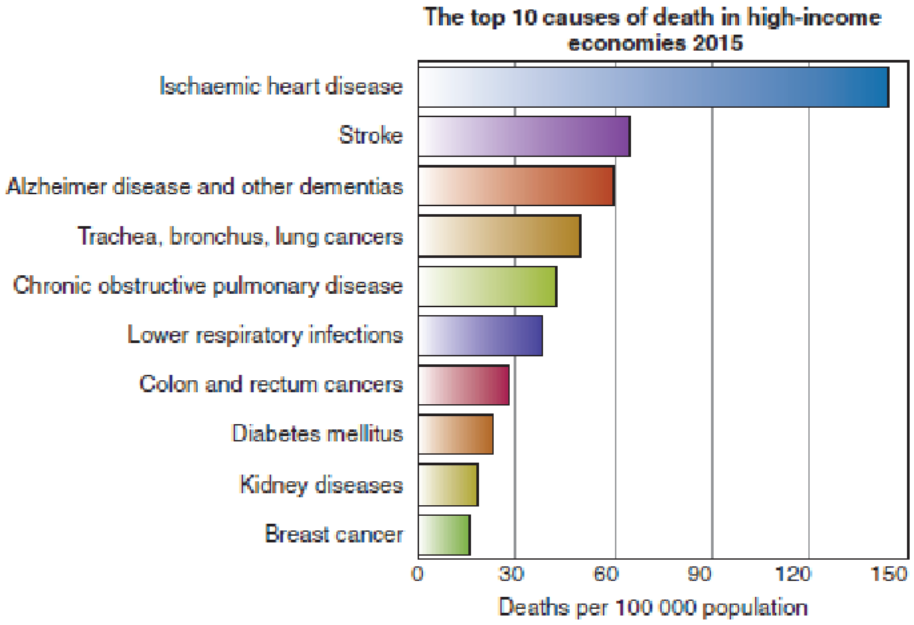
Sample answer:

The fact that the immune system is capable of recognising which cells belong to the body and which do not, can be very problematic for people who require organ donations. Due to the presence of antigens on the surface of all cells, the recipient's immune system will not recognise the transplant as belonging to their own body because the cells of the donated organ will have different antigens from those of the recipient. Consequently, the recipient's immune system will start to attack the transplant. To prevent this from happening the donor's antigens are matched as closely as possible to the recipient and the recipient is given immune suppression drugs to prevent (or slow down) the recipient's immune system from attacking the donated organ. Immune suppression drugs are often the only way to ensure the donated organ remains functional for the recipient.

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.

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.

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 • Provides possible reasons for why the prevalent causes of death differed between low and high-income economies in 2015 • 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 • Relates the results of analysis to why the prevalent causes of death differed between low and high-income economies • 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 • Links the results of the analysis to some reasons for the prevalent causes of death in low and/or high-income economies • 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 AND/OR • Outlines reason(s) for the prevalent causes of death in low and/or high-income economies AND/OR • Shows some understanding of infectious and/or non-infectious diseases	3–4
• Identifies relevant information from the graph(s) AND/OR • 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.

Question 22 (5 marks)

(a) Pasteur performed an experiment to identify the role of microbes in decay. **2**

Justify a conclusion that can be drawn from his results.

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(b) Describe the contribution of Robert Koch to our understanding of disease. **3**

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Question 22 (a)

Criteria	Marks
• Provides a conclusion and justification	2
• Provides some relevant information	1

Sample answer:

Microbes come from pre-existing microbes since no growth occurred in the sterile swan-necked flask.

Question 22 (b)

Criteria	Marks
• Describes the contribution of Koch to our understanding of infectious disease, including reference to the systematic identification of causative pathogens	3
• Outlines the contribution of Koch to our understanding of infectious disease	2
• Provides some relevant information	1

Sample answer:

Koch worked with microbes eg anthrax. He demonstrated the relationship between microbes and infectious disease and showed that specific microbes cause specific diseases. He developed a set of criteria to establish the cause of infectious diseases.

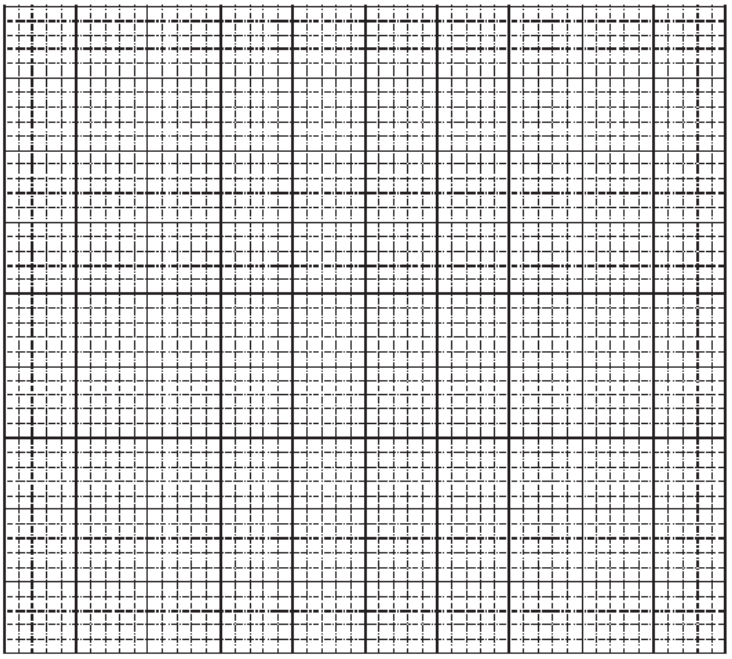
Question 24 (6 marks)

A new flu vaccine is prepared each year to protect the population against the current strains of influenza virus. The effectiveness of flu vaccines varies from year to year and can be measured using the overall vaccination effectiveness (VE) index. A VE of 60% means that a vaccinated individual's chance of getting the flu is reduced by 60%.

The following data show the VE over a 10-year period.

Influenza season	*VE (%)*
2006–2007	52
2008–2009	41
2010–2011	60
2012–2013	49
2014–2015	19

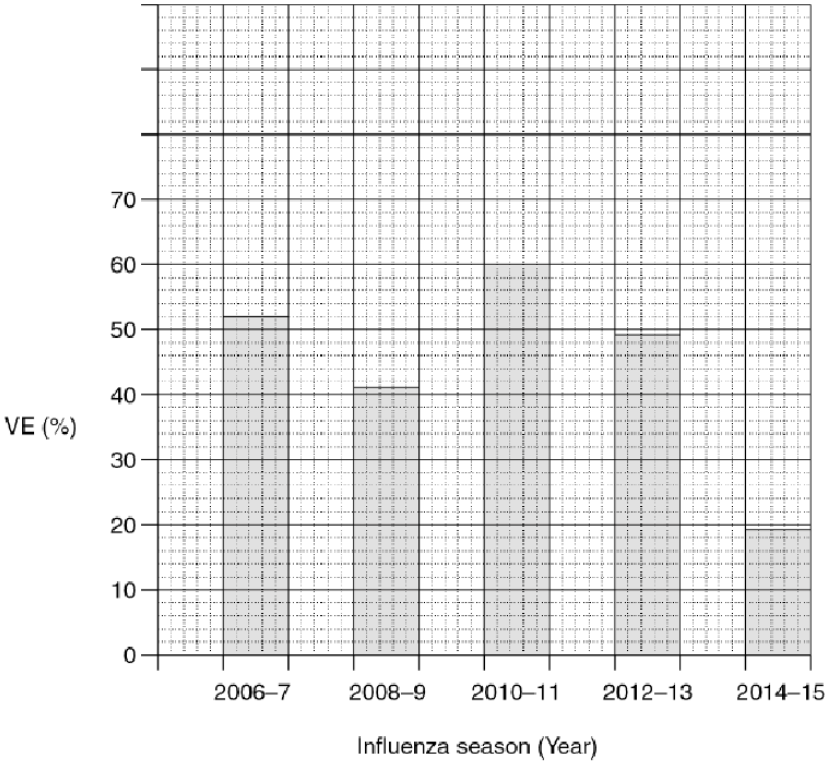
(a) Draw an appropriate graph to represent the data on the following grid. **3**



Question 24 (a)

Criteria	Marks
• Draws a column graph with: – axes labelled and scaled correctly – data plotted accurately	3
• Draws a substantially correct graph	2
• Provides some relevant information	1

Sample answer:



Question 24 (continued)

(b) Provide a possible explanation for the vaccination effectiveness (VE) index in 2014–2015. **3**

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Question 24 (b)

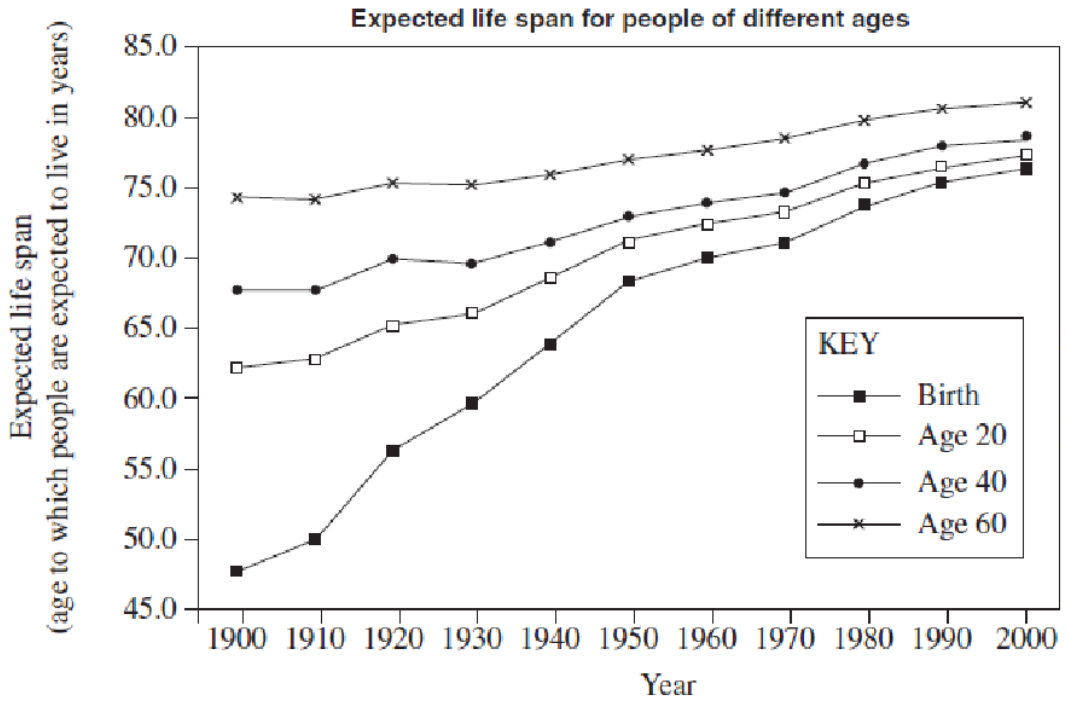
Criteria	Marks
• Explains the variation in VE including reference to: – composition of vaccines – effectiveness of immune response	3
• Outlines reason(s) for variation in VE trend	2
• Provides some relevant information	1

Sample answer:

In 2014–2015 the VE was much lower than in other years. This means that the vaccine was less effective. Vaccines work by giving a person a harmless form of an antigen from a pathogen and triggering the production of antibodies that are specific to the particular antigen. If the pathogen should later mutate and its antigen change shape, then the antibodies will no longer be effective. Hence the lower VE may have been due to mutation of the virus, making the vaccine less effective.

Question 30 (8 marks)

The graph shows the expected life span (the age to which people are expected to live in years) for people of different ages during the 20th century in one country. **8**



Historical Statistics of the United States – Colonial Times to 1970 Part 1; Bureau of the Census, pp12, 56; Vital Statistics of the United States 1980, 1990, 1992; Statistical Abstract of the United States 2001, 121st edition, Issued November 2001, p4

There have been many biological developments that have contributed to our understanding of the identification, treatment and prevention of disease.

Evaluate the impact of these developments on the expected life span. In your answer, include reference to trends in the data provided.

Question 30

Criteria	Marks
• Analyses the data to draw suitable conclusions • Demonstrates an extensive understanding of the development of the identification, treatment and prevention of disease • Links trends in the data to specific developments in identifying, treating and preventing disease • Synthesises information to draw a suitable conclusion/judgement about the impact of biological developments on life span • Uses precise biological terms	8
• Analyses the data to provide key trends • Demonstrates a thorough understanding of the development of the identification, treatment and prevention of disease • Links trends in the data to specific developments in identifying, treating and preventing disease • Provides a clear judgement about the impact of biological developments on life span • Uses suitable biological terms	6–7
• Provides a trend in the data • Demonstrates a sound understanding of the development of our understanding of disease • Links the data to developments in understanding disease • Uses some suitable biological terms	4–5
• Describes the data • Demonstrates some understanding of the development of our understanding of disease • Links data to understanding disease	2–3
• Provides some relevant information	1

Sample answer:

The graph shows that life span has increased for all ages over the last century. The younger the individual the greater the increase in life span. Life span at birth has increased dramatically from 48 years to 75 years. At other ages it has increased less (12 years for 20-year-olds, 10 years for 40-year-olds and the smallest increase of five years for 60-year-olds).

Being able to identify the cause of diseases such as measles, rubella and whooping cough is the result of our developing an understanding of pathogens as the cause of infectious disease through the work of Pasteur and Koch. They developed germ theory and a set of rules/postulates and culture techniques to be followed in establishing the link between a specific pathogen and disease. Knowledge of pathogens led to the development of vaccines (incorporating harmless versions of pathogens) that can be used to prevent common childhood diseases. Vaccines provide active immunity to specific pathogens. This has significantly reduced the number of deaths in young children resulting in a dramatic increase in their life expectancy.

Understanding bacterial pathogens and differences between prokaryotic and eukaryotic cells has led to the development of antibiotic treatments for pathogens such as *Staphylococcus aureus*. This means many infections can be treated instead of being life threatening. This has resulted in improved life span at all ages. However, the overuse of antibiotic treatment

resulted in bacterial resistance to many drugs and these gains may not be sustainable in the future.

The study of non-infectious diseases such as lung cancer though systematic epidemiology has resulted in being able to find the delayed link between lung cancer and smoking. Epidemiology involves careful planning and design, control groups, and the large-scale collection and analysis of data. This has led to public health campaigns that have reduced smoking rates and as a result are leading to increased life span for adults.

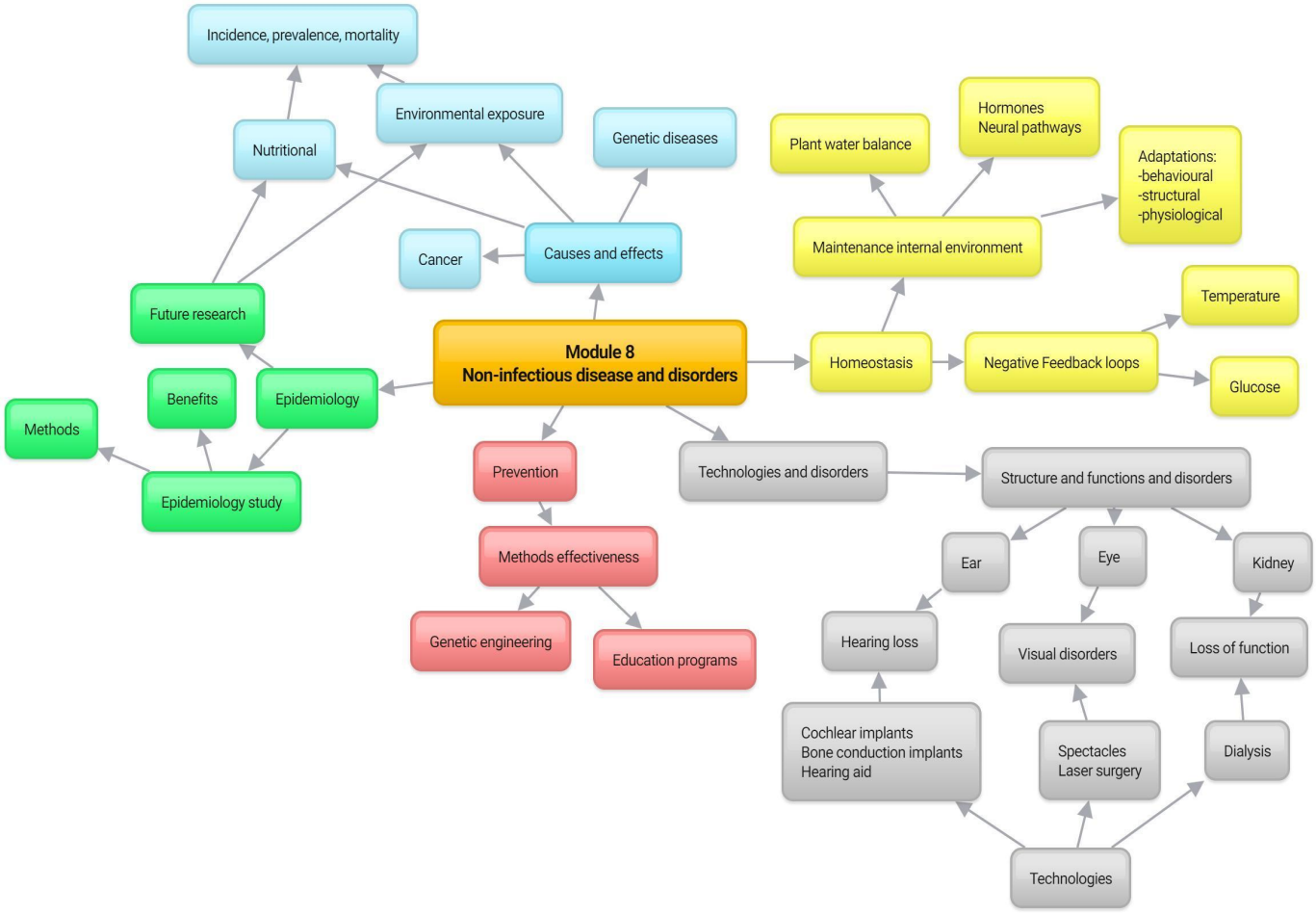
It is clear that biological developments have led to huge gains in expected life span in many countries. These gains are highest for the very young. However, life span around the world is variable as access to prevention and treatment is limited to those who can afford it.

Outcomes

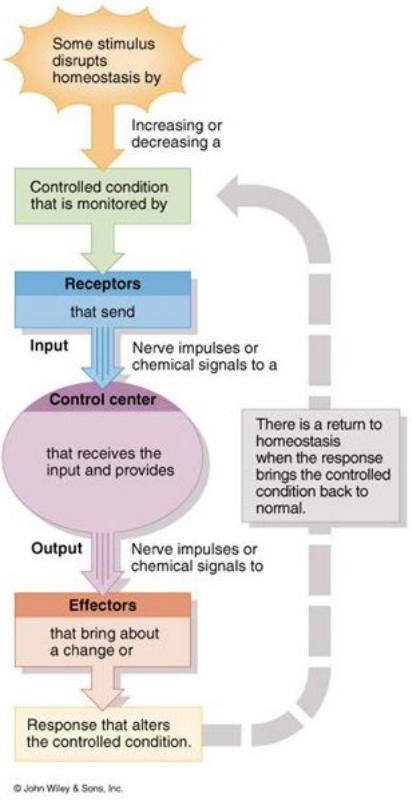
A student:

› analyses and evaluates primary and secondary data and information BIO11/12-5
› solves scientific problems using primary and secondary data, critical thinking skills and scientific processes BIO11/12-6
› communicates scientific understanding using suitable language and terminology for a specific audience or purpose BIO11/12-7
› explains non-infectious disease and disorders and a range of technologies and methods used to assist, control, prevent and treat non-infectious disease BIO12-15

Module concept map



Content

Homeostasis	*How to address the inquiry question and content statements*
Inquiry question: How is an organism's internal environment maintained in response to a changing external environment?	Define homeostasis, learn examples how homeostatic processes work when there are changes in the external environment, e.g. temperature, pH, sugar levels, water salinity.
● construct and interpret negative feedback loops that show homeostasis by using a range of sources, including but not limited to: (ACSBL101, ACSBL110, ACSBL111)	Learn ALL the examples below, temperature and glucose. There are many flow charts on the internet as models for this. Remember that those feedback loops must be annotated with a clear explanation of the processes involved. This is the basic negative feedback loop: stimulus, receptor, control centre, effector, response. 
– temperature (ACSBL098)	Replace the flow chart above with the processes to keep internal temperature constant
– glucose	Replace the flow chart above with the processes to keep internal sugar levels constant
● investigate the various mechanisms used by organisms to maintain their internal environment within tolerance limits, including:	Learn well all the content statements below. Focus on the verb investigate to draw conclusions about the mechanisms
– trends and patterns in behavioural, structural and physiological adaptations in endotherms that assist in maintaining homeostasis (ACSBL099, ACSBL114)	Define endotherms – generate own body heat to maintain a constant internal environment. Outline behavioural (e.g. move to sheltered areas, away from the heat), structural (e.g. skin features: spikes to collect water, fur colour) and physiological (e.g. increase/decrease blood flow to the surface of the skin) trends and patterns.
– internal coordination systems that allow homeostasis to be maintained, including hormones and neural pathways (ACSBL112, ACSBL113, ACSBL114)	Hormones pathways in the endocrine system – e.g. kidney hormones to maintain water balance, pancreas insulin release for blood sugar levels. Neural pathways – relationship between the sensors and effectors with the central nervous system to respond to stimulus.

	Tabulate differences between the two pathways, e.g. speed of response, long/short lasting response.
– mechanisms in plants that allow water balance to be maintained (ACSBL115)	Outline structural and physiological responses to maintain water balance: thin leaves, waxy cuticle, sunken stomata, decreasing photosynthesis, dropping leaves, reducing transpiration by closing stomata, deep root systems.
Cause and responses	
Inquiry question: Do non-infectious diseases cause more deaths than infectious diseases?	Define non-infectious disease as a non-transmittable/communicable disease that means it is not caused by a pathogen. Today non-infectious diseases exceed the number of deaths compared with infectious diseases.
● investigate the causes and host responses of non-infectious diseases in humans, including but not limited to:	Learn ALL the types of non-infectious disease below. Focus on causes and host responses, including symptoms. Learn an example/case study for each of them.
– genetic diseases	Genetic diseases are inherited diseases. Examples: sickle cell anaemia, Down syndrome
– diseases caused by environmental exposure	Outline mutagens that are causes of environmental non-infectious diseases, e.g. UV light, radiation, chemicals. Examples: asbestosis, skin cancer, environmental lymphomas
– nutritional diseases	Outline nutritional deficiency disorders such as, Rickets and Scurvy Eating disorders.
– cancer	Explain what causes cancer – uncontrolled division of body cells due to a mutation in cell cycle control. Examples: breast cancer, lung cancer, prostate cancer.
● collect data that shows the incidence, prevalence and mortality rates of non-infectious disease, for example:	Define incidence, prevalence and mortality Learn ONE example from below. The collection of data for the incidence, prevalence and mortality rates can be gathered from many data sets available publicly from the World Health Organisation and Cancer Council in Australia.
– nutritional diseases	WHO datasets https://www.who.int/gho/en/
– diseases caused by environmental exposure	Lung cancer has a lot of information and data sets.
Epidemiology	
Inquiry question: Why are epidemiological studies used?	Define epidemiology and epidemiological studies. Outline the uses of epidemiological studies: Identify correlations between diseases and risk factors to understand causes and effects of non-infectious diseases Analyse patterns and trends Suggest control, treatment and preventions
● analyse patterns of non-infectious diseases in populations, including their incidence and prevalence, including but not limited to:	Using the data collected in the previous content statement, analyse the patterns: incidence, prevalence, mortality and morbidity.
– nutritional diseases	Vitamin deficiency diseases has a lot of data in the internet
– diseases caused by environmental exposure	Lung cancer and asbestosis are the common ones to study.
● investigate the treatment/management, and possible future directions for further research,	Learn ONE case study well. Focus on treatment and management of symptoms, including current and future research of the disease.

of a non-infectious disease using an example from one of the non-infectious diseases categories listed above	Examples Melanoma – treatments: surgery/chemo-radiotherapy. Future directions: monoclonal antibodies for CDK4 antigen Type 2 diabetes – treatment/management: diet. Future directions: improvement in gut health
● evaluate the method used in an example of an epidemiological study	Focus on the verb evaluate to make a judgement about the value of the study, the length of time invested, the specificity of the population and limitations of the study Learn the methodology of epidemiological study well, following a set of steps: Identification of the disease, length of the study, variables controlled and large number of populations has to be taken into account for a valid study Data collection and analysis Causes and effects analysed, risk factors identified. Suggested control and prevention Examples: lung cancer, melanoma, asbestos, breast cancer.
● evaluate, using examples, the benefits of engaging in an epidemiological study	Focus on the verb evaluate to make a judgement about the study such as identification of risk factors, resources needed for health care, prevention, control and treatments, educational campaigns and future research directions. Learn more than one example: Cervical cancer
Prevention	
Inquiry question: How can non-infectious diseases be prevented?	Prevention refers to actions to reduce or eliminate the onset, causes and recurrence of disease.
● use secondary sources to evaluate the effectiveness of current disease-prevention methods and develop strategies for the prevention of a non-infectious disease, including but not limited to:	Focus on the verb evaluate to make a judgment about the effectiveness of prevention methods of non-infectious disease. The effectiveness relates to how the method or strategy reduces the incidence and prevalence of non-infectious disease and its prevention. Learn ALL the methods listed below
– educational programs and campaigns	Examples to research: Vaccination programs Quit Smoking campaign Sunsmart Assessing Cost Effectiveness Prevention study Bowel Cancer Screening Breast Cancer screening The Council Cancer Australia website has many of those programs and the Australian Institute of Health and Welfare has many data sources about those campaigns.
– genetic engineering	Molecular genetics helped to identify the non-infectious disease at genetic level and identify genes affected. Identification of those genes in people allows for preventive measurements, e.g breast cancer genes BRCA1 and BRCA2.

Technologies and Disorders	
Inquiry question: How can technologies be used to assist people who experience disorders?	Technologies that helped people with disorders are: Hearing aids Cochlear implants Visual aids: glasses, contact lenses, Braille systems Corneal transplants Dialysis machines Pacemakers Insulin pumps Discuss how those technologies assist people with the disorder: improve quality of life, increase survival rates.
• explain a range of causes of disorders by investigating the structures and functions of the relevant organs, for example:	Learn structures and functions of: Ear Eyes Kidneys Tabulate structures and functions Relate the cause and effect of lack of functions in those organs Learn ALL the examples listed below.
– hearing loss	Causes of hearing loss: -conductive (ear canal, eardrum, middle ear, ear ossicles) due to infections, trauma. -sensorineural (inner ear nerve cells or hairs) due to exposure to excessive noise, drugs, viral infections, trauma. -mixed hearing loss: combination of the two listed above
– visual disorders	Disorders and causes: -myopia (short-sighted) refractive error, distance between the retina and lens is too great -hyperopia (long sighted) refractive error, distance between the retina and the lens is too small -astigmatism cornea or lens irregularly shaped -cataracts lens is clouded over -macular degeneration deterioration of the macula in the central inner lining of the retina -glaucoma damage to the optic nerve due to increase pressure
– loss of kidney function	-chronic kidney disease due to smoking, drinking, high blood pressure, diabetes, trauma, infections, chronic inflammation, nephritic disease
• investigate technologies that are used to assist with the effects of a disorder, including but not limited to: (ACSBL100)	Focus on how technology assists in helping to restore the function of the organ. Reach conclusions
– hearing loss: cochlear implants, bone conduction implants, hearing aids	Cochlear implants: a sound processor is implanted that transforms the sound into an electrical impulse send via an electrode inserted in the cochlea Bone conduction implants: replace the conductive hearing loss, sound processor conducting the sound vibrations to the inner ear Hearing aids: replace conductive hearing loss, a microphone picks sound waves and amplifies them.
– visual disorders: spectacles, laser surgery	Explain how the follow technologies assist the disorder Spectacles and contact lenses: correct the refractive errors Laser surgery: correct refractive errors by reshaping the cornea. Cataract surgery: replacement of the opaque lens by an artificial intraocular lens

– loss of kidney function: dialysis	Haemodialysis: patient is connected to a machine that filters the blood of nitrogenous waste Peritoneal dialysis: tube inserted in the peritoneum which act as the blood filter using a dialysis fluid
• evaluate the effectiveness of a technology that is used to manage and assist with the effects of a disorder (ACSBL100)	Effectiveness relates to the value of the technology to assist the organ disorder in terms of cost, affordability, potential side effects, risks of intervention (surgery), lifespan of the technology, recovery/training after the technology is implanted. Hearing aid – cheap and easy to implant, digitalised, smaller in size Cataract surgery – short surgery, instant recovery Spectacles – cheap, easy to use, instant fixed Dialysis – long term procedure, time consumed, side effects on long term

Exam questions related to Module 8

Multiple choices

Exam paper 2019

6 How does the cochlear implant assist people with severe hearing loss?

A. It amplifies sound.

B. It stimulates the ear drum.

C. It stimulates the auditory nerve.

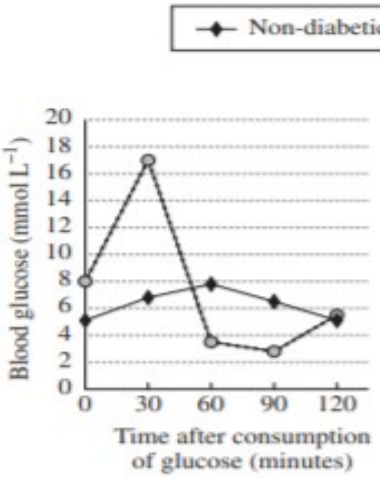
D. It amplifies vibrations in the cochlea.

12 The glucose tolerance test is used to investigate the control of glucose in the human body. Patients consume 75 g of glucose and their blood glucose is monitored.

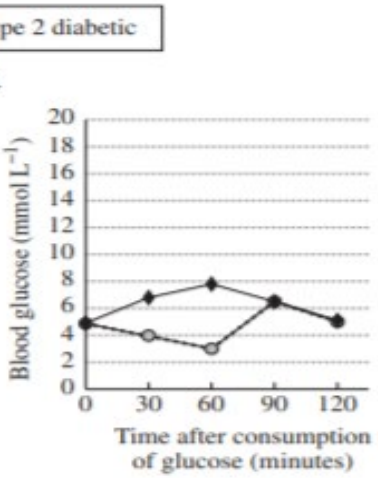
Type 2 diabetes is a condition where the cells of the body do not respond adequately to insulin.

Which graph could represent the results of glucose tolerance tests in a non-diabetic person and a person with untreated Type 2 diabetes?

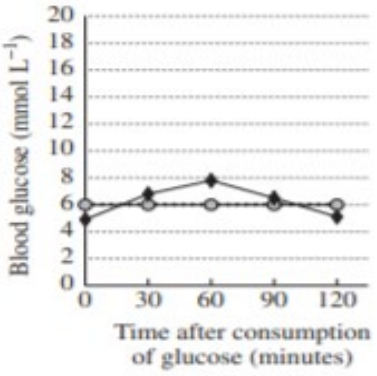
A.



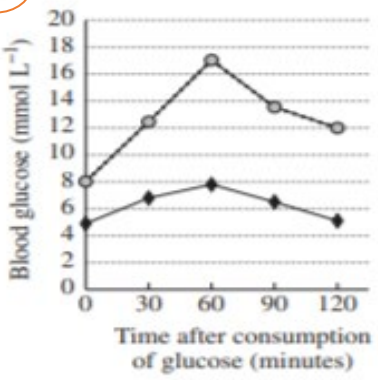
B.



C.

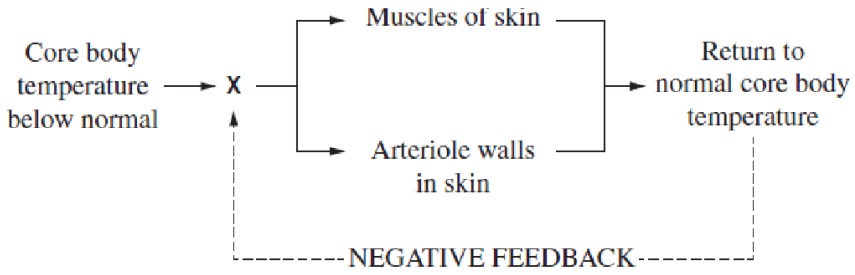


D.



Mod 8 – Question 1

The diagram shows a homeostatic mechanism in a mammal.



What does **X** represent in the diagram?

A. The brain

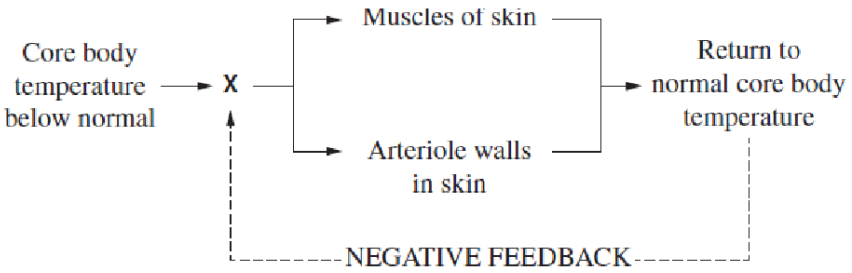
B. The heart

C. A thermoreceptor in the skin

D. A pressure receptor in a blood vessel

Mod 8 – Question 2

The diagram shows a homeostatic mechanism in a mammal.



Which row of the table describes what happens to the muscles and the arteriole walls in the skin when the core body temperature is below normal?

	Muscles of skin	*Arteriole walls in skin*
A.	Relax to lower epidermal hairs	Expand
B.	Contract to raise epidermal hairs	Contract
C.	Relax to raise epidermal hairs	Expand
D.	Contract to lower epidermal hairs	Contract

Mod 8 – Question 3

A student wanted to test the claim, made by an agricultural seed company, that their variety of wheat was more salt tolerant than other wheat varieties on the market. The company explained that their variety can better maintain water balance by increasing the organic salt concentration in the roots of the plants which increases osmotic pressure.

Which row of the table shows the independent and dependent variables that the student should use to test the company's claim?

	Independent	*Dependent*
A.	Salt concentration	Leaf turgor
B.	Salt concentration	Growth rate
C.	Variety of wheat plant	Organic salt concentration in roots
D.	Variety of wheat plant	Leaf turgor

Mod 8 – Question 4

What is the main focus of the study of epidemiology?

A. Skin diseases

B. Changes in the characteristics of a species

C. Factors involved in the occurrence, prevalence and spread of disease

D. How the body maintains its functions in response to variations in the environment

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

Mod 8 – Question 6

For many years, some cigarette companies have denied that there were increased risks of lung cancer as a result of cigarette smoking.

How can an epidemiological study into lung cancer be useful in this situation?

A. It can show that the chemicals in cigarette smoke cause cancer.

B. It can demonstrate that second-hand smoke has no impact on lung cancer rates.

C. It can provide evidence that people who smoke are more likely to develop lung cancer.

D. It can show that the cigarette companies have been lying about the cause of lung cancer.

Mod 8 – Question 7

Which of the following is an example of an educational program to reduce the incidence of skin cancer?

A. An advertising campaign on TV to promote sun safety
B. Making sunscreen freely available at pools and beaches
C. Increasing the availability of skin checks in regional centres
D. Providing free training to doctors to help them diagnose skin cancers

Mod 8 – Question 8

A patient has been diagnosed with severe hearing loss in the inner ear.

Which type of hearing technology can be used to help restore the patient's hearing?

A. Hearing aid
B. Cochlear implant
C. Artificial ear drum
D. Bone conduction implant

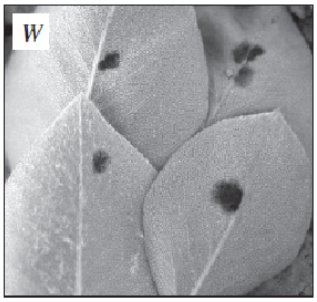
Mod 8 – Question 9

A patient has experienced an injury that affected the retina of her eye. She asked her doctor if LASIK eye surgery could help restore her sight. The doctor said that LASIK eye surgery would have no impact on her condition.

Why did the doctor give this advice?

A. LASIK eye surgery is a replacement of the lens in the eye and cannot repair a retina
B. LASIK eye surgery will only temporarily repair her retina and her vision problems would return
C. LASIK eye surgery is only used for people who have a damaged cornea and cannot repair a retina
D. LASIK eye surgery is only used to change the shape of the cornea to enhance vision and cannot repair a retina

11 The following plants were presented to a quarantine office in Australia as part of a shipment of plants entering Australia for the plant nursery trade.



A photograph, 'Spots observed on the underside of a cultivar Bartlett', photo by Jay Pscheidt, Oregon State University, 2013 – taken from https://pnwhandbooks.org/plantdisease/host-disease/pear-pyrus-spp-scab

https://orchardpeople.com/wp-content/uploads/2017/09/IMG_3168-2.jpg

'Oak leaf blister (Taphrina Caerulescens)', Joseph Obrien, USDA Forest Service, Bugwood.org

This material cannot be displayed, due to copyright issues.

Which of the following is a decision that the quarantine office is likely to make?

A. Plant *W* can enter Australia as it looks like it has 'black spot' which already occurs in Australia.

B. Plant *X* can enter Australia as it is unlikely the disease it has will transfer to Australian species.

C. Plant *Y* cannot enter Australia as it has a disease caused by shortage of soil magnesium.

D. Plant *Z* cannot enter Australia because its appearance suggests it may be carrying live insects.

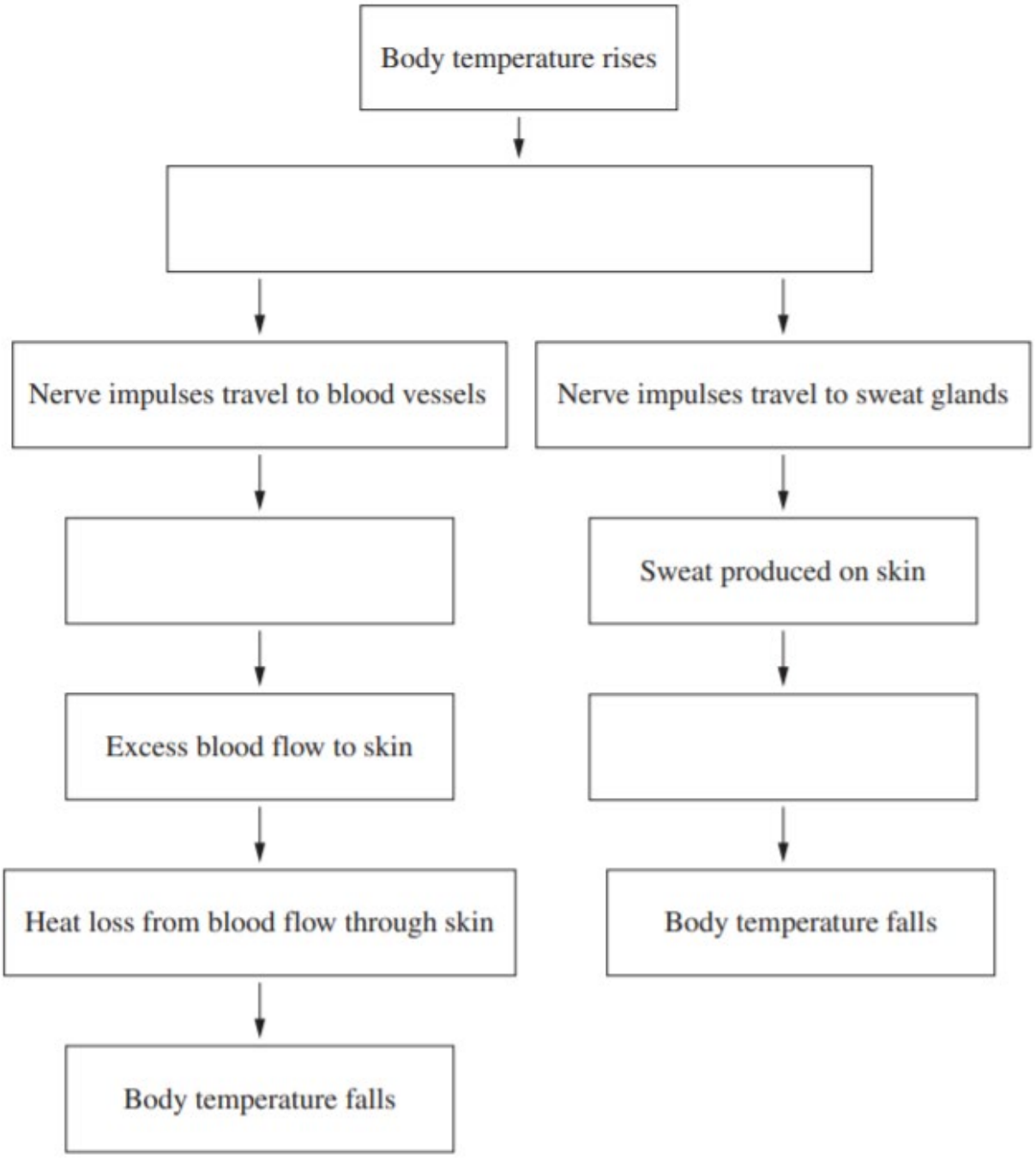
Extended responses

Exam paper 2019

Question 21 (3 marks)

The diagram shows a flow chart of the reaction of a human body to an increase in temperature. **3**

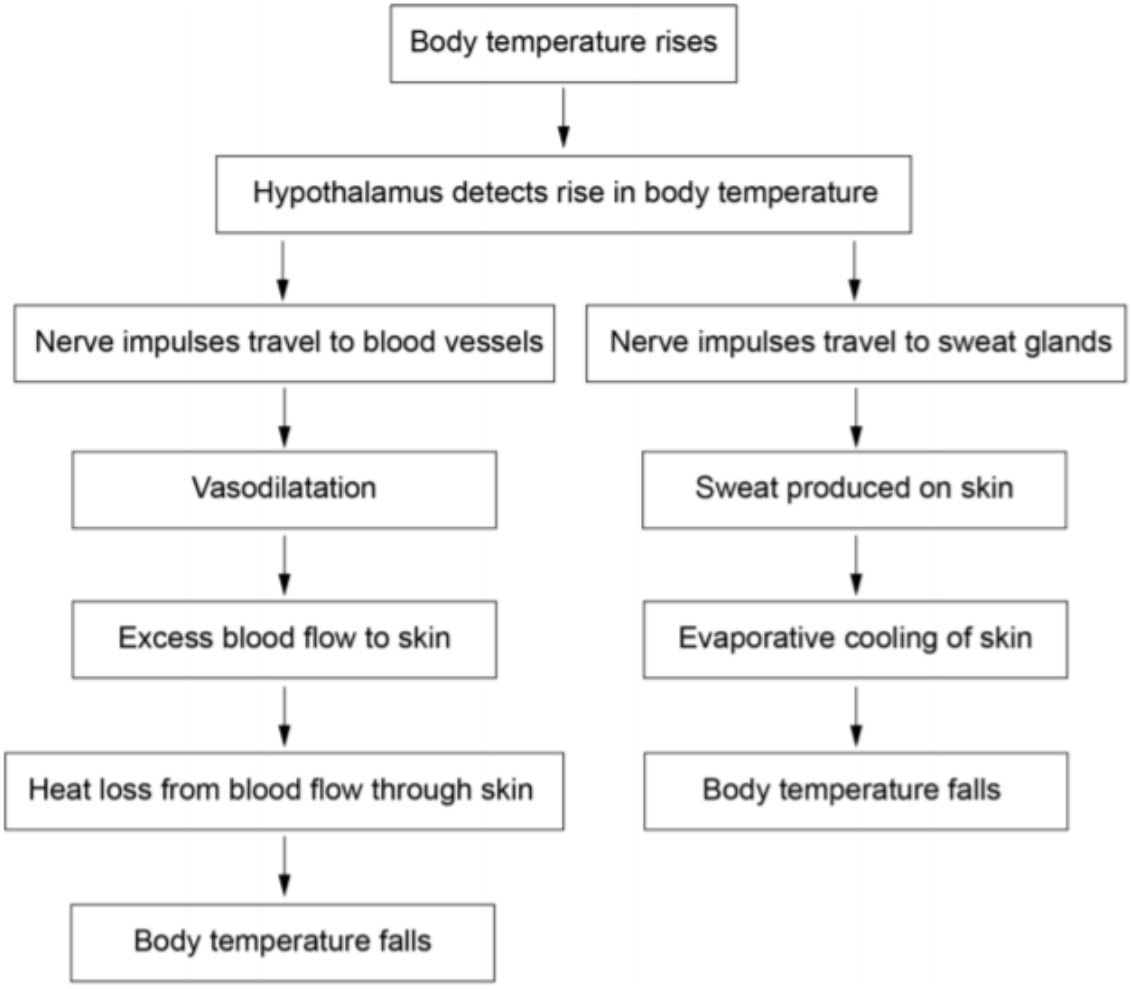
Fill in the three blank steps on the flow chart.



Question 21

Criteria	Marks
• Completes all steps in the flow chart correctly	3
• Completes some steps in the flow chart to demonstrate a basic understanding of the reaction	2
• Provides some relevant information	1

Sample answer:



Question 23 (5 marks)

Explain how educational programs can be effective in reducing the incidence of non-infectious diseases. Support your answer with examples. **5**

Question 23

Criteria	Marks
• Provides a thorough explanation of how educational programs reduce the incidence of non-infectious diseases • Supports answer with suitable examples	5
• Provides a sound explanation of how educational programs reduce the incidence of a non-infectious disease • Supports answer with suitable example(s)	4
• Provides some features of educational programs and links these to disease prevention • Provides a suitable example	3
• Provides some features or examples of educational programs that help prevent disease	2
• Provides some relevant information	1

Sample answer:

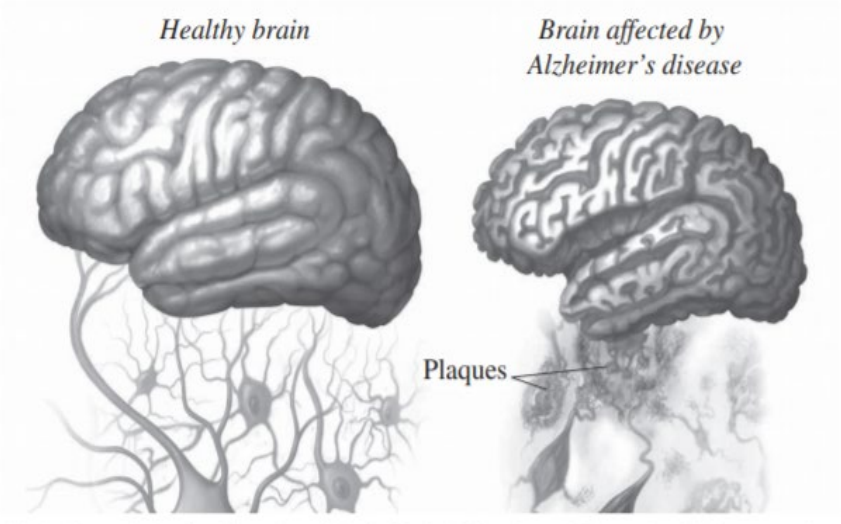
Name of disease:	*Program to prevent disease:*
Melanoma	Slip, slop, slap, seek, slide
Lung Cancer	Quit (smoking)

Public education programs can raise awareness of the risk of exposure to various harmful environmental agents. For example UV radiation can cause melanoma and tobacco smoke increases the risk of lung cancer. As a result of the programs, people can alter their behaviour to reduce their exposure to harmful situations. For example not everyone can avoid the sun in their daily lives but the program encourages them to wear a hat, shirt and sunscreen so that exposure to UV radiation is reduced. This reduces the risk of melanoma.

Question 33 (20 marks)

Alzheimer's disease causes destruction of brain tissue, dementia and eventually death.

The diagram shows the effect of Alzheimer's disease on the brain.



(a) Amyloid beta protein is produced in the human brain throughout life. In people with Alzheimer's disease, it accumulates in excessive amounts. **3**

Outline the main steps that brain cells use to make proteins such as amyloid beta.

Question 33 (a)

Criteria	Marks
• Outlines processes of transcription AND translation	3
• Provides features of transcription AND/OR translation	2
• Provides some relevant information	1

Sample answer:

The DNA is unzipped and a complementary mRNA strand is transcribed. The mRNA moves to the ribosomes where translation occurs. Each codon is matched to a tRNA molecule with a complementary anticodon and carries a specific amino acid. The amino acids are joined together to form a polypeptide/protein.

Question 33 (continued)

(b) The gene with the greatest known effect on the risk of developing late-onset Alzheimer's disease is called APOE. It is found on chromosome 19.

The APOE gene has multiple alleles, including e2, e3 and e4.

(i) What are multiple alleles? **2**

Question 33 (b) (i)

Criteria	Marks
• Provides a suitable definition	2
• Provides some relevant information	1

Sample answer:

Alleles are different versions of a gene. 'Multiple alleles' refers to three or more versions of a gene existing in a population.

(ii) The table shows the risk of developing Alzheimer's disease for various APOE genotypes compared to average risk in the population. **4**

APOE genotype	e2/e2	e2/e3	e2/e4	e3/e3	e3/e4	e4/e4
Risk of developing Alzheimer's disease (compared to average)	40% less likely	40% less likely	2.6 times more likely	Average	3.2 times more likely	14.9 times more likely

Risk of susceptibility, based on alleles. © Alzheimer.org

Analyse the data to assess the risk of developing Alzheimer's disease associated with the e2, e3 and e4 alleles.

Question 33 (b) (ii)

Criteria	Marks
• Analyses the data to provide relevant conclusions about the risk associated with the alleles and combinations of alleles	4
• Analyses the data to provide suitable conclusions about the risk associated with the alleles	3
• Outlines risks associated with alleles	2
• Provides some relevant information	1

Sample answer:

The presence of e2 reduces the risk of AD. When it is present in the homozygous genotype or heterozygous with e3 there is a 40% reduction in risk of AD. The e2 allele appears to mask the effect of the e3 allele (e2 is dominant over e3). When e2 is combined with e4 AD is 2.6 times more likely, suggesting that e2 cannot fully mask e4. If two e4 alleles are present the risk of AD is greatly increased and is 14.9 times more likely. This suggests that e2 reduces the risk of AD and that e4 significantly increases the risk of AD.

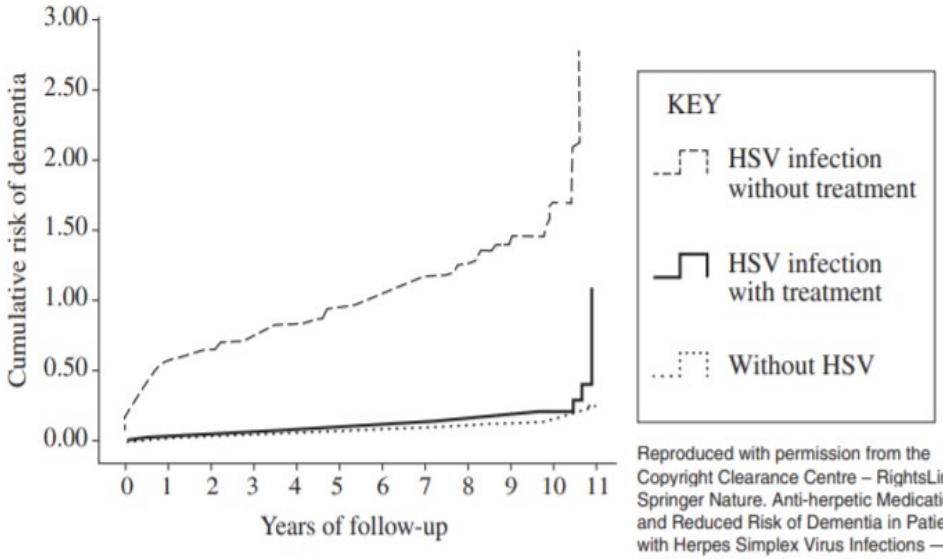
When the individual is homozygous for the e3 allele there is an average risk of AD. However when e3 and e4 are present together the presence of e3 appears to reduce the increased risk that is the result of the e4 allele (e3/e4 makes AD 3.2 times more likely).

Question 33 (continued)

(c) A large epidemiological study was conducted. It used historical data to investigate the association between *Herpes simplex* virus (HSV) infection and dementia. Dementia is caused by a variety of brain illnesses. Alzheimer's disease is the most common cause of dementia. **3**

The study used the records of 8362 patients with HSV infection and 25 086 randomly selected sex- and age-matched control patients without HSV infection. Some of the patients with HSV had been treated with antiviral medication.

The graph below shows some results of the study.



Describe the trends shown in the data.

Question 33 (c)

Criteria	Marks
• Describes trends in the data	3
• Outlines trends in the data	2
• Provides some relevant information	1

Sample answer:

Patients with untreated HSV infection have an increased risk of developing dementia each year compared to patients who are not infected or are treated. Both treated and untreated HSV infection groups show a sharp increase in the risk of dementia after 10 years, but the untreated HSV group increases to more than double the risk of the treated HSV group. The group that did not have HSV infection only has a very small increase in risk after 10 years.

Question 33 (continued)

(d) Diseases are classified as infectious or non-infectious. **8**

Evaluate whether Alzheimer's disease should be classified as an infectious disease or a non-infectious disease. In your answer, include reference to the information and data provided throughout Question 33.

Question 33 (d)

Criteria	Marks
• Demonstrates an extensive knowledge of infectious and non-infectious disease, including criteria for classification of disease • Supports the classification of AD with detailed and appropriate reference to information and data provided • Justifies a suitable judgement • Communicates logically and succinctly with precise biological terms	8
• Demonstrates a thorough knowledge of infectious and non-infectious disease, including criteria for classification of disease • Supports the classification of AD with appropriate reference to information and data provided • Justifies a suitable judgement • Communicates logically using biological terms	7
• Demonstrates a sound knowledge of infectious and non-infectious disease, including reference to criteria for classification of disease • Supports the classification of AD with some reference to information and data provided • Provides a suitable judgement • Communicates effectively using biological terms	5–6
• Demonstrates some knowledge of the infectious and/or non-infectious disease • Relates data to classification of AD	3–4
• Provides information about infectious or non-infectious disease and AD data OR • Relates data to classification of AD OR • Provides information about infectious and non-infectious disease	2
• Provides some relevant information	1

Sample answer:

Infectious diseases are caused by pathogens that can be passed from one person to another. A pathogen is established as a cause of disease using a rigorous set of criteria known as Koch's postulates.

The data from the study provides evidence for an association between untreated viral (HSV) infection and the increased risk of development of dementia. The data also shows that treating HSV patients with antiviral medication results in a much lower risk of dementia over the following years. This provides some evidence that the disease may be infectious – a result of infection with the virus *Herpes simplex*. A strength of the study was the large number of patients, the length of time of the study and the way the control group was matched to the HSV group. These factors add validity to the findings.

However, this does not prove that HSV actually causes dementia, as Koch's postulates would need to be fulfilled. Additionally the historical study obtained results about dementia, and not all of the dementia cases would have been Alzheimer's disease (although AD is the commonest cause of dementia). This reduces the validity of the findings in terms of establishing HSV as a cause of AD.

Non-infectious diseases do not spread from person to person and are not caused by pathogens. They are caused by other factors such as environmental factors or inherited genes.

AD is the result of the build up of amyloid protein. Protein synthesis is regulated by genes, suggesting the disease is non-infectious. The data about the APOE gene indicates that the presence of certain alleles, such as APOE-e4, result in a large increase in the risk of developing AD. It also appears that the presence of APOE-e2 allele reduces the risk of AD. This provides evidence for an inherited genetic basis for developing the disease, meaning that it could be classified as non-infectious. However, the development of AD may also be influenced by other genes and factors such as pathogens.

From the information provided it is not possible to classify Alzheimer's disease as infectious or non-infectious as there appears to be evidence that the risk of developing it is influenced by both a viral pathogen and genes.

Mod 8 – Question 10 (6 marks)

Glucose is a chemical that must be maintained at concentrations between 70 to 130 mg/dL in the blood in order for the body to function normally.

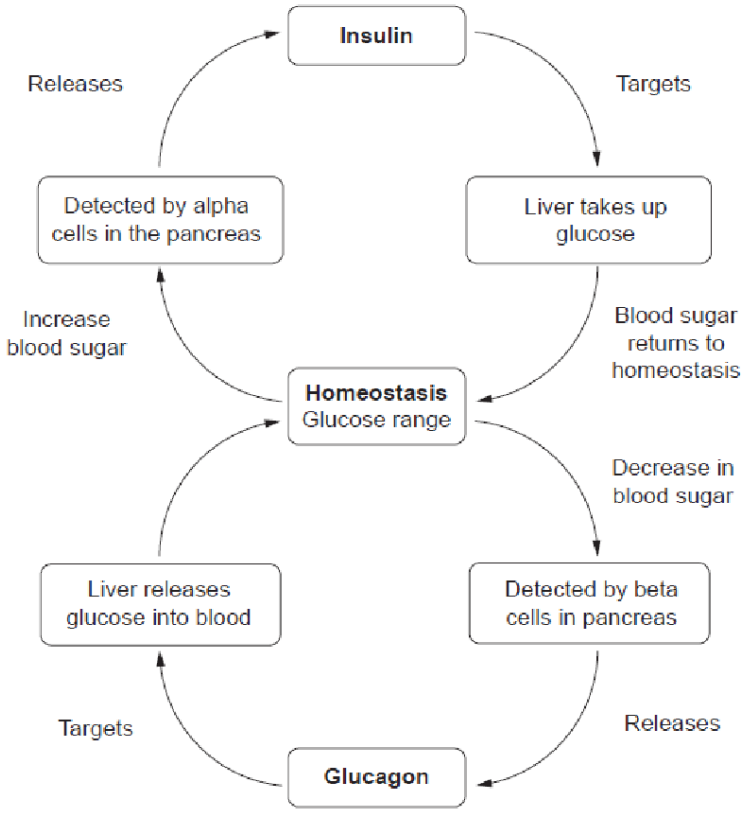
(a) Draw a diagram that illustrates how the body maintains blood glucose within this range. **3**

(b) Sketch a graph on the axes provided showing the expected blood glucose levels of both a healthy person and a diabetic person after consuming a fruit juice. On the same graph, show what would happen when the diabetic person injects themself with insulin 20 minutes after consuming the fruit juice. **3**

Marking guidelines (a):

Criteria	Marks
• Provides all relevant components ie pancreas, liver, relevant hormones • Draws appropriate sequence in feedback for both high and low blood sugar	3
• Draws relevant sequence of feedback for either high or low blood sugar OR • Draws a feedback system of both high and low blood sugar with missing components	2
• Provides some relevant information	1

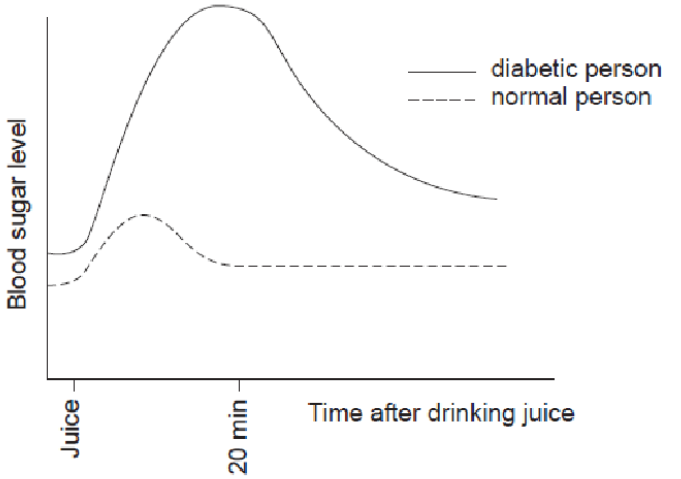
Sample answer:



Marking guidelines (b):

Criteria	Marks
• Provides correctly labelled axes and key • Draws representation of diabetic person with rapidly increasing blood glucose that decreases only after 20 minutes when insulin is taken • Draws representation of normal person with relatively low increase in blood glucose with decrease beginning before 20 minutes have elapsed	3
• Provides correctly labelled axes and key • Draws representation of diabetic person with rapidly increasing blood glucose in comparison to normal person	2
• Provides some relevant information	1

Sample answer:



Mod 8 – Question 11 (5 marks)

A scientist performed an epidemiological study to investigate the cause and effect relationship of smoking and lung cancer as follows. **5**

1. Handed out a scientifically valid questionnaire to all colleagues (n = 144) at work
2. Checked that there were an equal number of male and female respondents
3. Discovered that there were more non-smoking respondents than smoking respondents. Removed some of the non-smokers until both groups had equal numbers
4. Checked that all the respondents had a medical check-up in the past year
5. Analysed data, wrote the paper and published it in a scientific blog

From the information provided, assess the suitability of the methodology for this investigation.

Marking guidelines:

Criteria	Marks
• Makes an informed judgement of the suitability of the methodology • Outlines strengths and/or weaknesses in each part of the study	5
• Makes a judgement of the suitability of the methodology • Outlines strengths and/or weaknesses in some parts of the study	4
• Identifies strengths and/or weaknesses of the methodology • Outlines at least one strength or weakness	3
• Identifies strengths and/or weaknesses of the methodology OR • Outlines a weakness or a strength of the method	2
• Provides some relevant information	1

Sample answer:

The design of this study cannot validly lead to a link between disease and its likely causes. A valid questionnaire is good but the number of subjects is low and only confined to the workplace. The sample should be larger and broader. Ideally, the study should have a variety of equal categories, eg age, ethnicity, not just males: females equal. Participants should not be eliminated on the basis of their answers as this reduces the scientific validity. Any checks should be consistent, with a definite purpose related to the study, eg lungs checked. The final data should be peer reviewed for publication.

Mod 8 – Question 12 (3 marks)

Polio is a potentially life-threatening disease that can leave people permanently disabled. The poster shown is an example of an educational program that targets polio. **3**

Explain the benefits of such campaigns to the broader society.

Marking guidelines:

Criteria	Marks
• Explains benefits of such campaigns	3
• Explains a benefit of such campaigns OR • Outlines benefits of such campaigns	2
• Provides some relevant information	1

Sample answer:

Education programs designed to control and prevent the spread of a debilitating disease like polio have significant benefits to the broader society as they provide people with the education and information they need to help them to not contract polio in the first place. Because of this the government can save considerable amounts of money as education campaigns are typically much cheaper to run than supplying treatment and medical assistance to people ill with polio. Another benefit of education campaigns that prevent polio is that even after people are no longer sick with polio they can be left with significant disabilities that make it very difficult for them to work and as such they have a limited capacity to contribute to the economy and instead are often reliant on government assistance.

Mod 8 – Question 13 (6 marks)

(a) Identify a disorder or disease, and describe how it affects the normal function of an organ. **2**

(b) Evaluate the effectiveness of a technology in managing the disorder or disease described in part (a). **4**

Marking guidelines:

Criteria	Marks
• Identifies a disorder or disease and describes how it affects the normal function of an organ	2
• Provides some relevant information	1

Sample answer:

Polycystic kidney disease is a disease in which fluid-filled cysts grow in the kidney, interfering with the normal kidney tissue and limiting the kidney's ability to filter the blood. The number of cysts builds up over time, enlarging the kidney and reducing function. The disease is typically genetic in nature.

Marking guidelines (b):

Criteria	Marks
• Describes the circumstances in which an appropriate technology would be used • Describes how the technology functions to fulfil the normal function of the damaged organ • Outlines the benefits and limitations of the technology • Makes an informed judgement about the effectiveness of the technology	4
• Outlines the circumstances in which an appropriate technology would be used • Outlines how the technology functions to fulfil the normal function of the damaged organ • Identifies the benefits and limitations of the technology	3
• Outlines an appropriate technology • Identifies benefits and/or limitations of the technology	2
• Provides some relevant information	1

Sample answer:

People with polycystic kidney disease will typically progress to a point where kidney failure has occurred, at which point dialysis is required or the patient will die unless given a transplant. Dialysis technology works by taking over the normal function of the kidney, cleaning the patient's blood. There are two types of dialysis: haemodialysis and peritoneal dialysis. Haemodialysis is where the blood is removed from the patient and passed through the dialysis machine which uses osmosis to remove excess fluid, salts and toxins from the blood. This form of dialysis needs to be done 3 to 4 times a week and can take up to 4 hours. Patients typically need to go to a dialysis clinic for these treatments. Peritoneal dialysis in contrast uses the fluid in the peritoneal cavity and the systems of blood vessels lining the cavity to clean the blood. This is done by exchanging the fluid in the peritoneal cavity. Clean fluid is transferred into the peritoneal cavity and osmosis causes the excess salts and toxins to move from the blood into the fluid in the cavity. This fluid is then drained. This type of dialysis requires initial surgery to place the required catheter but has the benefit that the patient can manage the process themself in many instances.

Either form of dialysis is exceptionally effective, allowing people to live until such times as a kidney transplant becomes available. Without such technology people with kidney failure resulting from polycystic kidney disease would not survive beyond a week or so. As such, despite the inconvenience of having to visit haemodialysis clinics or manage peritoneal dialysis, this is a life-saving technology.

Mod 8 – Question 14 (7 marks)

Evaluate the effectiveness of renal dialysis in managing the loss of kidney function. 7

Marking guidelines:

Criteria	Marks
• Provides a clear and accurate description of the processes used by the kidney and in renal dialysis, using scientific terminology • Makes an informed judgement about the effectiveness of renal dialysis	7
• Provides a description of the processes used by both the kidney and in renal dialysis, using scientific terminology • Makes a judgement about the effectiveness of renal dialysis	6
• Provides an outline of some of the processes used by the kidney and in renal dialysis • Provides an advantage and a disadvantage of renal analysis	5
• Provides an outline of a process used by the kidney and/or in renal dialysis • Provides an advantage and/or a disadvantage of renal analysis	3–4
• Identifies a process used by the kidney and/or in renal dialysis OR • Identifies an advantage and/or a disadvantage of renal analysis	2
• Provides some relevant information	1

Answers could include:

Describes normal kidney function concerning:
- filtration
- selective reabsorption
- secretion
- hormonal control and feedback.

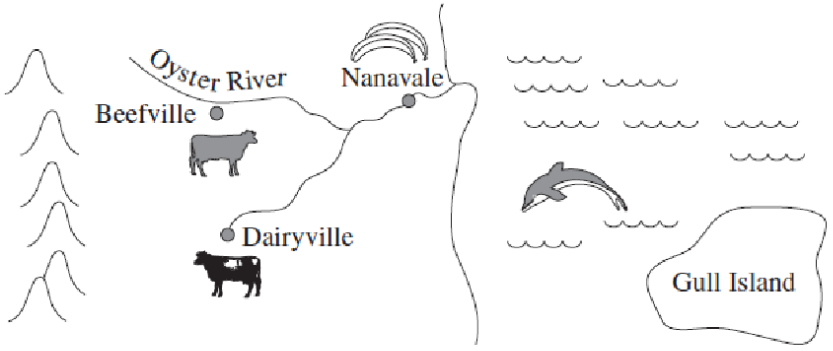
Describes renal dialysis with regard to need for:
- dialysis tubing
- countercurrent flow
- dialysis fluid.

Describes advantages and limitations of each process.

Makes a final judgement.

Mod 8 – Question 15 (7 marks)

The diagram shows a rural coastal area and the towns, rivers and associated 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.

Question 25

Criteria	Marks
• Shows thorough understanding of designing an investigation that takes into account validity and reliability • Shows thorough understanding of how an epidemiological study can be carried out in this scenario to investigate the origin of the disease • 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 • Shows sound understanding of how an epidemiological study can be carried out in this scenario • 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 • Shows some understanding of analysing patterns of non-infectious diseases, gathering data and/or analysing results in this investigation • 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.

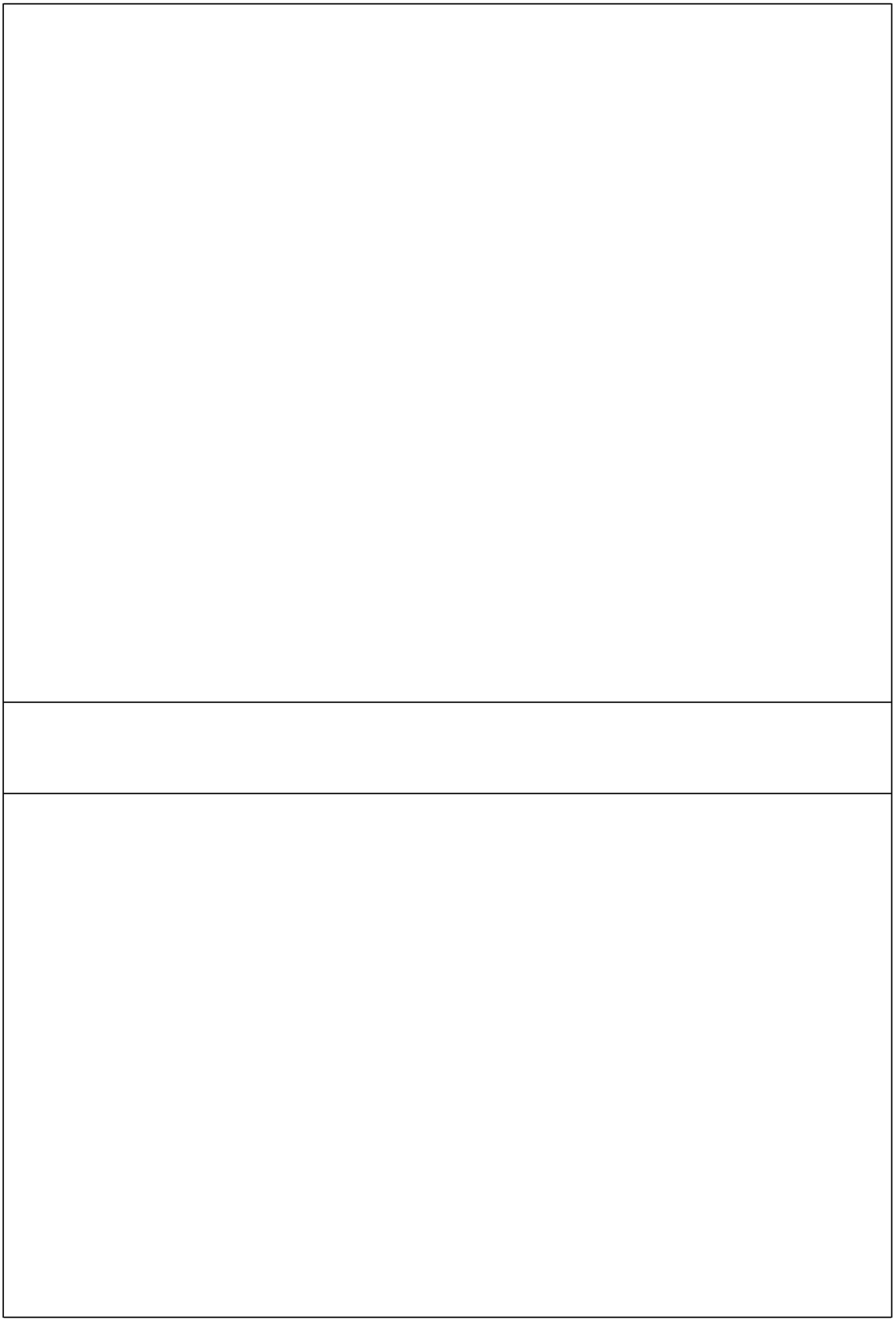
If we find common features, we would then interview a number of unaffected families to see whether they had been to the same places or done the same things but not been affected. This

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.

INQUIRY QUESTION/Content statement	
HYPOTHESIS	
AIM	
EQUIPMENT	**DIAGRAM**
Experimental design Independent variable Dependent variable Controlled variable	
PROCEDURE	
Risk Assessment	



RESULTS (tables, graphs, observation in sentences)

Validity and reliability

DISCUSSION AND CONCLUSION

Explain your results, relate to collection of evidences to answer the inquiry question, hypothesis and aim.

Glossary of verbs – NESA

Analyse
Identify components and the relationship between them; draw out and relate implications

Apply
Use, utilise, employ in a particular situation

Appreciate
Make a judgement about the value of

Assess
Make a judgement of value, quality, outcomes, results or size

Calculate
Ascertain/determine from given facts, figures or information

Clarify
Make clear or plain

Classify
Arrange or include in classes/categories

Compare
Show how things are similar or different

Construct
Make; build; put together items or arguments

Contrast
Show how things are different or opposite

Critically (analyse/evaluate)
Add a degree or level of accuracy depth, knowledge and understanding, logic, questioning, reflection and quality to (analyse/evaluate)

Deduce
Draw conclusions

Define
State meaning and identify essential qualities

Demonstrate
Show by example

Describe
Provide characteristics and features

Discuss
Identify issues and provide points for and/or against

Distinguish
Recognise or note/indicate as being distinct or different from; to note differences between

Evaluate
Make a judgement based on criteria; determine the value of

Examine
Inquire into

Explain
Relate cause and effect; make the relationships between things evident; provide why and/or how

Extract
Choose relevant and/or appropriate details

Extrapolate
Infer from what is known

Identify
Recognise and name

Interpret
Draw meaning from

Investigate
Plan, inquire into and draw conclusions about

Justify
Support an argument or conclusion

Outline
Sketch in general terms; indicate the main features of

Predict
Suggest what may happen based on available information

Propose
Put forward (for example a point of view, idea, argument, suggestion) for consideration or action

Recall
Present remembered ideas, facts or experiences

Recommend
Provide reasons in favour

Recount
Retell a series of events

Summarise
Express, concisely, the relevant details

Synthesise
Putting together various elements to make a whole

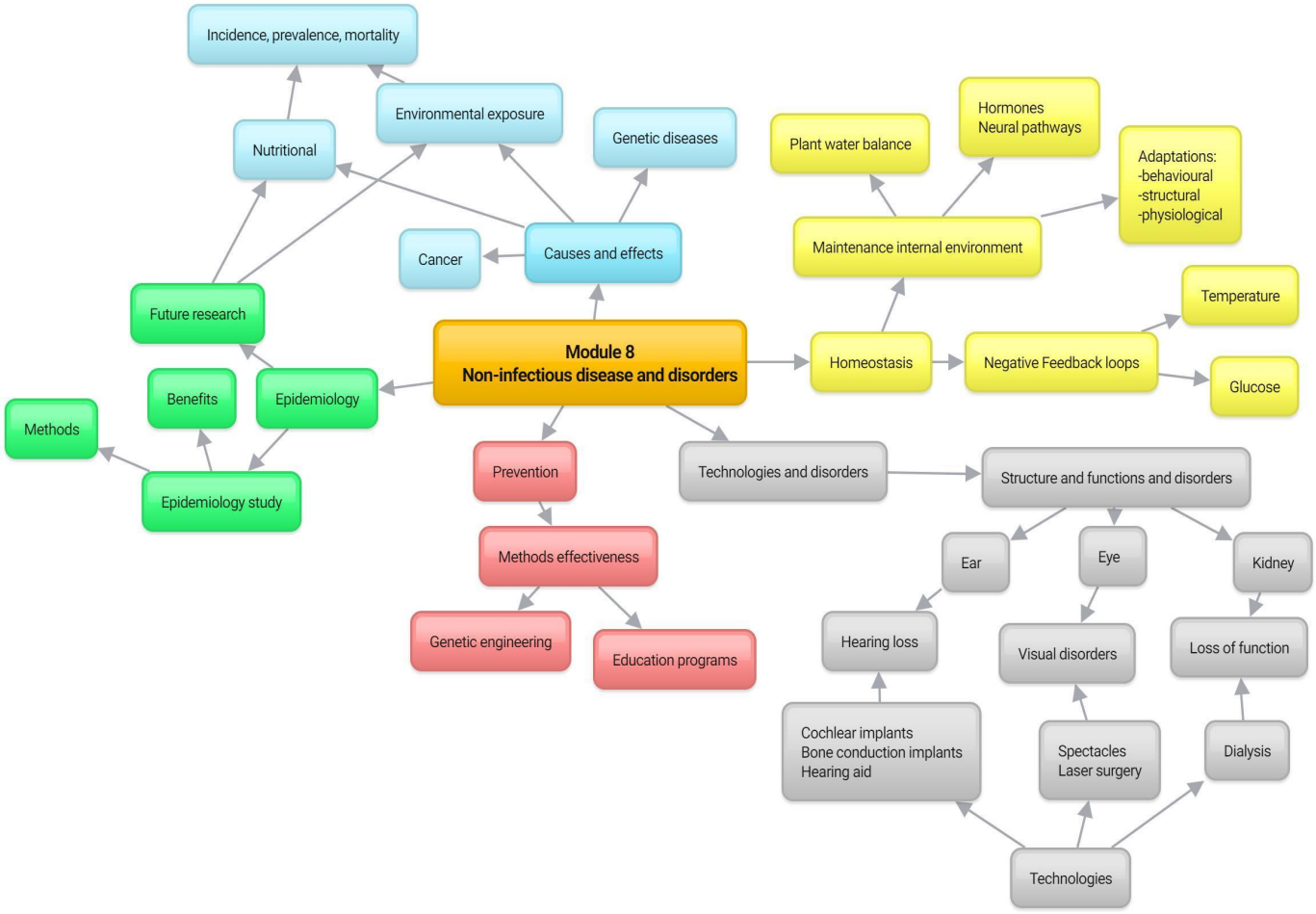
Module 8

Outcomes

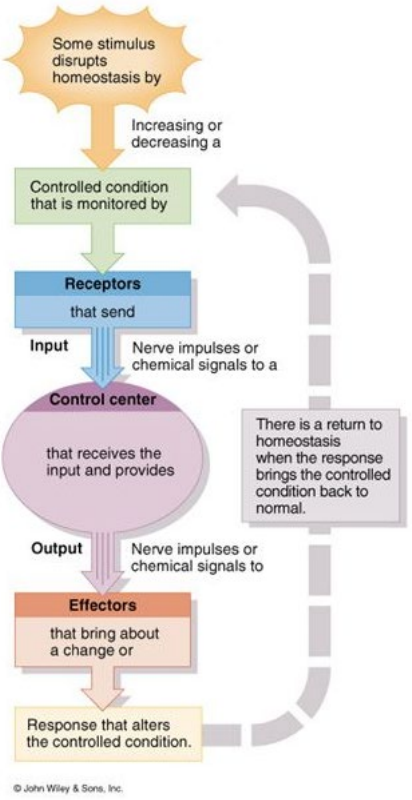
A student:

› analyses and evaluates primary and secondary data and information BIO11/12-5
› solves scientific problems using primary and secondary data, critical thinking skills and scientific processes BIO11/12-6
› communicates scientific understanding using suitable language and terminology for a specific audience or purpose BIO11/12-7
› explains non-infectious disease and disorders and a range of technologies and methods used to assist, control, prevent and treat non-infectious disease BIO12-15

Module concept map



Content

Homeostasis	*How to address the inquiry question and content statements*
Inquiry question: How is an organism's internal environment maintained in response to a changing external environment?	Define homeostasis, learn examples how homeostatic processes work when there are changes in the external environment, e.g. temperature, pH, sugar levels, water salinity.
● construct and interpret negative feedback loops that show homeostasis by using a range of sources, including but not limited to: (ACSBL101, ACSBL110, ACSBL111)	Learn ALL the examples below, temperature and glucose. There are many flow charts on the internet as models for this. Remember that those feedback loops must be annotated with a clear explanation of the processes involved. This is the basic negative feedback loop: stimulus, receptor, control centre, effector, response. 
– temperature (ACSBL098)	Replace the flow chart above with the processes to keep internal temperature constant
– glucose	Replace the flow chart above with the processes to keep internal sugar levels constant
● investigate the various mechanisms used by organisms to maintain their internal environment within tolerance limits, including:	Learn well all the content statements below. Focus on the verb investigate to draw conclusions about the mechanisms
– trends and patterns in behavioural, structural and physiological adaptations in endotherms that assist in maintaining homeostasis (ACSBL099, ACSBL114)	Define endotherms – generate own body heat to maintain a constant internal environment. Outline behavioural (e.g. move to sheltered areas, away from the heat), structural (e.g. skin features: spikes to collect water, fur colour) and physiological (e.g. increase/decrease blood flow to the surface of the skin) trends and patterns.
– internal coordination systems that allow homeostasis to be maintained, including hormones and neural pathways (ACSBL112, ACSBL113, ACSBL114)	Hormones pathways in the endocrine system – e.g. kidney hormones to maintain water balance, pancreas insulin release for blood sugar levels. Neural pathways – relationship between the sensors and effectors with the central nervous system to respond to stimulus.

	Tabulate differences between the two pathways, e.g. speed of response, long/short lasting response.
– mechanisms in plants that allow water balance to be maintained (ACSBL115)	Outline structural and physiological responses to maintain water balance: thin leaves, waxy cuticle, sunken stomata, decreasing photosynthesis, dropping leaves, reducing transpiration by closing stomata, deep root systems.
Cause and responses	
Inquiry question: Do non-infectious diseases cause more deaths than infectious diseases?	Define non-infectious disease as a non-transmittable/communicable disease that means it is not caused by a pathogen. Today non-infectious diseases exceed the number of deaths compared with infectious diseases.
● investigate the causes and host responses of non-infectious diseases in humans, including but not limited to:	Learn ALL the types of non-infectious disease below. Focus on causes and host responses, including symptoms. Learn an example/case study for each of them.
– genetic diseases	Genetic diseases are inherited diseases. Examples: sickle cell anaemia, Down syndrome
– diseases caused by environmental exposure	Outline mutagens that are causes of environmental non-infectious diseases, e.g. UV light, radiation, chemicals. Examples: asbestosis, skin cancer, environmental lymphomas
– nutritional diseases	Outline nutritional deficiency disorders such as, Rickets and Scurvy Eating disorders.
– cancer	Explain what causes cancer – uncontrolled division of body cells due to a mutation in cell cycle control. Examples: breast cancer, lung cancer, prostate cancer.
● collect data that shows the incidence, prevalence and mortality rates of non-infectious disease, for example:	Define incidence, prevalence and mortality Learn ONE example from below. The collection of data for the incidence, prevalence and mortality rates can be gathered from many data sets available publicly from the World Health Organisation and Cancer Council in Australia.
– nutritional diseases	WHO datasets https://www.who.int/gho/en/
– diseases caused by environmental exposure	Lung cancer has a lot of information and data sets.
Epidemiology	
Inquiry question: Why are epidemiological studies used?	Define epidemiology and epidemiological studies. Outline the uses of epidemiological studies: Identify correlations between diseases and risk factors to understand causes and effects of non-infectious diseases Analyse patterns and trends Suggest control, treatment and preventions
● analyse patterns of non-infectious diseases in populations, including their incidence and prevalence, including but not limited to:	Using the data collected in the previous content statement, analyse the patterns: incidence, prevalence, mortality and morbidity.
– nutritional diseases	Vitamin deficiency diseases has a lot of data in the internet
– diseases caused by environmental exposure	Lung cancer and asbestosis are the common ones to study.
● investigate the treatment/management, and possible future directions for further research,	Learn ONE case study well. Focus on treatment and management of symptoms, including current and future research of the disease.

of a non-infectious disease using an example from one of the non-infectious diseases categories listed above	Examples Melanoma – treatments: surgery/chemo-radiotherapy. Future directions: monoclonal antibodies for CDK4 antigen Type 2 diabetes – treatment/management: diet. Future directions: improvement in gut health
● evaluate the method used in an example of an epidemiological study	Focus on the verb evaluate to make a judgement about the value of the study, the length of time invested, the specificity of the population and limitations of the study Learn the methodology of epidemiological study well, following a set of steps: Identification of the disease, length of the study, variables controlled and large number of populations has to be taken into account for a valid study Data collection and analysis Causes and effects analysed, risk factors identified. Suggested control and prevention Examples: lung cancer, melanoma, asbestos, breast cancer.
● evaluate, using examples, the benefits of engaging in an epidemiological study	Focus on the verb evaluate to make a judgement about the study such as identification of risk factors, resources needed for health care, prevention, control and treatments, educational campaigns and future research directions. Learn more than one example: Cervical cancer
Prevention	
Inquiry question: How can non-infectious diseases be prevented?	Prevention refers to actions to reduce or eliminate the onset, causes and recurrence of disease.
● use secondary sources to evaluate the effectiveness of current disease-prevention methods and develop strategies for the prevention of a non-infectious disease, including but not limited to:	Focus on the verb evaluate to make a judgment about the effectiveness of prevention methods of non-infectious disease. The effectiveness relates to how the method or strategy reduces the incidence and prevalence of non-infectious disease and its prevention. Learn ALL the methods listed below
– educational programs and campaigns	Examples to research: Vaccination programs Quit Smoking campaign Sunsmart Assessing Cost Effectiveness Prevention study Bowel Cancer Screening Breast Cancer screening The Council Cancer Australia website has many of those programs and the Australian Institute of Health and Welfare has many data sources about those campaigns.
– genetic engineering	Molecular genetics helped to identify the non-infectious disease at genetic level and identify genes affected. Identification of those genes in people allows for preventive measurements, e.g breast cancer genes BRCA1 and BRCA2.

Technologies and Disorders	
Inquiry question: How can technologies be used to assist people who experience disorders?	Technologies that helped people with disorders are: Hearing aids Cochlear implants Visual aids: glasses, contact lenses, Braille systems Corneal transplants Dialysis machines Pacemakers Insulin pumps Discuss how those technologies assist people with the disorder: improve quality of life, increase survival rates.
• explain a range of causes of disorders by investigating the structures and functions of the relevant organs, for example:	Learn structures and functions of: Ear Eyes Kidneys Tabulate structures and functions Relate the cause and effect of lack of functions in those organs Learn ALL the examples listed below.
– hearing loss	Causes of hearing loss: -conductive (ear canal, eardrum, middle ear, ear ossicles) due to infections, trauma. -sensorineural (inner ear nerve cells or hairs) due to exposure to excessive noise, drugs, viral infections, trauma. -mixed hearing loss: combination of the two listed above
– visual disorders	Disorders and causes: -myopia (short-sighted) refractive error, distance between the retina and lens is too great -hyperopia (long sighted) refractive error, distance between the retina and the lens is too small -astigmatism cornea or lens irregularly shaped -cataracts lens is clouded over -macular degeneration deterioration of the macula in the central inner lining of the retina -glaucoma damage to the optic nerve due to increase pressure
– loss of kidney function	-chronic kidney disease due to smoking, drinking, high blood pressure, diabetes, trauma, infections, chronic inflammation, nephritic disease
• investigate technologies that are used to assist with the effects of a disorder, including but not limited to: (ACSBL100)	Focus on how technology assists in helping to restore the function of the organ. Reach conclusions
– hearing loss: cochlear implants, bone conduction implants, hearing aids	Cochlear implants: a sound processor is implanted that transforms the sound into an electrical impulse send via an electrode inserted in the cochlea Bone conduction implants: replace the conductive hearing loss, sound processor conducting the sound vibrations to the inner ear Hearing aids: replace conductive hearing loss, a microphone picks sound waves and amplifies them.
– visual disorders: spectacles, laser surgery	Explain how the follow technologies assist the disorder Spectacles and contact lenses: correct the refractive errors Laser surgery: correct refractive errors by reshaping the cornea. Cataract surgery: replacement of the opaque lens by an artificial intraocular lens

– loss of kidney function: dialysis	Haemodialysis: patient is connected to a machine that filters the blood of nitrogenous waste Peritoneal dialysis: tube inserted in the peritoneum which act as the blood filter using a dialysis fluid
• evaluate the effectiveness of a technology that is used to manage and assist with the effects of a disorder (ACSBL100)	Effectiveness relates to the value of the technology to assist the organ disorder in terms of cost, affordability, potential side effects, risks of intervention (surgery), lifespan of the technology, recovery/training after the technology is implanted. Hearing aid – cheap and easy to implant, digitalised, smaller in size Cataract surgery – short surgery, instant recovery Spectacles – cheap, easy to use, instant fixed Dialysis – long term procedure, time consumed, side effects on long term

Exam questions related to Module 8

Multiple choices

Exam paper 2019

6 How does the cochlear implant assist people with severe hearing loss?

A. It amplifies sound.

B. It stimulates the ear drum.

C. It stimulates the auditory nerve.

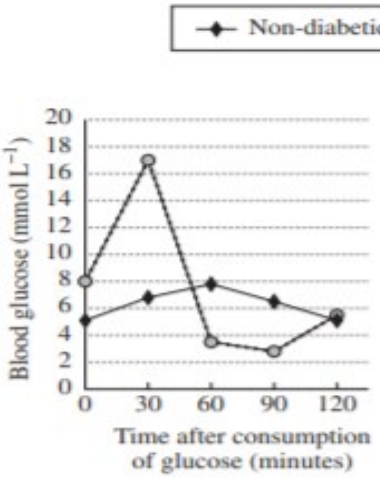
D. It amplifies vibrations in the cochlea.

12 The glucose tolerance test is used to investigate the control of glucose in the human body. Patients consume 75 g of glucose and their blood glucose is monitored.

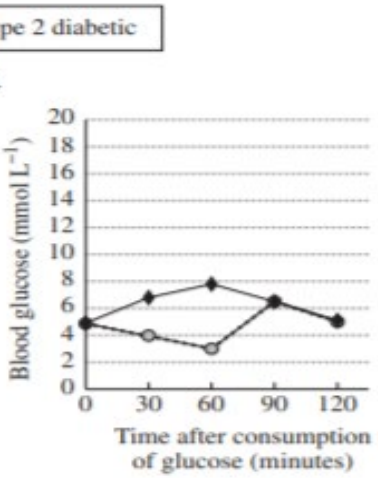
Type 2 diabetes is a condition where the cells of the body do not respond adequately to insulin.

Which graph could represent the results of glucose tolerance tests in a non-diabetic person and a person with untreated Type 2 diabetes?

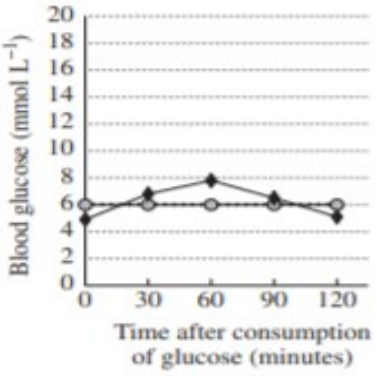
A.



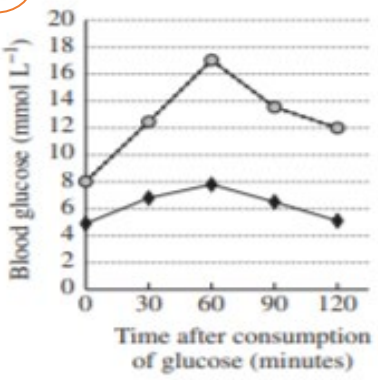
B.



C.

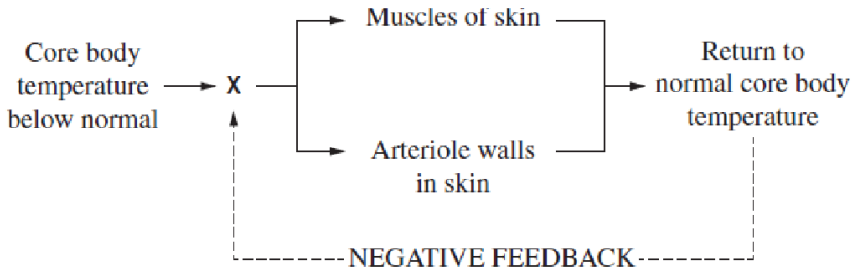


D.



Mod 8 – Question 1

The diagram shows a homeostatic mechanism in a mammal.



What does **X** represent in the diagram?

A. The brain

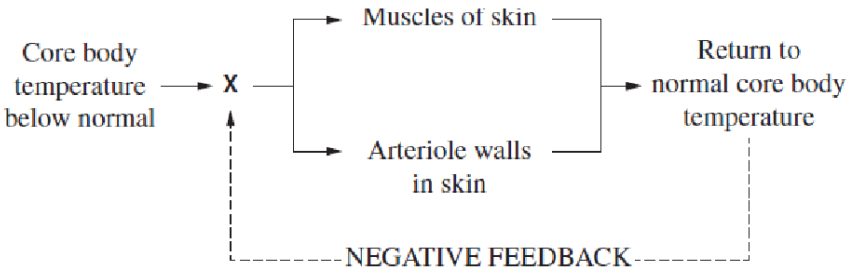
B. The heart

C. A thermoreceptor in the skin

D. A pressure receptor in a blood vessel

Mod 8 – Question 2

The diagram shows a homeostatic mechanism in a mammal.



Which row of the table describes what happens to the muscles and the arteriole walls in the skin when the core body temperature is below normal?

	Muscles of skin	*Arteriole walls in skin*
A.	Relax to lower epidermal hairs	Expand
B.	Contract to raise epidermal hairs	Contract
C.	Relax to raise epidermal hairs	Expand
D.	Contract to lower epidermal hairs	Contract

Mod 8 – Question 3

A student wanted to test the claim, made by an agricultural seed company, that their variety of wheat was more salt tolerant than other wheat varieties on the market. The company explained that their variety can better maintain water balance by increasing the organic salt concentration in the roots of the plants which increases osmotic pressure.

Which row of the table shows the independent and dependent variables that the student should use to test the company's claim?

	Independent	*Dependent*
A.	Salt concentration	Leaf turgor
B.	Salt concentration	Growth rate
C.	Variety of wheat plant	Organic salt concentration in roots
D.	Variety of wheat plant	Leaf turgor

Mod 8 – Question 4

What is the main focus of the study of epidemiology?

A. Skin diseases

B. Changes in the characteristics of a species

C. Factors involved in the occurrence, prevalence and spread of disease

D. How the body maintains its functions in response to variations in the environment

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

Mod 8 – Question 6

For many years, some cigarette companies have denied that there were increased risks of lung cancer as a result of cigarette smoking.

How can an epidemiological study into lung cancer be useful in this situation?

A. It can show that the chemicals in cigarette smoke cause cancer.

B. It can demonstrate that second-hand smoke has no impact on lung cancer rates.

C. It can provide evidence that people who smoke are more likely to develop lung cancer.

D. It can show that the cigarette companies have been lying about the cause of lung cancer.

Mod 8 – Question 7

Which of the following is an example of an educational program to reduce the incidence of skin cancer?

A. An advertising campaign on TV to promote sun safety
B. Making sunscreen freely available at pools and beaches
C. Increasing the availability of skin checks in regional centres
D. Providing free training to doctors to help them diagnose skin cancers

Mod 8 – Question 8

A patient has been diagnosed with severe hearing loss in the inner ear.

Which type of hearing technology can be used to help restore the patient's hearing?

A. Hearing aid
B. Cochlear implant
C. Artificial ear drum
D. Bone conduction implant

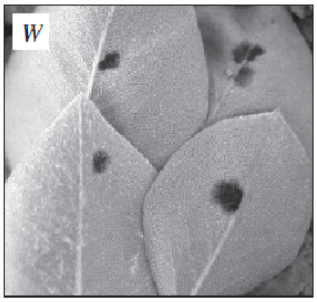
Mod 8 – Question 9

A patient has experienced an injury that affected the retina of her eye. She asked her doctor if LASIK eye surgery could help restore her sight. The doctor said that LASIK eye surgery would have no impact on her condition.

Why did the doctor give this advice?

A. LASIK eye surgery is a replacement of the lens in the eye and cannot repair a retina
B. LASIK eye surgery will only temporarily repair her retina and her vision problems would return
C. LASIK eye surgery is only used for people who have a damaged cornea and cannot repair a retina
D. LASIK eye surgery is only used to change the shape of the cornea to enhance vision and cannot repair a retina

11 The following plants were presented to a quarantine office in Australia as part of a shipment of plants entering Australia for the plant nursery trade.



A photograph, 'Spots observed on the underside of a cultivar Bartlett', photo by Jay Pscheidt, Oregon State University, 2013 – taken from https://pnwhandbooks.org/plantdisease/host-disease/pear-pyrus-spp-scab

https://orchardpeople.com/wp-content/uploads/2017/09/IMG_3168-2.jpg

'Oak leaf blister (Taphrina Caerulescens)', Joseph Obrien, USDA Forest Service, Bugwood.org

This material cannot be displayed, due to copyright issues.

Which of the following is a decision that the quarantine office is likely to make?

A. Plant *W* can enter Australia as it looks like it has 'black spot' which already occurs in Australia.

B. Plant *X* can enter Australia as it is unlikely the disease it has will transfer to Australian species.

C. Plant *Y* cannot enter Australia as it has a disease caused by shortage of soil magnesium.

D. Plant *Z* cannot enter Australia because its appearance suggests it may be carrying live insects.

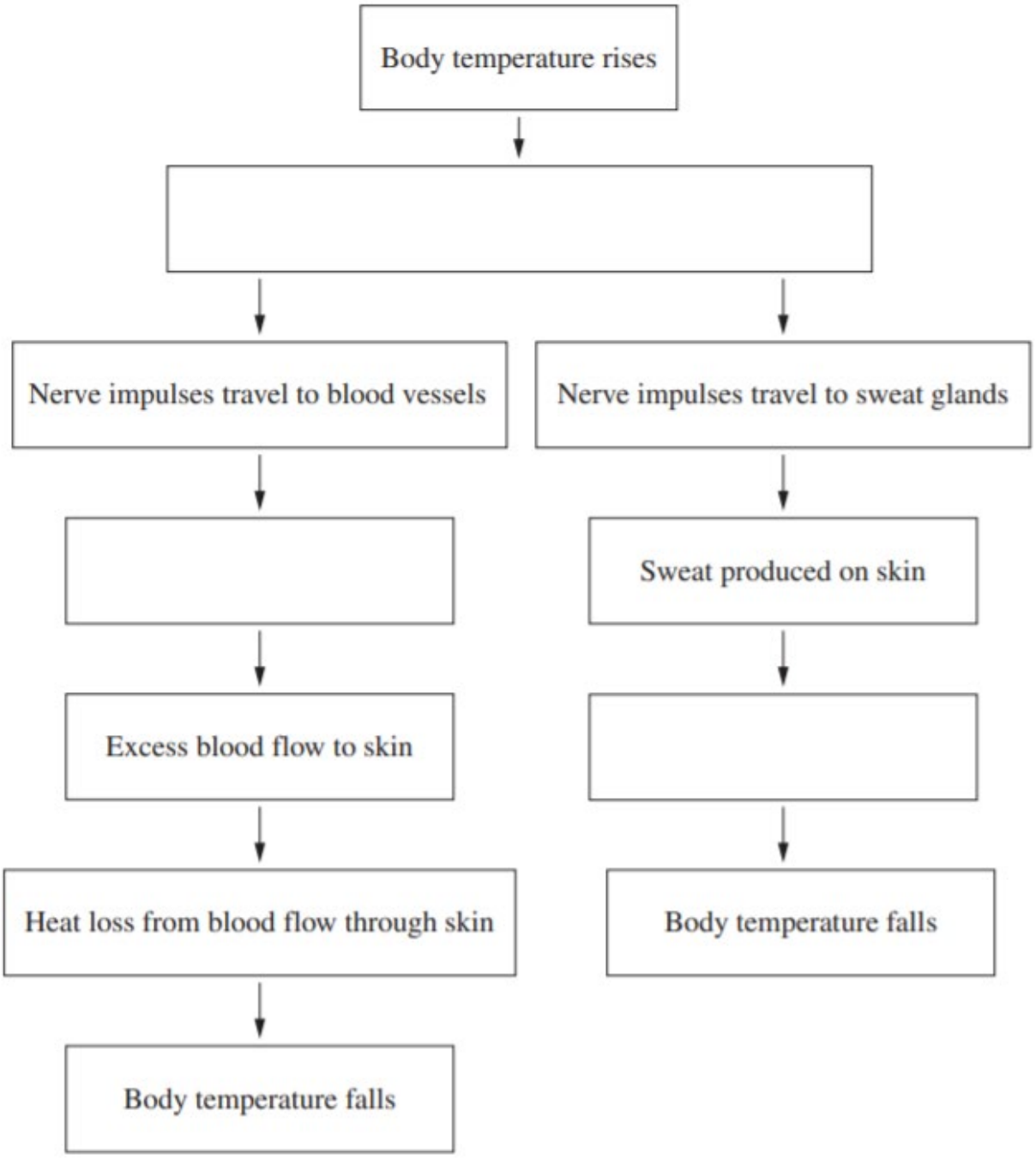
Extended responses

Exam paper 2019

Question 21 (3 marks)

The diagram shows a flow chart of the reaction of a human body to an increase in temperature. **3**

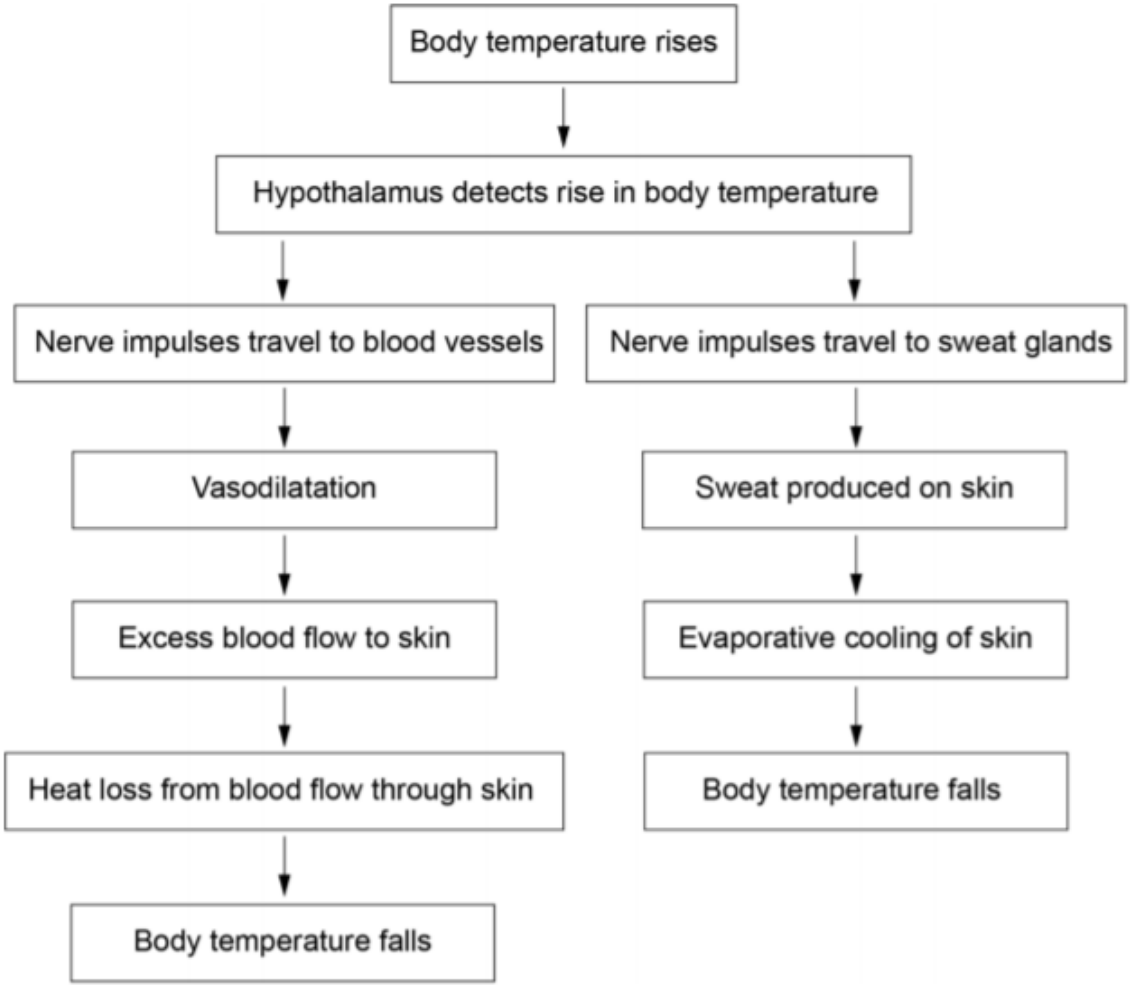
Fill in the three blank steps on the flow chart.



Question 21

Criteria	Marks
• Completes all steps in the flow chart correctly	3
• Completes some steps in the flow chart to demonstrate a basic understanding of the reaction	2
• Provides some relevant information	1

Sample answer:



Question 23 (5 marks)

Explain how educational programs can be effective in reducing the incidence of non-infectious diseases. Support your answer with examples. **5**

Question 23

Criteria	Marks
• Provides a thorough explanation of how educational programs reduce the incidence of non-infectious diseases • Supports answer with suitable examples	5
• Provides a sound explanation of how educational programs reduce the incidence of a non-infectious disease • Supports answer with suitable example(s)	4
• Provides some features of educational programs and links these to disease prevention • Provides a suitable example	3
• Provides some features or examples of educational programs that help prevent disease	2
• Provides some relevant information	1

Sample answer:

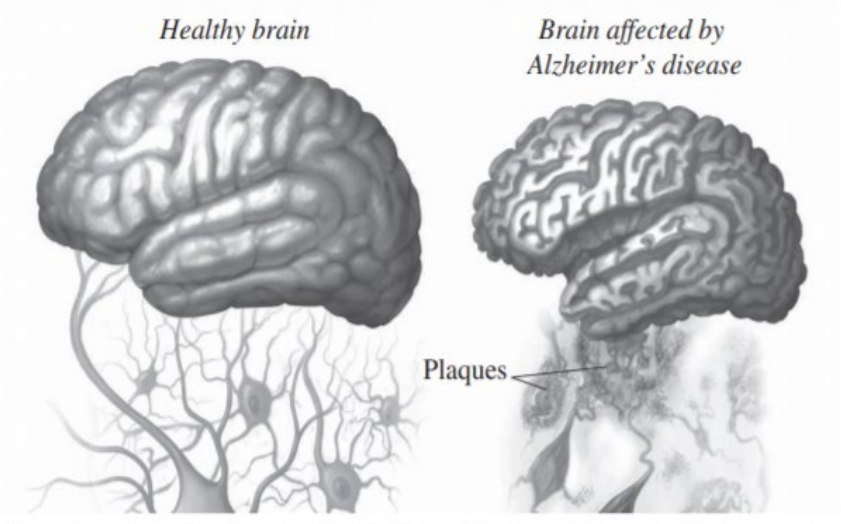
Name of disease:	*Program to prevent disease:*
Melanoma	Slip, slop, slap, seek, slide
Lung Cancer	Quit (smoking)

Public education programs can raise awareness of the risk of exposure to various harmful environmental agents. For example UV radiation can cause melanoma and tobacco smoke increases the risk of lung cancer. As a result of the programs, people can alter their behaviour to reduce their exposure to harmful situations. For example not everyone can avoid the sun in their daily lives but the program encourages them to wear a hat, shirt and sunscreen so that exposure to UV radiation is reduced. This reduces the risk of melanoma.

Question 33 (20 marks)

Alzheimer's disease causes destruction of brain tissue, dementia and eventually death.

The diagram shows the effect of Alzheimer's disease on the brain.



(a) Amyloid beta protein is produced in the human brain throughout life. In people with Alzheimer's disease, it accumulates in excessive amounts. **3**

Outline the main steps that brain cells use to make proteins such as amyloid beta.

Question 33 (a)

Criteria	Marks
• Outlines processes of transcription AND translation	3
• Provides features of transcription AND/OR translation	2
• Provides some relevant information	1

Sample answer:

The DNA is unzipped and a complementary mRNA strand is transcribed. The mRNA moves to the ribosomes where translation occurs. Each codon is matched to a tRNA molecule with a complementary anticodon and carries a specific amino acid. The amino acids are joined together to form a polypeptide/protein.

Question 33 (continued)

(b) The gene with the greatest known effect on the risk of developing late-onset Alzheimer's disease is called APOE. It is found on chromosome 19.

The APOE gene has multiple alleles, including e2, e3 and e4.

(i) What are multiple alleles? **2**

Question 33 (b) (i)

Criteria	Marks
• Provides a suitable definition	2
• Provides some relevant information	1

Sample answer:

Alleles are different versions of a gene. 'Multiple alleles' refers to three or more versions of a gene existing in a population.

(ii) The table shows the risk of developing Alzheimer's disease for various APOE genotypes compared to average risk in the population. **4**

APOE genotype	e2/e2	e2/e3	e2/e4	e3/e3	e3/e4	e4/e4
Risk of developing Alzheimer's disease (compared to average)	40% less likely	40% less likely	2.6 times more likely	Average	3.2 times more likely	14.9 times more likely

Risk of susceptibility, based on alleles. © Alzheimer.org

Analyse the data to assess the risk of developing Alzheimer's disease associated with the e2, e3 and e4 alleles.

Question 33 (b) (ii)

Criteria	Marks
• Analyses the data to provide relevant conclusions about the risk associated with the alleles and combinations of alleles	4
• Analyses the data to provide suitable conclusions about the risk associated with the alleles	3
• Outlines risks associated with alleles	2
• Provides some relevant information	1

Sample answer:

The presence of e2 reduces the risk of AD. When it is present in the homozygous genotype or heterozygous with e3 there is a 40% reduction in risk of AD. The e2 allele appears to mask the effect of the e3 allele (e2 is dominant over e3). When e2 is combined with e4 AD is 2.6 times more likely, suggesting that e2 cannot fully mask e4. If two e4 alleles are present the risk of AD is greatly increased and is 14.9 times more likely. This suggests that e2 reduces the risk of AD and that e4 significantly increases the risk of AD.

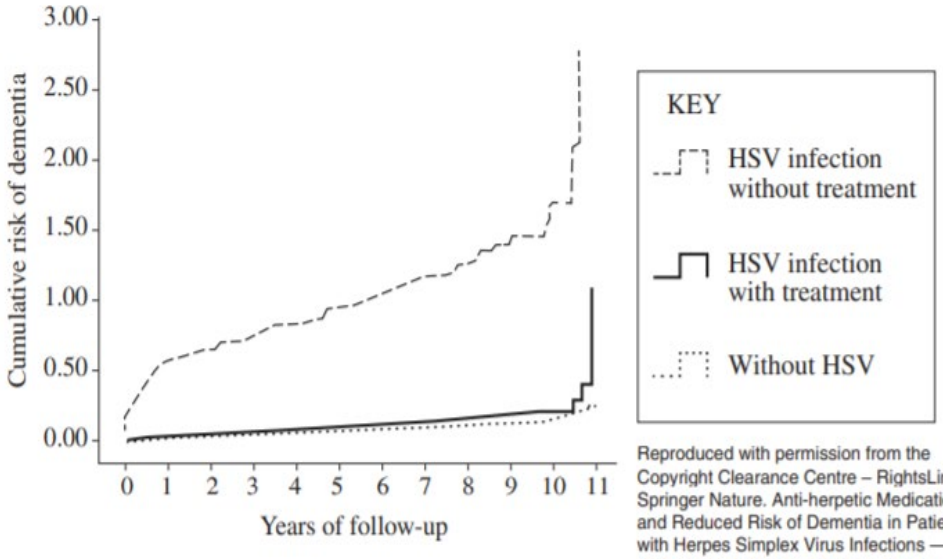
When the individual is homozygous for the e3 allele there is an average risk of AD. However when e3 and e4 are present together the presence of e3 appears to reduce the increased risk that is the result of the e4 allele (e3/e4 makes AD 3.2 times more likely).

Question 33 (continued)

(c) A large epidemiological study was conducted. It used historical data to investigate the association between *Herpes simplex* virus (HSV) infection and dementia. Dementia is caused by a variety of brain illnesses. Alzheimer's disease is the most common cause of dementia. **3**

The study used the records of 8362 patients with HSV infection and 25 086 randomly selected sex- and age-matched control patients without HSV infection. Some of the patients with HSV had been treated with antiviral medication.

The graph below shows some results of the study.



Describe the trends shown in the data.

Question 33 (c)

Criteria	Marks
• Describes trends in the data	3
• Outlines trends in the data	2
• Provides some relevant information	1

Sample answer:

Patients with untreated HSV infection have an increased risk of developing dementia each year compared to patients who are not infected or are treated. Both treated and untreated HSV infection groups show a sharp increase in the risk of dementia after 10 years, but the untreated HSV group increases to more than double the risk of the treated HSV group. The group that did not have HSV infection only has a very small increase in risk after 10 years.

Question 33 (continued)

(d) Diseases are classified as infectious or non-infectious. **8**

Evaluate whether Alzheimer's disease should be classified as an infectious disease or a non-infectious disease. In your answer, include reference to the information and data provided throughout Question 33.

Question 33 (d)

Criteria	Marks
• Demonstrates an extensive knowledge of infectious and non-infectious disease, including criteria for classification of disease • Supports the classification of AD with detailed and appropriate reference to information and data provided • Justifies a suitable judgement • Communicates logically and succinctly with precise biological terms	8
• Demonstrates a thorough knowledge of infectious and non-infectious disease, including criteria for classification of disease • Supports the classification of AD with appropriate reference to information and data provided • Justifies a suitable judgement • Communicates logically using biological terms	7
• Demonstrates a sound knowledge of infectious and non-infectious disease, including reference to criteria for classification of disease • Supports the classification of AD with some reference to information and data provided • Provides a suitable judgement • Communicates effectively using biological terms	5–6
• Demonstrates some knowledge of the infectious and/or non-infectious disease • Relates data to classification of AD	3–4
• Provides information about infectious or non-infectious disease and AD data OR • Relates data to classification of AD OR • Provides information about infectious and non-infectious disease	2
• Provides some relevant information	1

Sample answer:

Infectious diseases are caused by pathogens that can be passed from one person to another. A pathogen is established as a cause of disease using a rigorous set of criteria known as Koch's postulates.

The data from the study provides evidence for an association between untreated viral (HSV) infection and the increased risk of development of dementia. The data also shows that treating HSV patients with antiviral medication results in a much lower risk of dementia over the following years. This provides some evidence that the disease may be infectious – a result of infection with the virus *Herpes simplex*. A strength of the study was the large number of patients, the length of time of the study and the way the control group was matched to the HSV group. These factors add validity to the findings.

However, this does not prove that HSV actually causes dementia, as Koch's postulates would need to be fulfilled. Additionally the historical study obtained results about dementia, and not all of the dementia cases would have been Alzheimer's disease (although AD is the commonest cause of dementia). This reduces the validity of the findings in terms of establishing HSV as a cause of AD.

Non-infectious diseases do not spread from person to person and are not caused by pathogens. They are caused by other factors such as environmental factors or inherited genes.

AD is the result of the build up of amyloid protein. Protein synthesis is regulated by genes, suggesting the disease is non-infectious. The data about the APOE gene indicates that the presence of certain alleles, such as APOE-e4, result in a large increase in the risk of developing AD. It also appears that the presence of APOE-e2 allele reduces the risk of AD. This provides evidence for an inherited genetic basis for developing the disease, meaning that it could be classified as non-infectious. However, the development of AD may also be influenced by other genes and factors such as pathogens.

From the information provided it is not possible to classify Alzheimer's disease as infectious or non-infectious as there appears to be evidence that the risk of developing it is influenced by both a viral pathogen and genes.

Mod 8 – Question 10 (6 marks)

Glucose is a chemical that must be maintained at concentrations between 70 to 130 mg/dL in the blood in order for the body to function normally.

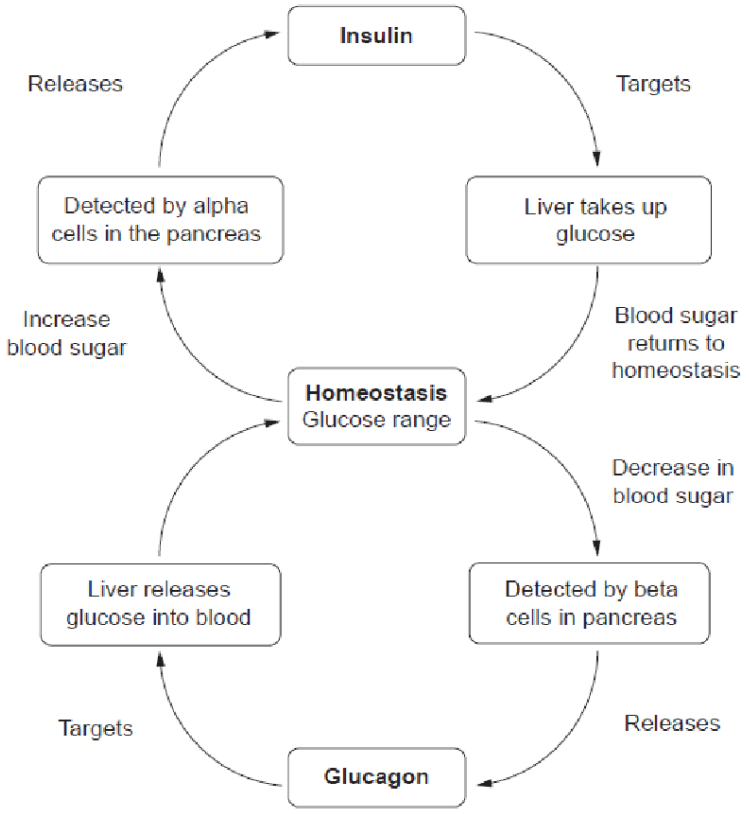
(a) Draw a diagram that illustrates how the body maintains blood glucose within this range. **3**

(b) Sketch a graph on the axes provided showing the expected blood glucose levels of both a healthy person and a diabetic person after consuming a fruit juice. On the same graph, show what would happen when the diabetic person injects themself with insulin 20 minutes after consuming the fruit juice. **3**

Marking guidelines (a):

Criteria	Marks
• Provides all relevant components ie pancreas, liver, relevant hormones • Draws appropriate sequence in feedback for both high and low blood sugar	3
• Draws relevant sequence of feedback for either high or low blood sugar OR • Draws a feedback system of both high and low blood sugar with missing components	2
• Provides some relevant information	1

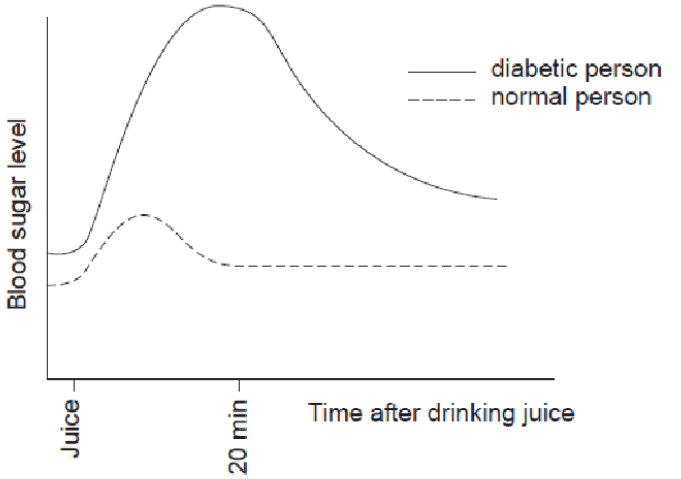
Sample answer:



Marking guidelines (b):

Criteria	Marks
• Provides correctly labelled axes and key • Draws representation of diabetic person with rapidly increasing blood glucose that decreases only after 20 minutes when insulin is taken • Draws representation of normal person with relatively low increase in blood glucose with decrease beginning before 20 minutes have elapsed	3
• Provides correctly labelled axes and key • Draws representation of diabetic person with rapidly increasing blood glucose in comparison to normal person	2
• Provides some relevant information	1

Sample answer:



Mod 8 – Question 11 (5 marks)

A scientist performed an epidemiological study to investigate the cause and effect relationship of smoking and lung cancer as follows. **5**

1. Handed out a scientifically valid questionnaire to all colleagues (n = 144) at work
2. Checked that there were an equal number of male and female respondents
3. Discovered that there were more non-smoking respondents than smoking respondents. Removed some of the non-smokers until both groups had equal numbers
4. Checked that all the respondents had a medical check-up in the past year
5. Analysed data, wrote the paper and published it in a scientific blog

From the information provided, assess the suitability of the methodology for this investigation.

Marking guidelines:

Criteria	Marks
• Makes an informed judgement of the suitability of the methodology • Outlines strengths and/or weaknesses in each part of the study	5
• Makes a judgement of the suitability of the methodology • Outlines strengths and/or weaknesses in some parts of the study	4
• Identifies strengths and/or weaknesses of the methodology • Outlines at least one strength or weakness	3
• Identifies strengths and/or weaknesses of the methodology OR • Outlines a weakness or a strength of the method	2
• Provides some relevant information	1

Sample answer:

The design of this study cannot validly lead to a link between disease and its likely causes. A valid questionnaire is good but the number of subjects is low and only confined to the workplace. The sample should be larger and broader. Ideally, the study should have a variety of equal categories, eg age, ethnicity, not just males: females equal. Participants should not be eliminated on the basis of their answers as this reduces the scientific validity. Any checks should be consistent, with a definite purpose related to the study, eg lungs checked. The final data should be peer reviewed for publication.

Mod 8 – Question 12 (3 marks)

Polio is a potentially life-threatening disease that can leave people permanently disabled. The poster shown is an example of an educational program that targets polio. **3**

Explain the benefits of such campaigns to the broader society.

Marking guidelines:

Criteria	Marks
• Explains benefits of such campaigns	3
• Explains a benefit of such campaigns OR • Outlines benefits of such campaigns	2
• Provides some relevant information	1

Sample answer:

Education programs designed to control and prevent the spread of a debilitating disease like polio have significant benefits to the broader society as they provide people with the education and information they need to help them to not contract polio in the first place. Because of this the government can save considerable amounts of money as education campaigns are typically much cheaper to run than supplying treatment and medical assistance to people ill with polio. Another benefit of education campaigns that prevent polio is that even after people are no longer sick with polio they can be left with significant disabilities that make it very difficult for them to work and as such they have a limited capacity to contribute to the economy and instead are often reliant on government assistance.

Mod 8 – Question 13 (6 marks)

(a) Identify a disorder or disease, and describe how it affects the normal function of an organ. **2**

(b) Evaluate the effectiveness of a technology in managing the disorder or disease described in part (a). **4**

Marking guidelines:

Criteria	Marks
• Identifies a disorder or disease and describes how it affects the normal function of an organ	2
• Provides some relevant information	1

Sample answer:

Polycystic kidney disease is a disease in which fluid-filled cysts grow in the kidney, interfering with the normal kidney tissue and limiting the kidney's ability to filter the blood. The number of cysts builds up over time, enlarging the kidney and reducing function. The disease is typically genetic in nature.

Marking guidelines (b):

Criteria	Marks
• Describes the circumstances in which an appropriate technology would be used • Describes how the technology functions to fulfil the normal function of the damaged organ • Outlines the benefits and limitations of the technology • Makes an informed judgement about the effectiveness of the technology	4
• Outlines the circumstances in which an appropriate technology would be used • Outlines how the technology functions to fulfil the normal function of the damaged organ • Identifies the benefits and limitations of the technology	3
• Outlines an appropriate technology • Identifies benefits and/or limitations of the technology	2
• Provides some relevant information	1

Sample answer:

People with polycystic kidney disease will typically progress to a point where kidney failure has occurred, at which point dialysis is required or the patient will die unless given a transplant. Dialysis technology works by taking over the normal function of the kidney, cleaning the patient's blood. There are two types of dialysis: haemodialysis and peritoneal dialysis. Haemodialysis is where the blood is removed from the patient and passed through the dialysis machine which uses osmosis to remove excess fluid, salts and toxins from the blood. This form of dialysis needs to be done 3 to 4 times a week and can take up to 4 hours. Patients typically need to go to a dialysis clinic for these treatments. Peritoneal dialysis in contrast uses the fluid in the peritoneal cavity and the systems of blood vessels lining the cavity to clean the blood. This is done by exchanging the fluid in the peritoneal cavity. Clean fluid is transferred into the peritoneal cavity and osmosis causes the excess salts and toxins to move from the blood into the fluid in the cavity. This fluid is then drained. This type of dialysis requires initial surgery to place the required catheter but has the benefit that the patient can manage the process themself in many instances.

Either form of dialysis is exceptionally effective, allowing people to live until such times as a kidney transplant becomes available. Without such technology people with kidney failure resulting from polycystic kidney disease would not survive beyond a week or so. As such, despite the inconvenience of having to visit haemodialysis clinics or manage peritoneal dialysis, this is a life-saving technology.

Mod 8 – Question 14 (7 marks)

Evaluate the effectiveness of renal dialysis in managing the loss of kidney function. 7

Marking guidelines:

Criteria	Marks
• Provides a clear and accurate description of the processes used by the kidney and in renal dialysis, using scientific terminology • Makes an informed judgement about the effectiveness of renal dialysis	7
• Provides a description of the processes used by both the kidney and in renal dialysis, using scientific terminology • Makes a judgement about the effectiveness of renal dialysis	6
• Provides an outline of some of the processes used by the kidney and in renal dialysis • Provides an advantage and a disadvantage of renal analysis	5
• Provides an outline of a process used by the kidney and/or in renal dialysis • Provides an advantage and/or a disadvantage of renal analysis	3–4
• Identifies a process used by the kidney and/or in renal dialysis OR • Identifies an advantage and/or a disadvantage of renal analysis	2
• Provides some relevant information	1

Answers could include:

Describes normal kidney function concerning:
- filtration
- selective reabsorption
- secretion
- hormonal control and feedback.

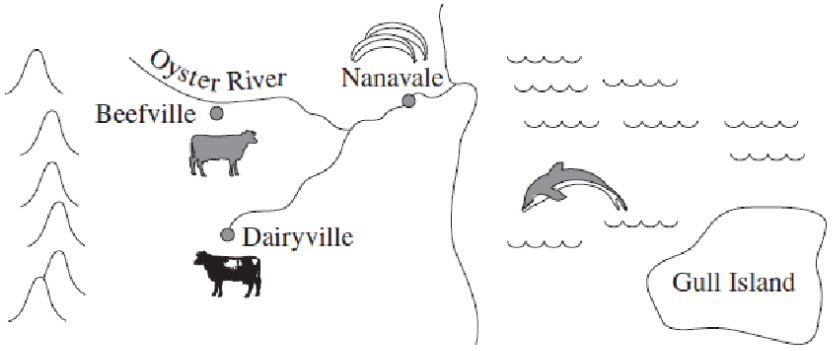
Describes renal dialysis with regard to need for:
- dialysis tubing
- countercurrent flow
- dialysis fluid.

Describes advantages and limitations of each process.

Makes a final judgement.

Mod 8 – Question 15 (7 marks)

The diagram shows a rural coastal area and the towns, rivers and associated 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.

Question 25

Criteria	Marks
• Shows thorough understanding of designing an investigation that takes into account validity and reliability • Shows thorough understanding of how an epidemiological study can be carried out in this scenario to investigate the origin of the disease • 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 • Shows sound understanding of how an epidemiological study can be carried out in this scenario • 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 • Shows some understanding of analysing patterns of non-infectious diseases, gathering data and/or analysing results in this investigation • 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.

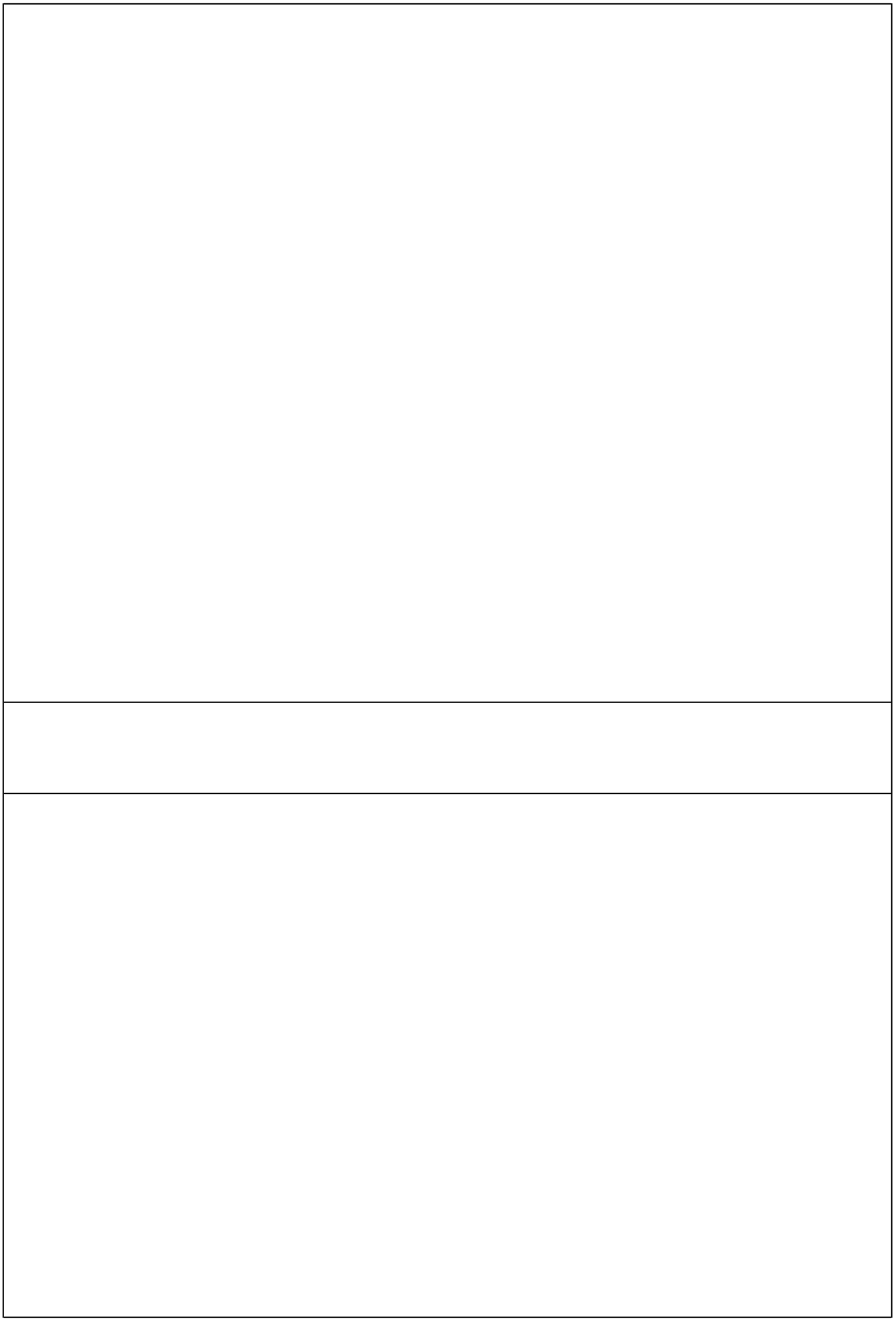
If we find common features, we would then interview a number of unaffected families to see whether they had been to the same places or done the same things but not been affected. This

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.

INQUIRY QUESTION/Content statement	
HYPOTHESIS	
AIM	
EQUIPMENT	**DIAGRAM**
Experimental design Independent variable Dependent variable Controlled variable	
PROCEDURE	
Risk Assessment	



RESULTS (tables, graphs, observation in sentences)

Validity and reliability

DISCUSSION AND CONCLUSION

Explain your results, relate to collection of evidences to answer the inquiry question, hypothesis and aim.

Glossary of verbs – NESA

Analyse
Identify components and the relationship between them; draw out and relate implications

Apply
Use, utilise, employ in a particular situation

Appreciate
Make a judgement about the value of

Assess
Make a judgement of value, quality, outcomes, results or size

Calculate
Ascertain/determine from given facts, figures or information

Clarify
Make clear or plain

Classify
Arrange or include in classes/categories

Compare
Show how things are similar or different

Construct
Make; build; put together items or arguments

Contrast
Show how things are different or opposite

Critically (analyse/evaluate)
Add a degree or level of accuracy depth, knowledge and understanding, logic, questioning, reflection and quality to (analyse/evaluate)

Deduce
Draw conclusions

Define
State meaning and identify essential qualities

Demonstrate
Show by example

Describe
Provide characteristics and features

Discuss
Identify issues and provide points for and/or against

Distinguish
Recognise or note/indicate as being distinct or different from; to note differences between

Evaluate
Make a judgement based on criteria; determine the value of

Examine
Inquire into

Explain
Relate cause and effect; make the relationships between things evident; provide why and/or how

Extract
Choose relevant and/or appropriate details

Extrapolate
Infer from what is known

Identify
Recognise and name

Interpret
Draw meaning from

Investigate
Plan, inquire into and draw conclusions about

Justify
Support an argument or conclusion

Outline
Sketch in general terms; indicate the main features of

Predict
Suggest what may happen based on available information

Propose
Put forward (for example a point of view, idea, argument, suggestion) for consideration or action

Recall
Present remembered ideas, facts or experiences

Recommend
Provide reasons in favour

Recount
Retell a series of events

Summarise
Express, concisely, the relevant details

Synthesise
Putting together various elements to make a whole